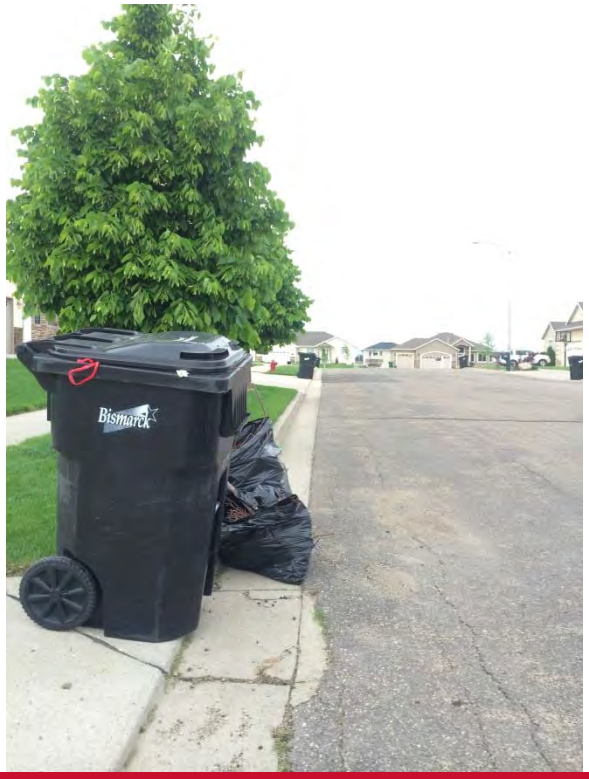

Final Report

Collection System Evaluation

City of Bismarck Solid Waste Utility

Bismarck, North Dakota
July 13, 2016

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1 Executive Summary

The City of Bismarck (City) contracted with HDR Engineering, Inc. (HDR) to provide: 1) an assessment and review of the current garbage collection system; 2) an evaluation of utility modification; and 3) recommendations for modifications to the collections utility. Collectively these tasks are known as the "Collection System Evaluation and Report" (Project). The goal of this Project is to provide the City with the tools, feasibility costs, and implementation recommendations to successfully meet the needs of the citizens of Bismarck while planning for the future.

The following is a summary of the key recommendations for the Project:

Key Recommendations	Justifications
Adopt a Volumetric Residential rate structure for residential collection. • Residential curbside should utilize automated collection and multiple cart sizes with additional waste in pre-sold bags. • Residential alley could be completed with semi-automated collection and multiple cart sizes with additional waste in pre-sold bags.	Automated vehicles and a policy of all waste placed in the cart or pre-sold bags will result in lower total operational costs. A Volumetric Rate structure will incentivize recycling and more equitably distribute the cost of garbage collection and disposal, based on use of the system. Volume of waste may be reduced when garbage is required to be placed in cart with occasional excess in specially marked pre-sold bags.
Provide seasonal residential curbside and residential alley yard debris pick-up, and cease operating a majority of the seasonal grass clipping drop sites. • Residential curbside Collection should utilize fully automated collection with a City-provided wheeled cart. • Residential alley Collection should utilize semi-automated collection and multiple cart sizes (City-provided).	The operational analysis concluded that the estimated cost of providing seasonal residential yard debris collection could be offset by closing a majority of the seasonal grass collection sites.

Key Recommendations	Justifications
Continue the twice yearly cleanup weeks and expand the policy to allow additional residential waste during portions of the year.	Providing cleanup weeks, at least twice a year, is a practice followed by the majority of communities in the region. Additional services or utility features include: • Scheduled bulk waste collection for a reasonable fee; • Residential holiday collection allowing excess garbage to be set out without use of pre-sold bags during Thanksgiving until New Years and; • Landfill Disposal Vouchers allowing passenger vehicle sized loads to be disposed at the landfill without the typical tipping fee.
Rebalance collection routes by customer service type and adopt residential garbage collection zones that result in residential collection occurring in a four-day per week schedule, rather than five days per week.	The current routes are based on vehicle type resulting in some routes finishing earlier in the day, and nearly all are returning to the landfill under capacity. A four-day per week schedule will meet the needs of the City and allow collection for the entire service area during weeks with holidays. The proposed collection routes allow for growth in the system, while still maintaining an overall balanced system. This results in trucks being able to complete their route independently, and in approximately the same time.
Perform a detailed evaluation and optimization of dumpster service.	The Project GIS documents the location, size, frequency of collection and type of collection for the dumpsters deployed as of July 2015. However, the route observations indicated a discrepancy in the number of pickups between the accounting records and observations. The current routes indicate the collection of residential alley garbage and dumpsters along an individual route. Analysis of the routes and collection tonnages based on the route observations performed as part of this study indicate that the dumpster collection may have room for optimization including size, frequency of collection and monthly fee.

Key Recommendations	Justifications
When converting to new collection technology, adopt a spare ratio policy for collection vehicles of 35%.	An industry accepted standard is a 35% spare ratio for automated collection vehicles and 25% for manual collection vehicles. Currently the City fleet is exceeding a 50% spare ratio for portions of the fleet. The City's current high spare ratio is a function of the residential holiday collection requiring double the fleet.
Track customers by service type: Residential Curbside, Residential Alley, Apartment Dumpsters, and Yard Debris.	As the utility grows, individual customer classes will utilize different collection technology and routing. Tracking data by customer class allows for future cost of service analysis and rate adjustments to spread the costs equitably among the customer classes.
Prior to purchasing new dedicated alley collection vehicles, perform a feasibility analysis for converting to automated side loaders.	This final report concludes that it is highly probably that 90% of alley users can be converted to automated side loaders.
Maintain and update the GIS database provided with this final report, at a minimum, on an annual basis. Adopt the rebalanced curbside garbage collection routes.	Asset management of dumpsters and customer account types were difficult to determine based on current customer data. The Project GIS database provided contains customer pick-up locations based on a combination of the City's GIS, collection truck wheel paths and accounting and billings data.

Execution of the Project consisted of gathering background data and information and the completion of a series of technical memoranda documenting the findings of specific portions of the utility. This final report summarizes the findings of the previous technical memoranda and presents new and revised information as a result of additional study completed after the delivery of the technical memoranda.

Section 3 includes evaluation of the existing utility operations with the intent of producing a baseline to allow comparison of the City's current program to other similar municipal operations, as well as identifying potential modifications to the City's current program. Included in this evaluation was a review of data and information provided by the City, observations of the existing collection routes, development of a baseline operational model and a benchmarking comparison to regional communities.

Section 4 documents an evaluation of potential utility modifications. Based on discussions with City staff, the City and HDR identified the following potential modifications to be evaluated 1) Variable Rate Cart structure for both curbside and alley customers; 2) Variable Rate Cart and Bag structure for both curbside and alley customers; and 3) Residential curbside and alley grass clipping collection. Also included in Section 4 is operational modeling evaluating the feasibility of providing residential

collection service based on a four day work week compared to the current five day work week.

Section 5 presents an analysis and recommendations for optimization of the residential collection routes and boundaries.

Section 6 is a comprehensive summary of the Project's findings and recommendations.

2 Introduction and Purpose

The City of Bismarck (City) contracted with HDR Engineering, Inc. (HDR) to provide: 1) an assessment and review of the current garbage collection system; 2) an evaluation of utility modification; and 3) recommendations for modifications to the collections utility. Collectively these tasks are known as the "Collection System Evaluation and Report" (Project). The goal of this Project is to provide the City with the tools, feasibility costs, and implementation recommendations to successfully meet the needs of the citizens of Bismarck while planning for the future.

In general, the Project provided an evaluation the City's existing municipal solid waste (garbage) collection system, benchmarked the City against other similar communities, performed a sensitivity analysis of potential changes to collection services and ultimately decided on recommendations for modifications to the collection utility in order to increase collection efficiency. This final report is intended to provide a planning tool for the future expansion of the residential collection system. This Project was completed with input from the City and review of previously completed technical memoranda (TM). The following TMs have been previously completed, and are included as appendices to this final report:

- TM 300 – Evaluation of Current Collection Operations & Identification of Potential System Modifications (Appendix B);
- TM 401 – Evaluation of Potential System Modifications (Appendix C);
- TM 402 – Recommended Residential Collection Boundaries (Appendix D); and
- TM 403 – Recommended Residential Collection Routes (Appendix E).

The following sections summarize the previously completed TMs and supplement the findings with comments and additional information and study identified during review with the City staff.

3 Evaluation of Existing Utility Operations

The Project included an evaluation of the existing utility operations with the intent of producing a baseline to allow comparison of the City's current program to other similar municipal operations, as well as identify potential modifications to the City's current program. The main components of this evaluation included:

- Reviewing data and information provided by the City;
- Establishing a baseline of the current collection system, including route observations;
- Conducting a benchmarking analysis;
- Identifying potential modifications for further evaluation; and
- Preparing a summary memorandum and reviewing with City Staff.

During the Project, TM 300 was prepared and reviewed with City staff. The TM presented the preliminary findings and recommendations for further evaluation of potential modifications to the current residential garbage collection system. The following

sections summarize the major components of TM 300. For reference, TM 300 is included as Appendix B to this report.

3.1 Current System Overview

The Service Operations Division of the Public Works Department for the City is responsible for providing garbage collection to all residential customers in the incorporated area. This includes a combination of curbside collection, alley collection, and collection from apartment complexes using dumpsters.

Residential Curbside Collection - The City provides once a week curbside collection service utilizing 96-gallon carts to approximately 17,270 single-family households. Collection crews are made up of one driver and one collector operating a multi-pack collection vehicle with both an automated side-loading arm and rear-load capabilities (referred to as semi-automated in this report).

Residential Alley Collection - Once a week alley collection is provided to approximately 1,912 households in the City. Alley customers can set out an unlimited number of containers of up to 35-gallons in size. Alley collection is accomplished using rear-load collection vehicles and crews of one driver and two collectors per vehicle.

Apartment Collection - Collection of waste from apartments is accomplished using a combination of front-load and rear-load collection vehicles to collect from approximately 783 dumpsters. Collection of apartment dumpsters occur street side, in parking lot areas, or in alleys, depending on the specific needs and configuration of individual properties.

TM 300 & TM 401 previously estimated residential collection consisted of 15,423 curbside and 3,270 alley households. The estimates used in TM 300 were the best available data from the City accounting and operational sources at the time that the work operational modeling was conducted. The number of households stated in TM 300 & TM 400 represented the number of accounts, and not the number of household units. In many cases, multi-family homes each receive individual carts but share one account with the City.

The updated household numbers used in this final report reflect the number of individual garbage collection pick-ups. The number of curbside and alley households used in the final report was refined by use of the GPS tracking of the vehicle wheel paths, accounting data containing units per account, and GIS analysis of the available data. Exhibit 1 Residential Collection Locations attached to this final report provides a graphical location of the residential households serviced by the City collection utility.

The City of Bismarck does not provide commercial collection or roll-off containers for construction and demolition debris. Commercial users, mobile home parks, and temporary roll-off container users are serviced by private haulers.

In order to evaluate the efficiency and effectiveness of the current residential collection system and identify opportunities for improvement, HDR first needed to baseline the current system. Our approach involved reviewing data provided by the City. The City provided data including costs and other details relating to labor and equipment used for the residential collection services, which were used in the development of the baseline information.

The baseline development also utilized route observation data collected by City staff. HDR developed a collection route observation form, provided it to the City, and described the process that should be followed by City staff when conducting observations. Route observations were completed in June of 2015. Observations were completed over a two-week period, and included following 38 routes.

The City currently organizes its residential garbage collection routes based on truck type used to collect the materials rather than basing them on customer type served. The City's typical weekly deployment of collection vehicles is illustrated in Table 1.

Table 1 - Typical Truck Deployments, Garbage Collection

	Number of Trucks Deployed				
Truck Type	**Monday**	**Tuesday**	**Wednesday**	**Thursday**	**Friday**
Multi-Pack	3	5	5	5	5
Rear-Load Residential Alley	0	2	2	2 (1)	0
Rear-Load Dumpsters	4	0	0	0	1
Front-Load	1 (2)	1	0	1	1
Total	8	8	7	8	7

Notes:
On Thursday the two rear-loads deployed were observed to collect residential alley routes for their first load and apartment dumpsters for their second load.
On Monday, a rear-load truck finished early and switched to a front-load truck to help on one of the other routes.

With regard to total trucks, the route observations conducted were related only to garbage collection. However, the City also operates 18 yard debris collection sites around the City that consist of dumpsters that are collected seven days a week during the growing season. As noted in Table 2, the City deploys three rear-load vehicles for yard debris collection from these sites each day from May through October.

Table 2 - Typical Truck Deployments, Yard Debris (1)

	Number of Trucks Deployed						
Truck Type	**Monday**	**Tuesday**	**Wednesday**	**Thursday**	**Friday**	**Saturday**	**Sunday**
Multi-Pack	0	0	0	0	0	0	0
Rear-Load	3	3	3	3	3	3	3
Front-Load	0	0	0	0	0	0	0
Total	3	3	3	3	3	3	3

Notes:
(1) May through October only.

Table 3 provides an overview of the City's collection fleet including the total number of collection vehicles by type, the maximum number of each type that is deployed for collection efforts on a given day, the number of spare vehicles, and spare ratios of each type the City has on hand.

Table 3 - Collection Fleet Summary

Truck Type	Total Fleet	Max Deployed	Spare	Spare Ratio
Multi-Pack	9	5	4	80%
Rear-Load	10	7	3	43%
Front-Load	2	1	1	100%

3.2 Summary of Route Observation Data

TM 300 includes an in depth discussion on the formulation of the key system metrics from the June 2015 route observations. The following tables summarize the key metrics as derived from the June 2015 route observations.

Table 4 - Key Metrics Yielded from June 2015 Route Observations (1)

	Avg. Set-Out Rate	Avg. Lbs./Set-Out	Avg. On Route Miles	Avg. Off Route Miles	Avg. On Route Time hh:mm	Avg. Off Route Time hh:mm	Avg. Turn Around Time at Facility hh:mm	Avg. Trips to Facility per Day
Residential Curbside	91%	60.2	7.7	8.7	1:53	0:48	0:19	2
Residential Alley	92%	72.1	6.8	7.5	2:20	0:45	0:22	2
Apartment Dumpsters	94% (2)	239.6	12.4	9.3	2:08	0:47	0:16	2

Notes:

(1) Miles and times are shown on a per trip basis rather than a per day basis.

(2) The average set-out rate for apartments is not shown as 100% because observations indicated instances where trucks on apartment routes passed by some dumpsters.

Table 5 - Week One Curbside Collection Metrics by Route (1) – June 2015

Route # Based on Primary Truck #	Avg. Set-Out Rate	Avg. Lbs./Set-Out	Avg. On Route Miles	Avg. Off Route Miles	Avg. On Route Time hh:mm	Avg. Off Route Time hh:mm	Avg. Turn Around Time at Facility hh:mm	Trucks Running Route
3335	89%	59.9	10.4	7.9	2:12	0:48	0:23	1
3409	90%	59.0	8.2	9.7	1:45	0:45	0:14	4
3482	89%	65.1	8.0	7.8	2:05	0:38	0:26	1
3551	92%	59.6	6.6	9.0	1:39	0:57	0:20	5
3552	84%	66.0	5.7	7.5	1:44	0:37	0:27	1
3558	92%	61.4	7.3	9.3	2:04	0:53	0:17	3
3562	95%	48.6	5.5	6.9	1:38	0:41	0:20	1

Notes:

(1) Miles and times are shown on a per trip basis rather than a per day basis.

Table 6 - Residential Alley Metrics by Route (1) – June 2015

Route # Based on Primary Truck #	Avg. Set-Out Rate	Avg. Lbs./Set-Out	Avg. On Route Miles	Avg. Off Route Miles	Avg. On Route Time hh:mm	Avg. Off Route Time hh:mm	Avg. Turn Around Time at Facility hh:mm	Trucks Running Route
3472	94%	66.0	5.0	11.1	2:20	0:46	0:08	1
3572	94%	62.7	5.3	7.4	2:01	0:44	0:15	2
3573	89%	79.9	7.8	8.1	2:14	0:31	0:26	1
3572-A (2)	98%	66.7	10.0	6.0	3:01	1:03	0:23	2
3573-A (2)	88%	72.1	6.8	4.3	2:53	1:18	0:18	1

Notes:

(1) Miles and times are shown on a per trip basis rather than a per day basis.

(2) On Thursday, trucks 3572 and 3573 drive a primary residential alley route for the first load and an apartment dumpster route for the second load.

Table 7 - Apartment Dumpster Collection Metrics by Route (1) – June 2015

Route # Based on Primary Truck #	Avg. Set-Out Rate	Avg. Lbs./Set-Out	Avg. On Route Miles	Avg. Off Route Miles	Avg. On Route Time hh:mm	Avg. Off Route Time hh:mm	Avg. Turn Around Time at Facility hh:mm	Trucks Running Route
3472-AA (2)	100%	183.2	Not Available	Not Available	2:39	1:02	0:17	1
3472-BB (2)	95%	207.1	8.0	11.5	1:39	1:16	0:25	1
3478 (rear)	100%	193.2	8.0	9.3	3:01	0:42	0:48	1
3557 (front)	99%	309.3	14.1	9.8	1:56	0:37	0:10	2
3572 (rear)	91%	231.8	16.5	8.9	2:57	0:54	0:12	1
3572-B (3)	100%	156.2	5.9	11.0	1:21	0:45	0:17	2
3573-B (3)	100%	196.5	3.8	6.7	1:08	0:18	Not Available	1

Notes:

(1) Miles and times are shown on a per trip basis rather than a per day basis.

(2) Route 3472-AA was observed on the first week with route 3472-BB observed the second week.

(3) On Thursday, trucks 3572 and 3573 drive a primary residential alley route for the first load and an apartment dumpster route for the second load.

3.3 Baseline of Current Operations

HDR endeavored to model the City's residential garbage collection operations on a customer type basis (i.e. curbside collection, alley collection, and apartment collection). However, the fact that many of the City's collection vehicles commonly pick up material from a variety of customer types on the same route made this difficult to accomplish for apartment collection. The following sections document assumptions and provide metrics used to model the curbside and residential alley collection. However, it was not possible to model the apartment collection in an informative manner. Table 8 summarizes the weekly number of pick-ups per customer class.

Table 8 - Weekly Pick-ups by Customer Class

Customer Class	Weekly Pick-ups
Residential Curbside	17,270
Residential Alley	1,912
Total	**19,182**
Dumpsters – Front Load	482
Dumpsters – Rear Load	647
Total	**1,129**

The total number of residential pick-ups, 19,182, reflects the number of individual households currently serviced by the collection utility.

The operational modeling has been updated to reflect that, for a number of accounts, there are multiple units that are collected individually. After the completion and review of TM 300 and TM 401, the number of alley customers and pick-up locations was further refined based on the additional data developed from City billing databases, GIS layers and analysis of the collection vehicle wheel paths as monitored by the GPS equipment in the trucks. The wheel track data, provided in GIS format, was used to refine the number of alley customers. The same data was also used to determine dumpster style (front or rear load) based on collection truck type.

3.3.1 Residential Curbside Collection

The City's current curbside garbage collection service is provided once a week to each household, and is comprised of three routes on Monday and five routes Tuesday through Friday, for a total of 23 routes per week. Two-person crews (one driver and one collector) use multi-pack collection vehicles to collect 96-gallon carts from each household

TM 300 summarized the key metrics for residential curbside route service, labor, operations and capital costs. These metrics were used to model the estimated annual cost for completing residential curbside garbage collection costs

Table 9 presents a summary of the estimated total annual costs for labor, operations and capital, associated with the City's residential curbside collection operations. Total annual expenses for curbside collection are estimated at approximately $1.34 million.

Table 9 – Residential Curbside Estimated Total Annual Cost

Description	Est. Cost
Total Annual Labor Cost	$699,000
Total Annual Vehicle Operating Cost	$160,000
Total Annual Operating Cost	**$ 859,000**
Total Annual Vehicle Capital Cost	$392,000
Total Annual Cart Cost	$86,000
Total Annual Capital Cost	**$478,000**
Estimated Total Annual Cost	**$1,337,000**

3.3.2 Residential Alley Collection

There are approximately 1,912 units included in alley collection. The current collection system for residential alley service includes rear-load vehicles that also collect a limited number of dumpsters (a hook is used to unload dumpsters into the rear of the vehicle).

The City's current residential alley collection service is provided once a week to each household and is comprised of two routes on Tuesday, Wednesday and Thursday for a total of six routes each week. On Wednesday, the two routes were observed to be completed by noon. Similarly, on Thursday, the two routes completed a primarily residential alley trip before collecting apartments in the afternoon. For the purposes of the existing conditions operational model, it was assumed that there is an average of two routes per day two days a week to accomplish alley collection. Three person crews (one-driver and two collectors) use rear-load collection vehicles to collect waste from user provided cans.

TM 300 summarized the key metrics for residential alley route service, labor, operations and capital costs. These metrics were used to model the estimated annual cost for completing residential curbside garbage collection costs.

Table 10 presents a summary of the estimated total annual costs for labor, operations, and capital associated with the City's residential alley collection operations. Total annual expenses for residential alley collection are estimated at approximately $566,000.

Table 10 – Residential Alley Estimated Total Annual Cost

Description	Est. Cost
Total Annual Labor Cost	$453,000
Total Annual Vehicle Operating Cost	$49,000
Total Annual Operating Cost	**$502,000**
Total Annual Vehicle Capital Cost	$64,000
Total Annual Cart Cost	$0
Total Annual Capital Cost	**$64,000**
Estimated Total Annual Cost	**$566,000**

3.3.3 Apartment Dumpster Collection

As of August 2015, the City has about 671 accounts and 783 dumpsters deployed for the collection of waste from apartments and municipal buildings. Waste is collected in City supplied dumpsters of 1, 1.5, 2, 3, 4, 6 and 8 cubic yard capacity with the option for collection one, two or three times per week. The current collection system involves using rear-load vehicles for alleys and other tight locations and a front-load vehicle that collects from locations with sufficient space for dumpster deployment and service.

Rear-load vehicles are considered a manual collection service because the dumpster must be rolled to the back of the vehicle and manually hooked to a cable wench to be dumped. Each rear-load vehicle is typically manned by one driver and two collectors. Front-load vehicles are considered an automated technology because the dumpster is collected by an automated front swing arm. Front-load vehicles are typically manned by one driver and no collectors. Table 11 indicates the number of trucks deployed primarily for dumpster collection on a weekly basis.

Exhibit 2 included in this final report shows the location of the dumpsters currently deployed and collected by the City. This exhibit was created from the GIS database developed for this Project.

Table 11 – Typical Truck Deployments, Dumpsters

Truck Type	Monday	Tuesday (1)	Wednesday (1)	Thursday (2)	Friday	Total
Rear	4	0	0	1	1	6
Front	1	1	0	1	1	4
Total	5	1	0	2	2	10

Notes:

(1) On Tuesday and Wednesday, a rear load truck was observed collecting primarily residential alley customers and occasional dumpster for all trips.

(2) On Thursday, two rear load trucks each completed one primarily alley trip and one primarily dumpster trip.

Table 12 summarizes the total number of dumpsters collected by each truck type. Over half of the dumpsters are collected more than once per week.

Table 12 - Dumpsters by Vehicle Type

	Rear Load	Front Load	Total
No. of Dumpsters	479	304	783

Additional data was collected and analyzed subsequent of the TM 401 findings. This City provided updated data including an updated database (including the number of accounts, size and number of dumpsters per account, and number of days each account was collected), a GIS layer with the approximate location of each dumpster identified in the database, and the GIS wheel paths from the actual collection trucks. Utilizing this new data, a GIS analysis was conducted to determine the vehicle type and collection day for each dumpster identified. Table 13 compares the number of dumpsters observed to be collected using the GIS layer, the June 2015 observations, and the accounting records. Table 14 summarizes the dumpster collection metrics determined from this GIS analysis.

Table 13 – Dumpster Collection Frequency

	Monday		Tuesday		Wednesday		Thursday		Friday		Grand Total		
	Front	Rear	Front	Rear	Front	Rear	Front	Rear	Front	Rear	Front	Rear	
GIS Estimate	179	460	117	17	0	26	91	108	95	36	482	647	1,129
Observations	148	467	135	4	0	17	84	130	93	38	460	656	1,116
Accounting (1)	-	-	-	-	-	-	-	-	-	-	-	-	1,083

Notes:

(1) City accounting files do not contain the collection day for each dumpster.

Table 13 indicates a narrow margin of error between the GIS analysis and the route observations. Additionally, both methods indicate more frequent pickups than the accounting records.

Table 14 – Dumpster Service Metrics

	Front Load				Rear Load			
	# of Dumpsters Picked Up (GIS) (1)	Total Dumpster Capacity (CY) (2)	Total Lbs. Collected (3)	Lbs/CY (4)	# of Dumpsters Picked Up (GIS) (1)	# of Dumpsters Picked Up (GIS) (2)	Total Lbs. Collected (3)	Lbs/CY (4)
Monday	179	895.5	46,920	52.4	460	1,000.5	89,240	89.2
Tuesday	117	431.5	40,620	94.1	17	53.5	841	15.7
Wednesday	-	-	-	-	26	104.0	3,576	34.4
Thursday	91	450.0	23,680	52.6	108	289.5	19,328	66.8
Friday	95	502.5	28,840	57.4	36	142	7,740	54.5
∑	482	2,279.5	140,060	61.4	647	1,589.5	120,725	52.1

Notes:

(1) The Number of Dumpsters Picked Up was determined using the City's GIS layer combined with the wheel paths of the trucks. This metric has a narrow margin of error compared to the June Observations.

(2) The Total Dumpster Capacity was determined by summing the dumpster sizes, as reported in the City's GIS layer, for all dumpsters collected that day.

(3) Total Lbs. Collected is the reported pounds collected during the June Observations.

(4) Lbs./CY is calculated by dividing the Total Lbs. Collected by the Total Dumpster Capacity (CY)

The average size of a front-load dumpster is 4.7 cubic yards and the average size of a rear-load dumpster is 2.5 cubic yards.

Using the reported tons collected during the observations, the average pounds per cubic yard of waste collected by a front-loader is 61.4 and for rear-loaders is 52.1. Both of these values are well below the expected 150 lbs/cy of waste in a dumpster. This indicates the potential to collect dumpsters less frequently or scale dumpsters to a smaller size. Additionally, the data indicates capacity to add dumpsters to the routes. It is recommended that going forward, front-load dumpsters are deployed over rear-load, where possible.

3.4 Benchmarking

HDR performed a preliminary search for regional cities with comparable systems in order to benchmark specific operations and financial metrics. The preliminary search included considering population, housing density, service provider, collection style and frequency of service. A preliminary list of communities, as well as a list of questions/metrics, was developed and discussed with the City prior to contacting the benchmarking communities.

Based on the goals for this Project, the benchmarking was focused on determining the major collection metrics of similar sized communities using semi-automated and fully automated methods for residential collection, and the total cost of collection service in these communities. With regard to the major collection metrics, the survey focused on the number of residential customers, total weekly collection routes and availability of curbside recycling, yard debris collection and bulk waste disposal. Financial metrics were focused on a break-down of the monthly collection fee charged to residential customers to determine the level of service included and the estimated costs.

The preliminary list included approximately 15 communities in an effort to receive responses from a minimum of six. Any communities that utilize private or contract collection services for residential garbage collection were not included in the benchmarking metrics. Communities with privatized collection that are similarly sized to Bismarck included: Sioux Falls, SD; Vermillion, SD; Rochester, MN; Maple Grove, MN; and Duluth, MN. Benchmarking information was obtained from eight regional communities with varying degrees of completeness and detail. The complete benchmarking matrix is available as an attachment to TM 300.

Of the communities contacted, Bismarck is unique in using multi-pack vehicles for residential, automated cart collection service. For the purposes of this benchmarking analysis, Bismarck's collection that utilizes multi-pack trucks is considered semi-automated.

As shown in Table 15 below, the preferred frequency for residential garbage collection is one time per week. This is largely due to the regional adoption of collection technology utilizing fully automated or semi-automated collection with carts. Similarly the majority of the communities with automated collection services have a volumetric based fee structure, meaning that there are multiple cart sizes available for a range of monthly fees.

Fully automated operations are able to maximize productivity as compared to semi-automated systems. However, fully automated options may not meet the needs of all communities. It is common for municipalities to incorporate a blend of fully automated and semi-automated operations to address specific service requirements unique to their community. For example, it is not uncommon for residential curbside collection to be fully automated and residential alley collection to consist of semi-automated or manual service. It should be noted that the success of any collection system rests on the establishment of a comprehensive "Code of Ordinances" that can be fairly and uniformly enforced to maximize efficiencies and adherence to the designed service.

Table 15 – Benchmarking Overview

Community	Number of Households (1)	Style of Collection	Frequency of Collection	# of Routes per Week	Fee Type
Bismarck, ND	19,182 (2)	Manual & Semi-Automated (5)	1 x week	23 Multi-Pack 8 - Manual	Fixed
Fargo, ND	26,000 (3)	Automated	1 x week	30	Volumetric
Grand Forks, ND	22,000 (3)	Automated & Semi-Automated (6)	1 x week	20	Volumetric
Minot, ND	11,.500	Manual	2 x week	25	Fixed
Mankato, MN	10,000	Automated	1 x week	15	Volumetric
Moorhead, MN	11,000	Automated	1 x week		Volumetric
Fergus Fall, MN	4,400	Automated	1 x week	10	Volumetric
Aberdeen, SD	8,000	Manual	1 x week	16	Fixed
Billings, MT	34,000 (4)	Automated	1 x week	28	Fixed

Notes:
Residential accounts

(1) 17,270 curbside customers and 1,912 alley customers
(2) Includes alley accounts collected via automated service
(3) 17,000 90-gal containers and 8,500 300-gallon containers collected using the same vehicles
(4) Semi-automated is side-load with rear compactors (multi-pack trucks)
(5) Semi-automated is front-load with automated tippers

3.4.1 Residential Manual Collection Comparison

Table 16 summarizes the benchmarking communities that perform manual residential collection. The City of Bismarck is included in the table for comparison.

The number of routes required is impacted by a number of variables including set-out rates (the percent of homes that set-out garbage for collection in a given week), average pounds per set out (how much garbage is set out at each home), set-out restrictions (limits on the amount, size, or manner in which garbage can be placed out for collection), the level of enforcement of set-out restrictions, route timing, and staff configuration.

Bismarck's residential collection service is a mixture of manual collection from alley customers and semi-automated collection from curbside customers. The increased efficiency of the semi-automated curbside collection is reflected in Bismarck's collection service showing a higher average number households served per route compared to the communities with manual collection.

Based on conversations with the Minot and Aberdeen collections staff, it was determined that neither community had detailed formal metrics for set-out rates or timing of routes. Both communities compared well to Bismarck as each provides residential collection in both newer areas via curbside collection and via alleys in older portions of the community. It should be noted that Minot collects each account twice per week and based on anecdotal observations by the Minot staff, the set-out rate is not consistent for each collection day. It is common for curbside set-outs to drop below 50% on the second collection day in communities that offer twice per week collection.

Table 16 - Residential Manual Collection Service Metrics

Metric	Bismarck	Minot	Aberdeen
Housing Density (Units/mi2)	544	659	512
Avg. Households/Route	671 (semi-auto)	575	400
Set-Out Limits	Limited (1)	32 gal containers	In container (2)
Work Week	5 days	4 days	4 days
Hours per Day	8	8	8
Bulk Waste Curbside	Yes	Yes	No
Recycling Curbside	Yes - Contract	No	Yes – Contract
Yard Debris Curbside	No	No	No
Enforcement	Drivers	Drivers	Drivers
Monthly Fee	$12.31 (96 Gal) $3.81 (Recycle) $16.12 Total	$10.18	$13.50

Notes:

1) Set-out quantity is limited to truck lifting capability and capacity.

(1) Must be contained within the selected size container.

3.4.2 Residential Automated Collection Comparison

Table 17 below summarizes the benchmarking communities that perform automated or semi-automated residential collection. The City of Bismarck is included in the table for comparison purposes even though the collection system is not considered fully automated for the purposes of this analysis.

The number of routes required is impacted by a number of variables including set-out rates (the percent of homes that set out garbage for collection in a given week), average pounds per set out (how much garbage is set out, on average, at each home), set out restrictions (limit on the amount, size, or manner in which garbage can be placed out for collection), the level of enforcement of set out restrictions, route timing and staff configuration.

The majority of the surveyed automated collection service communities have a higher average number of homes serviced per route when compared to Bismarck. For example, based on the survey, Billings, Fargo and Grand Forks have developed collection routes for curbside residential, alleys and multifamily that is nearly fully automated. This is reflected in the number of accounts that an average route can service each day. Each of these communities has a volumetric collection fee structure that forces the users to limit refuse collection to dedicated containers or specially marked, pre-purchased bags.

The communities surveyed did not have formal set-out rates or time metrics for their collection systems. All reported that observed set-out rates were over 90%. Based on the published data and conversations with the collection staff of each community, Billings, Fargo and Grand Forks have similar solid waste systems to the City of Bismarck as each community provides collection services and owns the landfill where the waste is disposed. The Minnesota communities only operated a collection system and disposal occurs at a private landfill or transfer station.

It was anticipated, based on these benchmarking results, that the City of Bismarck could realize similar average households per route as Fargo, Grand Forks and Billings by implementing fully automated residential curbside collection and refined semi-automated alley collection.

Table 17 – Residential Automated Service Metrics

Metric	Bismarck	Fargo	Grand Forks	Mankato	Fergus Falls	Moorhead	Billings
Housing Density (Units/mi2)	544	532	1,095	547	286	555	585
Avg. Households/Route	671	866	1,100	666	440	No Response	910
Set-Out Limits - Garbage	Limited (1)	Must be in container (2)	Must be in container (2)	Must be in container or pre-purchased bag (2)	Must be in container (2)	Must be in container or pre-purchased bag (2)	Must be in container (2)
Work Week	5 days	5 days	5 days	5 days	5 days	5 days	4 days
Hours per Day	8	8	8	8	8	8	10
Bulk Waste Curbside	Yes	Fee	Fee	Fee	Fee	Fee	Yes
Recycling Curbside	Yes - Contract	Yes	Yes - Contract	Yes - Contract	Yes - Contract	Yes	No
Yard Debris Curbside	No	No	Yes	Yes	No	Yes	Yes
Enforcement	Drivers	Drivers/Admin	Drivers/Admin	Drivers/Admin	Drivers/Admin	Drivers/Admin	Drivers/Admin
Monthly Fee	$12.31 (96 Gal) $3.81 (Recycle) $16.12 Total	$6 (48 Gal) $9 (64 Gal) $14 (96 Gal)	$15.82 per 60 Gal Container	$11 (35 Gal) $16 (65-Gal) $25 (95 Gal)	$16 (65-Gal) $25 (95 Gal)	$11 (35 Gal) $16 (65-Gal) $25 (95 Gal)	$8.98

Notes:

1) Set-out quantity is limited to truck lifting capability and capacity.
2) Must be contained within the provided, selected size (if available) container.

3.4.3 Residential Automated Collection Comparison

Table 18 summarizes the monthly residential collection fee for each community surveyed. The table summarizes the total fee charged to the residential user class, indicates which services are provided, and summarizes if the cost of service for collection and disposal is being covered by the fee collected. Many of the communities surveyed that performed both collections and operated a landfill indicated that the residential collection cost of service was subsidized by the commercial tipping fee from the landfill or the general fund.

Table 18 – Monthly Fee Summary

Community	Monthly Fee (1)	Fee Type	Services Included (2)	Costs Included (3)	Notes
Bismarck, ND (7)	$16.12	Fixed	G, R, B	G, R, B, D	(5)
Fargo, ND (7)	$14	Volumetric	G, R	G, R	(5)
Grand Forks, ND (7)	$15.82	Volumetric	G, R, Y	G, R, Y	(5)
Minot, ND (7)	$10.18	Fixed	G	G, D	(6)
Mankato, MN (8)	$25	Volumetric	G, R, Y	G, R, Y, D	(4)
Moorhead, MN (8)	$25	Volumetric	G, R, Y	G, R, Y, D	(4)
Fergus Fall, MN (8)	$25	Volumetric	G, R	G, R, Y, D	(4)
Aberdeen, SD (8)	$13.50	Fixed	G, R, B	1 x week	(4)
Billings, MT (7)	$8.98	Volumetric	G, R, B	G, R, B, D	(6)

Notes

(1) For volumetric fee structures, this is the largest container fee.
(2) Curbside services: G=Garbage, R=Recycling, Y=Yard Debris, B=Bulk Waste.
(3) Costs of service: G=Garbage, R=Recycling, Y=Yard Debris, B=Bulk Waste, D=Disposal.
(4) Fee covers cost of service for collections and disposal.
(5) Fee covers cost of service for collections; Disposal costs are covered by other income.
(6) Fee does not cover full cost of service for collection and disposal.
(7) Municipality owns and operates a municipal solid waste landfill.
(8) Municipality hauls waste for disposal at a third part municipal solid waste landfill.

4 Evaluation of Utility Modifications

After determination of the “short-listed” scenarios for further evaluation, HDR prepared TM 401 for the purpose of documenting the identified scenarios in comparison of the existing conditions baseline model. Based on discussions with City staff, the City and HDR identified the following potential modifications to be evaluated:

- Variable Rate Cart structure for both curbside and alley customers;
- Variable Rate Cart and Bag structure for both curbside and alley customers; and
- Residential curbside and alley grass clipping collection.

For each of the alternative scenarios identified, HDR evaluated the scenarios based on the following set of criteria, compared to the current case:

- Estimated route metric impacts;
- Estimated labor cost impacts;
- Estimated operating and maintenance cost impacts; and
- Estimated capital cost impacts.

Detailed discussions and analysis are included in TM 401 in Appendix C. The following sections summarize the findings of the evaluation of the three scenarios for the residential curbside and residential alley customer classes.

4.1 Residential Curbside Garbage Collection

The City's current curbside garbage collection service is provided once a week to each household and is comprised of three routes on Monday and five routes Tuesday through Friday, for a total of 23 routes per week. Two-person crews (one driver and one collector) use multi-pack collection vehicles to collect 96-gallon carts from each household. While curbside customers are provided with a 96-gallon cart, set-outs are not currently limited to what is placed in the cart. Materials are required to be properly containerized, but may be placed in the cart, in bags, or in other customer provided containers of up to 35-gallons in size with lids.

Based on discussions with other communities that have implemented variable rate cart programs that include additional, specially marked and purchased, bags for out-of-cart set-outs, it has been observed that initially, there are higher numbers of additional bags set out by residents. However, over time, the number of additional bags set out for collection decreases dramatically. For example, a number of communities reported that during the initial 18-24 months of operation, a majority of customers set-out additional bags for collection. However, after this initial period, customer set-outs of additional bags reduced sharply and eventually approached zero additional bags during an average week.

For these reasons, a "Variable Rate Cart + Bag - Mature" scenario as well as a "Variable Rate Cart + Bag – Initial" scenario have been included in this analysis in order to show differences in certain metrics (though some metrics are identical) between a mature system and a recently implemented (Initial) system. Therefore, the model was designed to evaluate estimated, planning level cost and operational impacts under the following scenarios:

1. No change in services offered ("Current Case");
2. Changing to a Variable Rate Cart program collected by a fully-automated side-loader ("Variable Rate Cart"), with no allowance for out-of-cart set-outs;
3. Changing to a Variable Rate Cart program with specially marked bags for purchase by customers for out-of-cart set-outs, collected by a fully-automated side-loader, in a mature system ("Variable Rate + Bag – Mature"); and
4. Changing to a Variable Rate Cart program with specially marked bags for purchase by customers for out-of-cart set-outs, collected by a fully-automated side-loader, initially ("Variable Rate + Bag - Initial).

TM 401 included an analysis of the anticipated costs of providing changes to the residential service collection as described above continuing the process of collecting five days per week. During staff review of the findings and recommendations of TM 300, it was requested that the feasibility of providing residential curbside collection four days per week be analyzed. The following sections summarize the TM 401 analysis and an updated analysis for completing the collection four days per week.

4.1.1 Five Days per Week Collection Estimated Costs

The anticipated impact on number of vehicles and routes for the potential system modifications compared to the Current Case for curbside garbage collection service is shown in Table 19 . With each of the potential modifications, the number of vehicles/routes could be reduced to 4, from the Current Case that uses 5 vehicles.

Table 19 – Residential Curbside Alternative Scenarios – 5 Days per Week

Scenario	Vehicle Type	Number of Vehicles	Routes per Week
Current Case	Multi-Pack	5	23
Variable Rate Cart	Fully-Automated Side-Loader	4	20
Variable Rate Cart + Bag - Mature	Fully-Automated Side-Loader	4	20
Variable Rate Cart + Bag - Initial	Fully-Automated Side-Loader	4	20

Each of the proposed scenarios results in increases in the number of customers that can be served on each route. This is demonstrated in the ability to reduce the number of trucks deployed and routes per week.

Collection Technology

By switching to fully-automated side-loaders, sanitary collectors are not required.

It is expected that for the Variable Rate Cart + Bag – Mature scenario, the use of additional bags will be rare, which will allow the vehicle driver to collect the bags with minimal effect on efficiency, and no need for a collector. For the Variable Rate Cart + Bag – Initial scenario, it is assumed that one collector will be used in order to assist with collecting the extra bags, expected to be more frequent in the initial system.

Each of the three proposed scenarios will result in a decrease in the number of sanitary collectors required for the utility. Reducing the number of required sanitary collectors does not indicate the recommendation, or requirement, to downsize City staff. Any changes to the collections operations will require multiple years to fully implement and it is expected that excess staff will be relocated to other positions or handled through attrition.

Also included in the evaluation was the effect of modification on annual costs associated with vehicle operation and maintenance, and capital costs. All of the proposed scenarios include changing to fully automated vehicles from the current use of multi-pack trucks. Although the fully-automated side-loader has a higher annual maintenance and repair cost, the smaller fleet size results in an overall annual savings.

Capital costs include the purchase and distribution of new variable sized wheeled carts, purchase of new and replacement collection vehicles and other necessary large items to operate the utility. The proposed scenarios result in an estimated savings of nearly

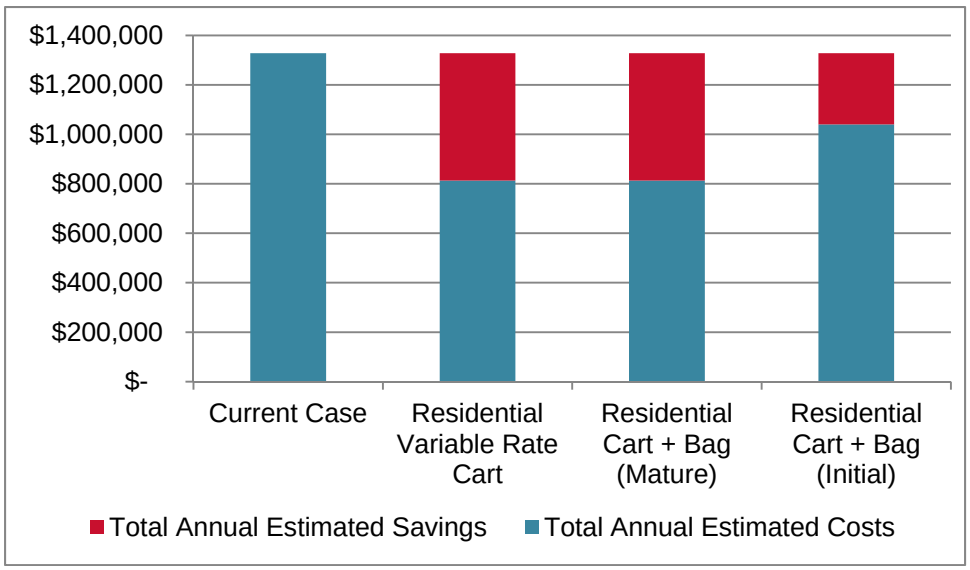
$515,000 in capital costs each year. The fully-automated side-load vehicles are believed to be available at a lower cost than the current multi-pack vehicles. Additionally, the alternative scenarios require fewer vehicles.

Table 20 summarizes the total annual estimated costs associated with the current system and the alternative scenarios. Due to the planning level nature of this evaluation, which is intended to be used to demonstrate the relative magnitude of potential changes to the system, the estimated total annual costs have been rounded to the nearest hundred.

Table 20 - Residential Curbside Garbage - Estimated Total Annual Cost. 5-Days Per Week

Metric	Current	Variable Rate Cart	Variable Rate Cart + Bag - Mature	Variable Rate Cart + Bag - Initial
Estimated Total Annual Labor Cost	$699,000	$352,000	$352,000	$579,000
Estimated Total Annual Vehicle Operating Cost	$160,000	$148,000	$148,000	$148,000
Estimated Total Annual Operating Cost	**$859,000**	**$500,000**	**$500,000**	**$727,000**
Estimated Total Annual Vehicle Capital Cost	$392,000	$236,000	$236,000	$236,000
Estimated Total Annual Cart Cost	$86,000	$86,000	$86,000	$86,000
Estimated Total Annual Capital Cost	**$478,000**	**$322,000**	**$322,000**	**$322,000**
Estimated Total Annual Cost	**$1,337,000**	**$822,000**	**$822,000**	**$1,049,000**
Estimated Total Annual Savings	**$-**	**$515,000**	**$515,000**	**$288,000**

Figure 1 - Residential Curbside Garbage - Estimated Total Annual Costs, 5 Days per Week



As shown in Figure 1, each of the alternative scenarios results in an overall estimated savings compared to the current case. The above costs are presented as feasibility numbers for the purpose of comparing multiple scenarios. This analysis is not a true cost of service calculation. Potential annual savings will be realized over a number of years as changes are implemented and the operations mature.

4.1.2 Four Days per Week Collection Estimated Costs

Currently, the City observes 10 holidays throughout the year. The garbage collection schedule is modified during weeks with a holiday resulting in delayed service to customers. Generally, this adjustment results in two routes being collected on one day.

In order to accommodate holidays, a four-day per week collection system was modeled. Operating four days per week would allow all customers to receive collection service weekly, regardless of holidays.

The four-day collection model was based on the following assumptions:

1. Collection would occur Monday through Thursday;
2. Collection schedule would shift during weeks with holidays;
3. Four, fully-automated side loaders would be utilized;
4. The collection staff would work a 10-hour shift;
5. A maximum achievable production rate is within 190 to 200 stops/hour.

The results of the impacts to key route metrics are shown in Table 21. For comparison purposes, the Current Case is included, along with the Variable Rate Cart alternative, presented in TM 401.

Table 21 - Residential Curbside Route Model Results. 4 Days per Week

Metric	Current	Variable Rate Cart – 5 Days	Variable Rate Cart – 4 Days
Number of Units (1)	17,270	17,270	17,270
Trips to Facility (2)	2	2	3
Hours per Day	6.43	7.17	9.42
Number Stops per Day	3,416	3,281	4,102
Miles per Trip (3)	16.44	18.91	23.63

Notes:

1) TM 300 and 401 previously modeled the number of accounts. This number has been updated to reflect the number of household units.
2) Due to truck weight capacity limits, the 4 –Day system would require trucks make 3 trips to the facility throughout the day.
3) With eight less trips to the facility overall, each route will increase in length.

Table 21 indicates that the residential curbside collection could be achieved within a four day week, while keeping collectors working within a 10-hour day. As a result of fewer overall routes, the 4-day collection system has longer routes with more homes per route, and therefore has a larger fuel expense.

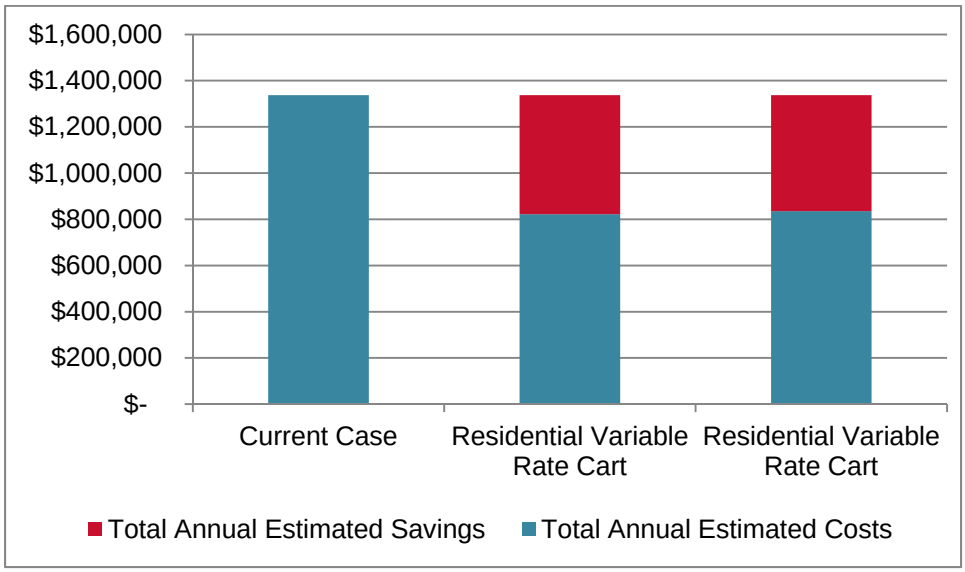
Table 22 summarizes the total annual estimated costs associated with the current system and a 4-day collection system. Due to the planning level nature of this evaluation, which is intended to be used to demonstrate the relative magnitude of potential changes to the system, the estimated total annual costs have been rounded to the nearest hundred.

Table 22 - Residential Curbside Garbage - Estimated Total Annual Cost. 4 Days Per Week

Metric	Current	Variable Rate Cart – 5 Days	Variable Rate Cart – 4 Days
Estimated Total Annual Labor Cost	$699,000	$352,000	$352,000
Estimated Total Annual Vehicle Operating Cost	$160,000	$148,000	$161,000
Estimated Total Annual Operating Cost	**$859,000**	**$500,000**	**$513,000**
Estimated Total Annual Vehicle Capital Cost	$392,000	$236,000	$236,000
Estimated Total Annual Cart Cost	$86,000	$86,000	$86,000
Estimated Total Annual Capital Cost	**$478,000**	**$322,000**	**$322,000**
Estimated Total Annual Cost	**$1,337,000**	**$822,000**	**$835,000**
Estimated Total Annual Savings	**$-**	**$515,000**	**$502,000**

As shown in Table 22, the 4-day system results in an overall estimated savings compared to the current case and addresses the challenge of holiday collection, though its costs are estimated slightly higher than the five day per week scenario, due to the difference in fuel expense.

Figure 2 - Residential Curbside Garbage - Estimated Total Annual Costs, 4 Days per Week



4.1.3 Residential Curbside Collection System Capacity

After the completion of TM 300 and TM 401, City staff requested that analysis of the collection technology change include an estimate of the total number of pick-ups that could be collected. This estimate could be used to determine when additional routes (trucks) would need to be added to the system in the future.

Table 23 demonstrates the estimated total number of residential curbside units that could be serviced by the four routes per day operating 10-hours per day. As shown, this automated system would have the ability to potentially service an additional approximate 2,000 to 3,000 curbside units, though some rebalancing of routes may be required.

The “Bismarck and Mandan North Dakota Housing Demand Analysis – 2030” prepared by Hanna:Keelan Associated in October of 2015 predicted that, on average, Bismarck will add 350 new single family homes per year between 2015 and 2030. This results in an estimate that a new curbside residential route be added in approximately 5 to 8 years.

Table 23 - Residential Curbside System Capacity

Stops per Hour	Hours per Day	No. of Units	Increased Capacity (Units) (1)
190	9.75	19,307	2,037
200	9.75	20,323	3,053

Notes:

1) The increased capacity is the number of units exceeding the existing 17,270 units currently serviced.

4.2 Residential Alley Garbage Collection

The City’s current alley garbage collection service is provided once a week to each household using rear-load collection vehicles, and is comprised of two routes on Tuesday and two routes Wednesday and Thursday that complete one trip designated as alley before collecting apartments, for a total of 4 complete routes per week. Two-person crews (one driver and one collector) use rear-load collection vehicles to collect garbage from each household. The residential alley customers provide their own garbage cans and are not limited to the amount of garbage that can be set out.

4.2.1 Residential Alley Semi-Automated Collection

Collection Technology

Switching alley collection to fully automated collection technology was not considered feasible by City staff due to the limited clearance in the alley serviced

The selection of potential system modifications, similar to the curbside system, resulted in three alternative scenarios for alley garbage collection service, as shown in Table 24. In each alternative scenario, a 20 cubic yard rear-load vehicle with a tipper is recommended, rather than the 25 cubic yard rear-load vehicles that are used in the Current Case. The recommendation of a smaller vehicle size is due to the fact that the Current Case vehicles are estimated to be only half full when arriving at the

facility each trip. The alternative scenarios also include a recommendation to complete two full days of residential alley routes, instead of the existing system which consists of one full day and two partial days, each with two vehicles. The model was designed to evaluate estimated, planning level cost and operational impacts under the following scenarios:

1. No change in services offered (Current Case);
2. Changing to a Variable Rate Cart program collected by rear-load vehicles with tippers (Variable Rate Cart);
3. Changing to a Variable Rate Cart program with specially marked bags for purchase collected by rear-load vehicles with tippers (Variable Rate Cart + Bag – Mature);
4. Changing to a Variable Rate Cart program with specially marked bags for purchase collected by rear-load vehicles with tippers (Variable Rate Cart + Bag – Initial)

Table 24 – Residential Alley Semi-Automated Alternative Scenarios

Scenario	Vehicle Type	Number of Vehicles	Routes per Week	Vehicle Capacity
Current Case	Rear-Load	2	4	25 CY
Variable Rate Cart	Rear-Load with Tipper	1	3	20 CY
Variable Rate Cart + Bag - Mature	Rear-Load with Tipper	1	3	20 CY
Variable Rate Cart + Bag - Initial	Rear-Load with Tipper	1	3	25 CY

The scenarios presented in TM 401 have been modified to adjust to the updated number of units. After the completion and review of TM 300 the number of alley customers and pick-up locations was further refined based on the additional data developed from City billing databases, GIS layers and analysis of the collection vehicle wheel paths as monitored by the GPS equipment in the trucks. The wheel track data, provided in GIS format, was used to refine the number of alley customers. As a result, the number of alley customers has decreased from the value reported in TM 300 and TM 401.

Each of the proposed scenarios includes the use of cart tippers installed on the rear-load vehicles. While this is a change in technology the result is not an automated solution and the total number of customers per day that can be served by each route does not greatly increase.

Labor costs will not be reduced for the proposed scenarios as all will include the same number of drivers and collectors. Again, without changing to a fully automated collection technology, there will not be a significant change in estimated labor costs.

Also included in the evaluation was the effect of modification on annual costs associated with vehicle operations and maintenance, and capital costs. The anticipated savings for switching to a smaller vehicle size is approximately $218,000 annually. The Variable Rate Cart and Mature Variable Rate Cart + Bag alternative scenarios indicates the same amount of savings because they each assume the use of smaller (20 cubic yard) vehicles and a reduced estimate of maintenance cost per vehicle. Potential savings from a smaller truck size is offset by the need to purchase and distribute wheeled carts to the

alley customers. The Variable Rate Cart + Bag – Initial alternative does not reduce the waste per household significantly enough to use a smaller vehicle. As result, there is fewer savings for the vehicle capital cost.

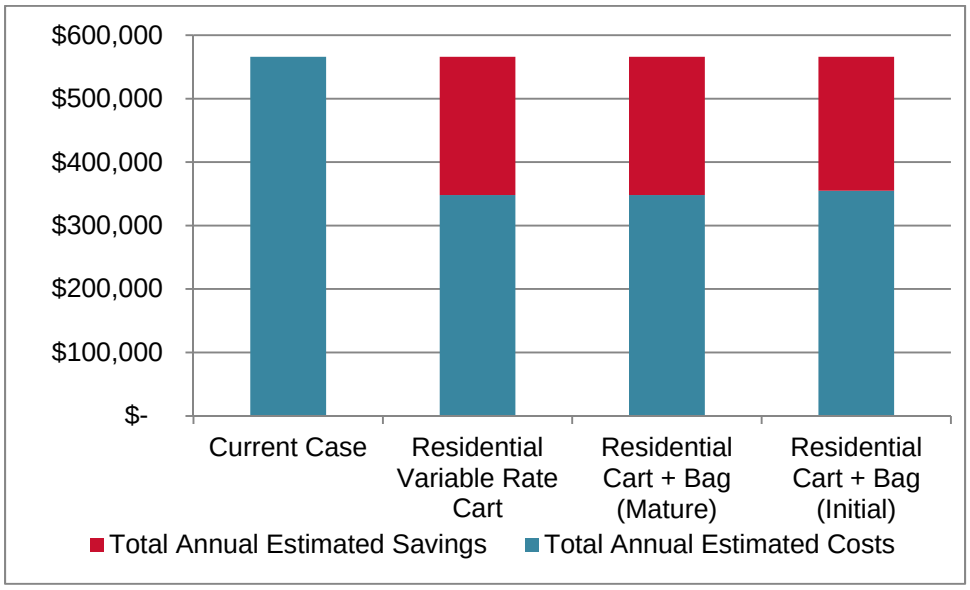
Table 25 summarizes the total annual estimated costs associated with the current system and the alternative scenarios. Due to the planning level nature of this evaluation, which is intended to be used to demonstrate the relative magnitude of potential changes to the system, the estimated total annual costs have been rounded to the nearest hundred.

Exhibit 3 shows the residential alley service collection locations included in the semi-automated modeling.

Table 25 – Residential Alley Semi-Automated Collection- Estimated Total Annual Cost

Metric	Current	Variable Rate Cart	Variable Rate Cart + Bag - Mature	Variable Rate Cart + Bag - Initial
Estimated Total Annual Labor Cost	$453,000	$453,000	$453,000	$453,000
Estimated Total Annual Vehicle Operating Cost	$49,000	$25,000	$25,000	$25,000
Estimated Total Annual Operating Cost	**$502,000**	**$301,000**	**$301,000**	**$301,000**
Estimated Total Annual Vehicle Capital Cost	$64,000	$44,000	$44,000	$51,000
Estimated Total Annual Cart Cost	$-	$3,000	$3,000	$3,000
Estimated Total Annual Capital Cost	**$64,000**	**$47,000**	**$47,000**	**$54,000**
Estimated Total Annual Cost	**$566,000**	**$348,000**	**$348,000**	**$355,000**
Estimated Total Annual Savings	**$-**	**$218,000**	**$218,000**	**$211,000**

Figure 3 - Residential Alley Semi-Automated Estimated Total Annual Costs



Completing residential alley collection on a four-day per week collection schedule does not require additional feasibility analysis because the total number of routes does not exceed four per week. It is anticipated that residential alley collection will be modified for two-day per week collection if the decision is made to convert to volumetric fee structure and semi-automated collection methods.

4.2.2 Residential Alley Automated Collection

After the completion and review of TM 300 & TM 401 the number of alley customers and pick-up locations was further refined based on the additional data developed from City billing databases, GIS layers and analysis of the collection vehicle wheel paths as monitored by the GPS equipment in the trucks.

After review with City collection staff, a GIS layer indicating the pick-up location for residential alley customers was developed. The number of alley pick-up locations was determined to be 1,912. Additionally, the alley locations were reviewed in the field with the City staff and determined that approximately 90% could likely be converted to automated pick-up in the alley locations. The remaining pick-ups would likely need to be completed using rear-load trucks because it would not be feasible to collect with an automated side loader truck. These pickups have the potential to be collected by the rear-load vehicle dumpster fleet. Exhibit 4 shows the residential alley locations that can likely be converted to automated collection.

A model was designed to evaluate estimated, planning level cost and operational impacts for switching to fully-automated collection for a majority of the alley customers. The model was created under the following assumptions:

1. Collection would occur Monday through Thursday;
2. Fully-automated side loaders would be utilized;
3. The collection staff would work a 10-hour shift;

4. Customers would place the garbage carts in the alley location and would not be required to place the carts in the street.
5. Automated collection will require either a collection vehicle with an arm on each side or for the vehicle to drive each alley twice.
6. Customers located in alleys with limited space would be collected by the dumpster rear-load fleet.

The results of the impacts to key route metrics are shown in Table 26. For comparison, the Current Case and Variable Rate Cart alternative, presented in TM 401, are also shown.

Table 26 - Automated Residential Alley Metrics

Metric	Current	Variable Rate Cart - Manual	Variable Rate Cart – Automated
Number of Units (1)	1,912	1,912	1,912
Number of Collection Days per Week	2	3	2
Number of Trucks	2	1	1
Trips to Facility (2)	2	2	3
Stops per Day	880	605	1,816
Total Number of Sanitation Collectors (3)	4	2	0
Total Number of Truck Drivers	2	1	2
Vehicle Cost	$149,500	$155,000	$275,000

Notes:

1) The Current Case number of units has been reduced from TM 300 and TM 401 as a result of updated GIS data. The Automated Alley Collection assumes 90% of alley customers are capable of being accessed by a full-automated vehicle.
2) The Automated Alley Collection assumes a 10-hour work day and an increase in trips to the facility.
3) Switching to an automated collection allows the driver to collect the carts without exiting the vehicle.

As shown in Table 26, collecting the alleys with a fully-automated vehicle could be achieved in two, ten-hour days, with one vehicle. With the fully-automated vehicle, a higher rate of stops per hour is achievable. The fully-automated vehicle also does not require use of sanitary collectors, allowing those positions to fill another role in the utility. However, the fully-automated vehicle has a higher purchase price and higher expected annual maintenance costs.

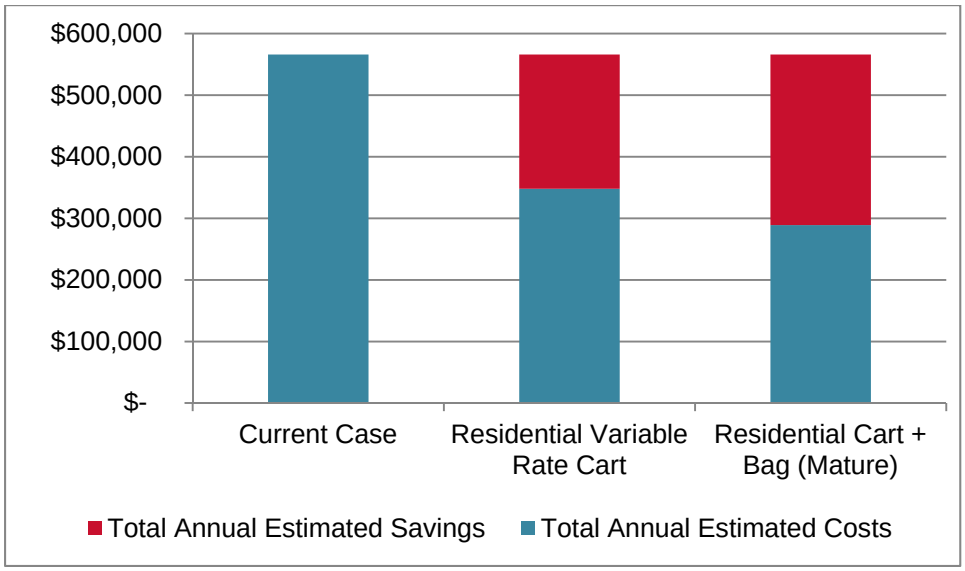
Table 27 summarizes the total annual estimated costs associated with the current system and the alternative scenarios. Due to the planning level nature of this evaluation, which is intended to be used to demonstrate the relative magnitude of potential changes to the system, the estimated total annual costs have been rounded to the nearest hundred.

Table 27 - Automated Residential Alley - Estimated Total Annual Cost

Metric	Current	Variable Rate Cart - Manual	Variable Rate Cart - Automated
Estimated Total Annual Labor Cost	$453,000	$276,000	$162,000
Estimated Total Annual Vehicle Operating Cost	$49,000	$25,000	$45,000
Estimated Total Annual Operating Cost	**$502,000**	**$301,000**	**$207,000**
Estimated Total Annual Vehicle Capital Cost	$64,000	$44,000	$79,000
Estimated Total Annual Cart Cost	$-	$3,000	$3,000
Estimated Total Annual Capital Cost	**$64,000**	**$47,000**	**$82,000**
Estimated Total Annual Cost	**$566,000**	**$348,000**	**$289,000**
Estimated Total Annual Savings	**$-**	**$218,000**	**$277,000**

Table 27 indicates the Variable Rate Cart – Automated alternative presents a cost savings of approximately $277,000. The fully-automated vehicle, due to its higher achievable efficiency rate, has the ability to collect more households in fewer collection days. This results in greater labor related savings.

Figure 4 - Residential Alley Garbage - Estimated Total Annual Costs Automated Collection



4.3 Residential Yard Waste Collection

The City currently operates 18 yard debris collection sites that consist of dumpsters that are collected seven days a week during the growing season. The City deploys three rear-load vehicles for yard debris collection from these sites each day from May through October. TM 401 includes a detailed discussion for the development of the estimated annual costs of the yard debris collection program. The following sections of this report

summarize the findings of TM 401, which is included as Appendix C. For 2016, the City estimates that the labor, fuel and vehicle maintenance (total operating cost) cost of providing these collection sites is $224,000. Based on conversations with the City and their cost of service consultant, capital costs are not included (e.g. amortization of collection vehicles and dumpsters used in this service).

An operational model was developed to estimate the operational and financial impacts of implementing a curbside and alley yard waste collection service for residential customers under the following assumptions:

- Curbside yard waste collection would utilize 25 cubic yard fully-automated side-loaders;
- Alley yard waste collection would utilize 20 cubic rear loaders with tippers;
- Each resident would receive an additional 96-gallon cart to use for yard waste.
- The yard waste collection would occur May through October.

It is important to note that the TM 401 modeling exercise estimates annual metrics for route, labor, operations and maintenance, and capital. However, as the City would only offer the service for five months out of the year, for the summary metrics, a 41.66% ratio has been applied to labor and operating expenses. Capital costs were not reduced for seasonal variations. Additionally, the yard waste was modeled as an independent service. It is likely that the yard waste collection service would utilize the same staff and vehicle resources as garbage collection. The estimated costs below reflect salaries and capital costs for separate labor and vehicles, though if the City decided to implement this service, labor and vehicle costs could potentially be shared with other services. Table 28 shows the estimated annual cost of providing seasonal curbside yard waste collection.

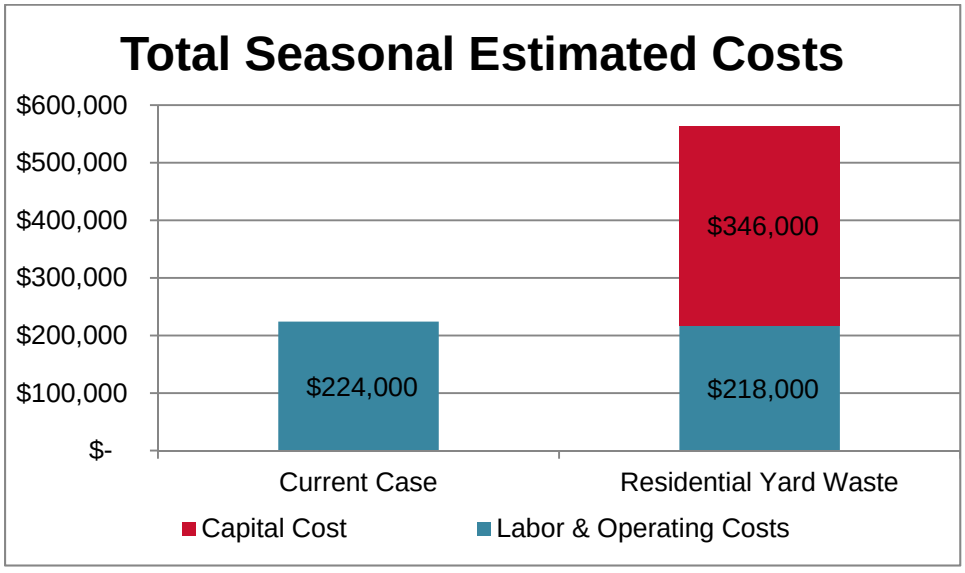
Table 28 - Residential Yard Waste Estimated Total Seasonal Costs

Estimated Cost	Curbside Yard Waste Collection	Alley Yard Waste Collection	Total Residential Yard Waste Collection
Total Labor Cost (1)	$105,000.00	$50,000	$155,000
Total Vehicle Operating Cost (1)	$53,000.00	$10,000	$63,000
Total Operating Cost (1)	**$158,000**	**$60,000**	**$218,000**
Total Vehicle Capital Cost (2)	$196,000	$44,000	$240,000
Total Cart Cost (2)	$95,000	$11,000	$106,000
Total Capital Cost (2)	**$291,000**	**$55,000**	**$346,000**
Total Cost	**$449,000**	**$115,000**	**$564,000**

Notes:
(1) Seasonal cost, it is assumed that labor will be shared with other parts of the utility.
(2) Annual cost, it is assumed that the capital costs will be allocated to this service.

Although the estimated costs for providing residential grass clipping collection exceed the current estimated Total Operating Cost of $224,000, it is important to note that the current cost does not contain the amortization cost of vehicles and dumpsters. Additionally, it is likely that garbage collection staff could perform this service. As an example, the proposed alley collection service consists of one vehicle operating twice per week. The same crew would be able to perform the yard waste collection during the remainder of the week, with the same vehicle. As a result, the estimated labor cost, vehicle capital cost, and vehicle operating cost would be reduced as they are already represented in the garbage collection cost.

Figure 5 - Residential Yard Waste - Estimated Total Annual Costs



5 Collection Boundaries for Optimization & Growth

Currently, Bismarck operates a 5-day per week collection schedule, with the City divided into five zones for residential collection. During weeks with holidays, the schedule is modified, resulting in either the collection of two zones on one day, or a zone being skipped during that week. The boundaries were revised with the following objectives and assumptions:

1. Collection would be performed on a 4-day per week basis;
2. Curbside collection would be converted to automated system with the requirement that all waste is contained in a cart or prepaid bag,
3. The number of units would be balanced per zone;
4. The number of units would remain balanced with the addition of platted, but currently undeveloped, parcels;
5. Alley customers would not be represented as they make up a minority of the customer base and are collected by a rear load truck.

5.1 Existing Residential Collection Zones

The City currently serves the 17,270 customers on a 5-day per week basis. The collection schedule is comprised of three routes on Monday and five routes Tuesday through Friday. Table 29 indicates the number of pick-ups per weekday.

Table 29 - Existing Residential Pick-ups

	Existing Units	Platted Future Units	Increase
Monday	2,900	3,532	632
Tuesday	3,638	3,852	214
Wednesday	3,348	3,808	460
Thursday	3,900	3,973	73
Friday	3,484	3,947	463
Total	17,270	19,112	1,842

The platted future units per zone were estimated by assigning a pick-up to currently undeveloped, platted lots. Although Mondays contain fewer pick-ups than the other zones, Table 29 indicates that with the addition of platted future units, the five zones will become more balanced over time.

Exhibit 1 Residential Collection Locations, included as an attachment to this final report, documents the existing and platted future pick-up locations that were used to develop the revised route zone boundaries. The GIS layer used to create this exhibit is included in the project GIS data transferred to the City with this final report.

5.2 Recommended Revised Residential Collection Zones

The existing route boundaries were revised under the assumption that the City would perform the collection throughout the course of four days during the week and assuming changes in technology for curbside collection would enable the City to collect more efficiently. Under these assumptions, the maximum number of pick-ups per zone is approximately 4,800. The zones were revised in order to accommodate growth to the northwest and northeast without requiring major boundary changes. Table 30 contains the number of pick-ups within each of the revised zones.

Table 30 – Revised Residential Pick-ups Zones

	Existing Units	Platted Units	Increase
Zone 1	4,442	4,779	337
Zone 2	3,818	4,480	662
Zone 3	4,779	5,210	431
Zone 4	4,231	4,643	412
Total	**17,270**	**19,112**	**1,842**

The recommended collection zones maintain an overall balanced schedule. Additionally, the boundaries would accommodate growth to the north with minimal changes to the boundaries. As the customer base extends north, it is recommended that the northern boundary of Zone 2 also moves north to the next major street. This allows the north-south boundary lines to remain the same and only requires the shifting of one border.

Collecting over four days provides flexibility to the collection service. This allows all customers to receive service, regardless of the presence of holidays or other delays in service. Using the Growth Management Plan developed by the City, the revised boundaries were also evaluated to determine the long-range planned customers. It was assumed that for Low Density Residential, there would be an average of 6 units per acre. Table 31 contains the number of low density units within each zone boundary.

Table 31 - Growth Management Pick-ups

	Low Density Residential (acres)	Growth Management Units	Total Units[1]
Zone 1	3,370	20,220	24,999
Zone 2	303	1,818	6,298
Zone 3	1,627	9,762	14,972
Zone 4	265	1,590	6,233
Total	5,565	33,390	52,502

Notes:

(1) Total Units includes Existing Units, Platted Future Units and Growth Management Units.

As previously mentioned, it is recommended that as the City continues to develop to the north, the northern boundary of Zone 2 be moved further north to maintain balanced routes on a daily basis. Refer to the attached Exhibit 5 for a graphic representation of the proposed collection zones.

5.3 Proposed Collection Routes

Each zone has been further divided to show the approximate collection route that each truck will need to cover inside the zone. The routes within the collection zones were revised with the following objectives and assumptions:

1. Four, fully-automated vehicles would perform the collection;
2. The work day for the collection staff would begin at 7:00 am and end at 5:30 pm, allowing for a half-hour lunch and three fifteen-minute breaks;
3. The number of units, including existing units and platted, currently undeveloped units, would be balanced per route;
4. Growth Management Units were not represented as they will occur over a significant time period, likely greater than 10-years; and
5. Residential alley customers would not be represented as they make up a minority of the customer based and are collected by a rear load truck.

The boundaries were created in order to accommodate growth to the northwest and northeast without requiring major boundary changes. By balancing the existing units and platted, currently undeveloped units, the route boundaries will require minimum rebalancing within the next two to three years. Table 32 through Table 35 contain the number of pickups within each route boundary per collection zone. In these tables, the "Existing Units" are the estimated collection points as of the July 2015 billing listing and GIS analysis of the truck routes. "Platted Units" are lots that have been created by existing plats, are zoned residential, and will be a garbage collection location after a structure is built. "Total Units" is the sum of the "Existing Units" and "Platted Units".

Table 32 – Zone 1 Route Boundaries

Route	Existing Units	Platted Units	Total Units(1)	Trips to Landfill
Route 1-1	817	156	973	3
Route 1-2	1,485	34	1,519	3
Route 1-3	1,335	37	1,372	3
Route 1-4	805	110	915	3
Total	**4,442**	**337**	**4,779**	**-**

Notes:
(1) Total Units refers to the combination of Existing Units and Platted Units presented in TM 402. Total Units is the number of existing collection points plus the undeveloped platted single family parcels that will eventually be curbside collection points.

The recommended route boundaries for Zone 1 provide additional capacity to Route 1-1 and Route 1-4. These route boundaries were established to accommodate the anticipated growth to the northeast with minimal changes to the route boundaries.

Table 33 – Zone 2 Route Boundaries

Route	Existing Units	Platted Units	Total Units	Trips to Landfill
Route 2-1	1,069	9	1,078	3
Route 2-2	1,095	2	1,097	3
Route 2-3	675	529	1,204	3
Route 2-4	979	122	1,101	3
Total	**3,818**	**662**	**4,480**	**-**

As described in TM 402, Zone 2 is expected to have minimal growth compared to the other collection zones as indicated in the Growth Management Plan. As a result, the recommended route boundaries for Zone 2 are overall balanced.

Table 34 – Zone 3 Route Boundaries

Route	Existing Units	Platted Units	Total Units	Trips to Landfill
Route 3-1	1,332	3	1,335	4
Route 3-2	1,470	6	1,476	4
Route 3-3	1,126	179	1,305	4
Route 3-4	851	243	1,094	3

Table 34 – Zone 3 Route Boundaries

Route	Existing Units	Platted Units	Total Units	Trips to Landfill
Total	**4,779**	**431**	**5,210**	**-**

The recommended route boundaries for Zone 3 provide additional capacity to Route 3-4 in order to accommodate the anticipated growth to the northwest with minimal changes to the route boundaries. The four routes operate in a high-density population area. As a result, the trucks are expected to reach weight capacity in less time, resulting in an additional trip to the landfill, without exceeding the overall collection time frame.

Table 35 – Zone 4 Route Boundaries

Route	Existing Units	Platted Units	Total Units	Trips to Landfill
Route 4-1	708	264	972	3
Route 4-2	947	137	1,084	3
Route 4-3	1,234	4	1,238	4
Route 4-4	1,342	7	1,349	4
Total	**4,231**	**412**	**4,643**	**-**

The recommended route boundaries for Zone 4 also provide additional capacity to Route 4-1 and Route 4-2 in order to accommodate the anticipated growth to the north with minimal changes to the route boundaries.

Refer to Exhibit 6 through Exhibit 9 for a graphical representation of the routes by zone.

6 Conclusions

The following sections include a summary of key findings and conclusions from the evaluation of the City's current collection system and potential system modifications.

6.1 Key Findings for the Existing System

6.1.1 General System

Based on the review of the system data and route observations, the following general system key findings were identified:

1. Residential curbside collection consists of a semi-automated service with limited collection restrictions placed on the customers.
2. Residential alley collection consists of manual service with limited collection restrictions placed on the customers.
3. Apartment collection service consists of dumpster collections. Collection restrictions are inherent in the dumpster size and frequency of collection.
4. Currently, the collection service is managed by collection truck type and not customer service type. For example, residential alley collection occurs on the same routes as apartment collection.
5. Collection routes are not documented in a graphic format (maps).
6. Customer account numbers and types were difficult to determine based on the current process used to manage the data.
7. Asset management of containers and dumpsters is limited. It was difficult to determine the location of City owned dumpsters and the locations where City containers have been deployed.
8. The City currently has an 80% spare ratio for multi-pack vehicles, which is higher than a typical 35% spare ratio that is generally recommended for automated/semi-automated vehicles. This spare ration is higher than average due to the need to deploy additional routes on collection days following a City recognized holiday.
9. Collection crews return to the landfill for lunch breaks, which means vehicles are not necessarily at or near capacity when returning to the landfill. Changing this practice has the potential to make routes more efficient by only having collection vehicles return to the landfill when they are at or near capacity, or at the end of a collection day.

6.1.2 Residential Curbside Service

1. Residential curbside garbage collection service occurs five days a week with a total of 23-routes per week. There are approximately 17,200 curbside customers.
2. Individual routes are not documented in maps or GIS format.
3. Collection is completed with a semi-automated system, where residents have carts but are also allowed to place items outside of the carts. The City uses multi-pack

vehicles that have side-arm loading capabilities in addition to rear-loading capabilities.

4. The City's current residential curbside garbage collection system covers an average of 671 homes per route as shown by the route observations, which is well within the range of 500 to 800 homes per route that is typically observed in manual and semi-automated collection systems.
5. Use of the multi-pack vehicles for the current system that allows unlimited garbage to be placed at the curb is an efficient means of collection.
6. In fully automated systems, garbage routes typically cover between 1,000 and 1,300 homes per route.
7. Benchmarking of regional automated collection systems support the ability to service additional homes per route.
8. To achieve the benefits of fully automated collection, set out limits are required to be enacted and enforced.
9. It was observed that three of the seven curbside routes required more than one vehicle to complete the route. It was also observed that the time spent on the routes varied widely.

6.1.3 Residential Alley Service

1. The City's current residential alley garbage collection service occurs three days a week with a total of six routes per week. There are approximately 1,912 current residential alley customers.
2. Collection is completed using rear-load trucks where sanitation collectors manual load the garbage into the back of the truck. There are no setout limits on the amount of garbage placed at collection areas.
3. Residential alley customers provide their own refuse containers in the form of 32-gallon garbage cans and/or bags of refuse.
4. Routes occur three days per week and typically only collect alley service half of the day. On the second half of the day the same trucks collect apartment dumpsters.
5. Individual routes are not documented in maps or GIS format.
6. A limited number of apartment dumpsters are collected on the residential alley routes.
7. Determination of the location of current residential alley customers is difficult because the City does not have a record of the addresses, or accounts, that are collected on alley routes.
8. Alley collection locations were interpreted from account addresses, proximity to alley's identified in the GIS layers and review with the City staff.
9. City staff has indicated that switching to an automated collection technology is not practical due to the limited access and overhead obstacles in many of the collection locations.

10. Based on review of the interpreted alley collection locations, it appears that there is a portion of the alley service being competed in private driveways or private alleys.
11. Conversion of a significant portion of the alley collection to an automated technology may be possible for customers located adjacent to public alleys.

6.1.4 Apartment Dumpster Service

1. The City's current apartment collection system uses rear-load vehicles with a hook system to collect dumpsters from apartments and front-load automated vehicles to collect dumpsters from apartments.
2. Of the 783 dumpsters, 304 are believed to be collected by a front-load truck while the remaining 479 are collected by a rear-load truck.
3. Data gathered from both dumpster styles indicated they are under the 150 pounds per loose cubic yard expected with apartment residential waste.
4. A limited number of apartment dumpsters are collected by the residential alley routes.
5. Individual routes are not documented in maps or GIS format.
6. The City does not have an established asset management program for the dumpsters deployed.
7. Similar to curbside service, it was observed that two of the five alley/apartment collection routes required more than one vehicle to complete the route. It was also observed that time spent on each route varied widely.

6.1.5 Goals of Potential Modifications

With input from the City staff the following goals for modifying the collection system to allow for cost savings and efficacy included:

1. Change collection technology for the purpose of increasing the number of accounts that can be collected by individual routes.
2. Adopt and enforce residential set-out limits (amount of waste) and restrictions (how waste is containerized) for the purpose of increasing the number of accounts that can be collected by individual routes.
3. Rebalance and document collection routes.
4. Revise vehicle replacement policies to more efficiently manage spare ratios.
5. Revise collection routes by customer service type.
6. Implement a refined asset management mechanism utilizing the City's GIS databases to track deployed containers, track customer pickup locations, summarize customer service type by property, and document individual collection routes.

6.2 Key Findings for Potential Modifications

6.2.1 Residential Curbside Automated Collection

1. All scenarios included switching to fully automated collection trucks and providing set-out limits either in the form of wheeled carts of varying sizes and/or pre-sold bags.
2. These changes would be considered a “volumetric” fee base, as customers would be charged based on the size cart selected, and therefore amount of waste disposed.
3. The Variable Rate scenario and the Variable Rate + Bag – Mature scenario, for five day per week collection, are estimated to provide the City with the greatest savings, at roughly $515,000 in annual savings compared to the Current Case.
    a. Estimated savings are largely due to a switch to fully-automated side-load collection vehicles that would require only one driver and no collectors, and
    b. Would allow the City to complete collections with four routes per day instead of the current five routes per day.
4. The Variable Rate + Bag – Initial scenario is estimated to provide the City with some savings (nearly $288,000 annually), compared to the Current Case
    a. Estimated savings are largely due to the use of fully-automated side-load collection vehicles, which would allow the City to complete collections with 4 routes per day instead of the current 5 routes per day.
    c. However, the initial system would likely require one driver and one collector until the use of the extra bags by residents is diminished.
5. It is possible to complete the residential curbside collection utilizing a four day per week, 10-hour per day, schedule. The Variable Rate + Bag – Mature, for four day per week collection scenario is estimated to provide the City with roughly $502,000 in annual savings compared to the Current case.
6. It is estimated that the proposed four automated routes would be able to serve an additional 2,000 to 3,000 curbside units. Based on recent housing projections an additional route (truck) would need to be added between 2020 and 2023.

6.2.2 Residential Alley Collection

1. All scenarios included providing set-out limits either in the form of wheeled carts of varying sizes and/or pre-sold bags.
2. These changes would be considered a “volumetric” fee base, as customers would be charged based on the size cart selected, and therefore amount of waste disposed.
3. Without changing to an automated collection technology, it does not appear to be possible to achieve a significant increase in collection efficiency or cost savings.
    a. The Variable Rate scenario and the Variable Rate + Bag – Mature scenario are estimated to provide the City with the greatest savings, at roughly $218,000 in annual savings compared to the Current Case.

i. Estimated savings are largely due to labor related savings as a result of consolidating the current two routes into one route.

b. The Variable Rate + Bag – Initial scenario is estimated to provide the City with some savings (nearly $211,000).

c. Estimated savings are largely due to lower vehicle costs associated with the 20 cubic yard rear-loaders with tippers.

d. The initial system would likely require one driver and two collectors until the use of the extra bags by residents is diminished.

e. Changing to 20-cubic yard collection vehicles may not be an efficient modification for the potential annual costs savings as this would introduce a second size rear-load truck to the City fleet.

4. Review of the alley pick-up locations using GIS analysis and field visits determined that converting 1,712 of the 1,912 alley customers to an automated collection system appears possible.

   a. The Variable Rate – Automated scenario is estimated to provide the City with $277,000 in annual savings compared to the Current Case.

      i. Estimated savings are largely due to a switch to fully-automated side-load collection vehicles that would require only one driver and no collectors.

      ii. However, the fully-automated vehicle requires more annual maintenance and has a higher vehicle price.

   b. It is possible to complete the alley customers with one fully-automated vehicle in two days utilizing a 10-hour per day schedule.

6.2.3 Residential Yard Waste Collection

1. The City's current yard waste collection system consists of 18 yard debris collection sites with dumpsters located around the City that are collected seven days a week during the growing season.
2. The City deploys three rear-load vehicles for yard waste collection from these sites each day from May through October. The City estimates the current yard waste collection system total operations costs are estimated to be $225,000 for 2016. Capital costs are not included in this estimate (e.g. the amortization of collection vehicles or dumpsters).
3. If the City were to offer 96-gallon cart collection of yard waste to residential curbside and alley customers, the total estimated capital costs would be nearly $346,000 per year including the amortization of collection vehicles and carts.
4. The estimated total operations costs for providing 96-gallon cart collection of yard waste to residential curbside and alley customers is $218,000 per year.
5. The costs of the curbside yard waste collection can potentially be further offset by utilizing the same staff and vehicles as garbage collection.

6.2.4 Apartment Dumpster Service

1. The City's current dumpster collection system consists of 304 front-load dumpsters and 479 rear-load dumpsters collected between one and three times per week.
2. The current collected pounds of dumpster weight per loose cubic yard is well below the expected 150 pounds per cubic yard. This indicates the potential to scale dumpsters to a smaller size or collect on a less frequent basis.
3. Vehicles collecting dumpsters were observed to return to the landfill at half capacity, indicating capacity in the system to grow, and the potential to rebalance the route and fleet. This could also indicate the potential to convert to 20 cubic yard trucks.

7 Recommendations

1. Establish customer classes and track key metrics by these classes.
    a. Customer Classes should include, at a minimum,:
        i. Residential Alley Garbage
        ii. Residential Curbside Garbage
        iii. Apartment Dumpsters Garbage
        iv. Residential Alley Yard Debris
        v. Residential Curbside Yard Debris
    b. Base collection routes on Customer Class.
    c. Track and document collected garbage, and yard debris, by Customer Class on a monthly and annual basis.
2. Update the utility finical model to determine the cost of service by Customer Class and adjust the rates as approved by the City Council for a fair and equitable allocation of the true costs of the utility. How the rates are adjusted would be a policy decision to be made by the City Council.
3. Maintain and update the GIS database, provided with this final report, that can be used by the operators of the utility to:
    a. Track the location of deployed dumpsters and residential carts;
    b. Document the collection zones and collection routes;
    c. Document the location of customers by class.
4. Adopt a Volumetric Residential rate structure to incentivize recycling and equitably distribute the cost of garbage collection and disposal based on use of the system.
    a. Volumetric Rate structures are commonly used in water and sewer utilities. Customers understand that higher use of the utility results in a higher price.
    b. Garbage collection utilities can utilize the same principal. A volumetric rate structure charges a variable fee based on the size cart chosen by the customer.

5. Prior to implementing a volumetric collection system it is recommended that the City implement an education program that
    a. Informs the users of the size containers available,
    b. The typical number of bags of garbage each container holds on average, and
    c. Requests that the user selects a container size for the program.
    d. Based on previous experience, the majority of the users may not respond and will be assigned the default container size. Some systems allow a “swap out” period at no charge to change the size container, but begin charging a “swap out” fee outside of the initial grace period. Prior to the implementation, the City will need to determine the default container size for the utility.
6. To continue to provide high quality service to the customers after the adoption of a volumetric rate structure, implement the following additional services or utility features:
    a. Scheduled bulk waste collection. This service should consist of customers scheduling bulk waste item pick-up for a reasonable fee. Communities have reported that utilizing a bulk waste collection program has reduced the amount of large items set-out during spring/fall clean-up weeks and illegal dumping.
    b. Residential Holiday Collection. This program would allow excess garbage to be set-out without using pre-sold bags for the time from the first collection after Thanksgiving until the first collection of the New Year. This type of program benefits users that have typically limited garbage quantities but may have an increase from hosting holiday visitors.
    c. Landfill Disposal Vouchers. Provide users with disposal vouchers that allow passenger vehicle sized loads to dispose at the landfill without paying the typical tipping fee. Vouchers can be distributed on an annual basis, or as a coupon included with each utility bill. It is recommended that the program be based on vouchers, or coupons, that must be turned in at the landfill scale instead of based on address or showing a utility bill. Use of a voucher will mitigate the potential of abuse from commercial or non-City resident users.
    d. Spring/Fall Cleanup Weeks. It is recommended that the City continue the practice of cleanup weeks for large items and excessive waste. Other communities have reported that when these weeks are eliminated, illegal dumping increases.
7. Require that all residential garbage is placed in a City provided wheeled cart. Excess waste can be placed in specially marked, pre-sold bags adjacent to the cart. No oversized waste or garbage contained in user provided bags will be collected.
8. Modify the residential curbside to a fully automated system based on the “Variable Rate Cart + Bag - Mature” option described in this final report and TM 401.
9. Modify the residential alley collection to be a semi-automated system based on the “Variable Rate Cart + Bag - Mature” option described in this final report and TM 401.
    a. It is recommended that the residential alley collection be completed with the existing Heil multi-packs or rear-load vehicles.

b. Prior to purchasing new dedicated alley collection vehicles, the operational feasibility of converting to automated side loaders should be further explored. This final report concludes that it is highly probable that 1,712 users (90%) can be converted to automated side loader service.

10. Modify the residential collection to be performed on a four-day per week basis.
11. Perform a detailed evaluation and optimization of the Apartment Dumpster service to:
    a. Balance the collection days,
    b. Convert rear-load service to front load as operational consideration allows; and
    c. Review the size, number and routes of collection vehicles to optimize the returning weights of the collection fleet.
12. Cease to operate the 18-seasonal grass clipping drop sites. Replace with residential curbside and alley yard debris collection as described in this final report and TM 401.
13. Adopt the Collection Zones as shown in Exhibit 5.
    a. These zones result in a four-day per week, 10-hour per day, schedule.
    b. Collection should occur Monday – Thursday.
    c. Holiday collection should shift the balance of the week one day per zone with Thursday service being completed on Friday.
14. Adopt the Collection Routes as shown in Exhibit 6 to Exhibit 9.

Appendix A. Exhibits

Exhibit 1 Residential Collection Locations

Exhibit 2 Dumpster Collection Locations

Exhibit 3 Residential Alley Collection Locations – Semi Automated Service

Exhibit 4 Residential Alley Collection Locations – Automated Service

Exhibit 5 Proposed Residential Curbside Collection Zones

Exhibit 6 Proposed Residential Curbside Collection Routes – Zone 1

Exhibit 7 Proposed Residential Curbside Collection Routes – Zone 2

Exhibit 8 Proposed Residential Curbside Collection Routes – Zone 3

Exhibit 9 Proposed Residential Curbside Collection Routes – Zone 4

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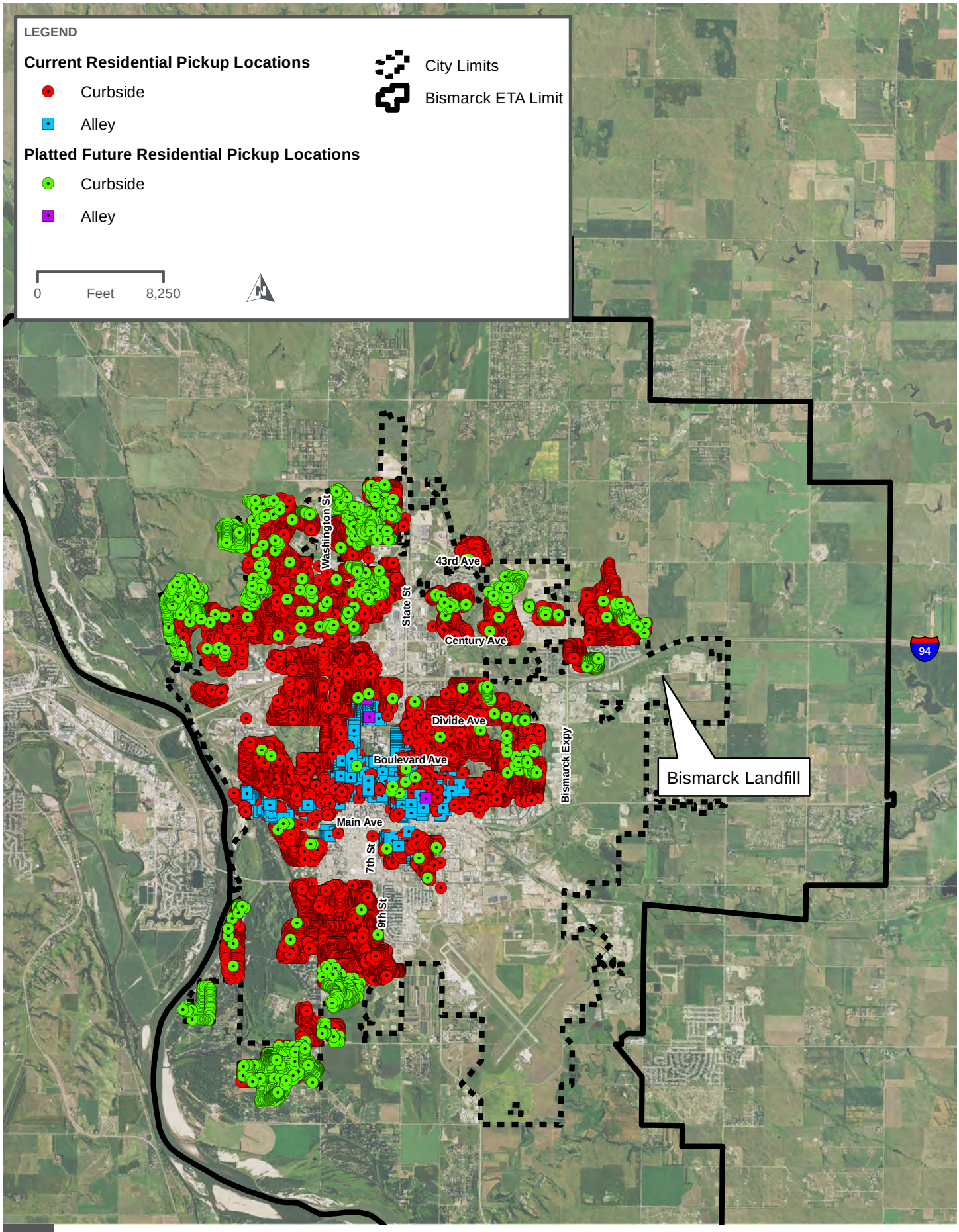
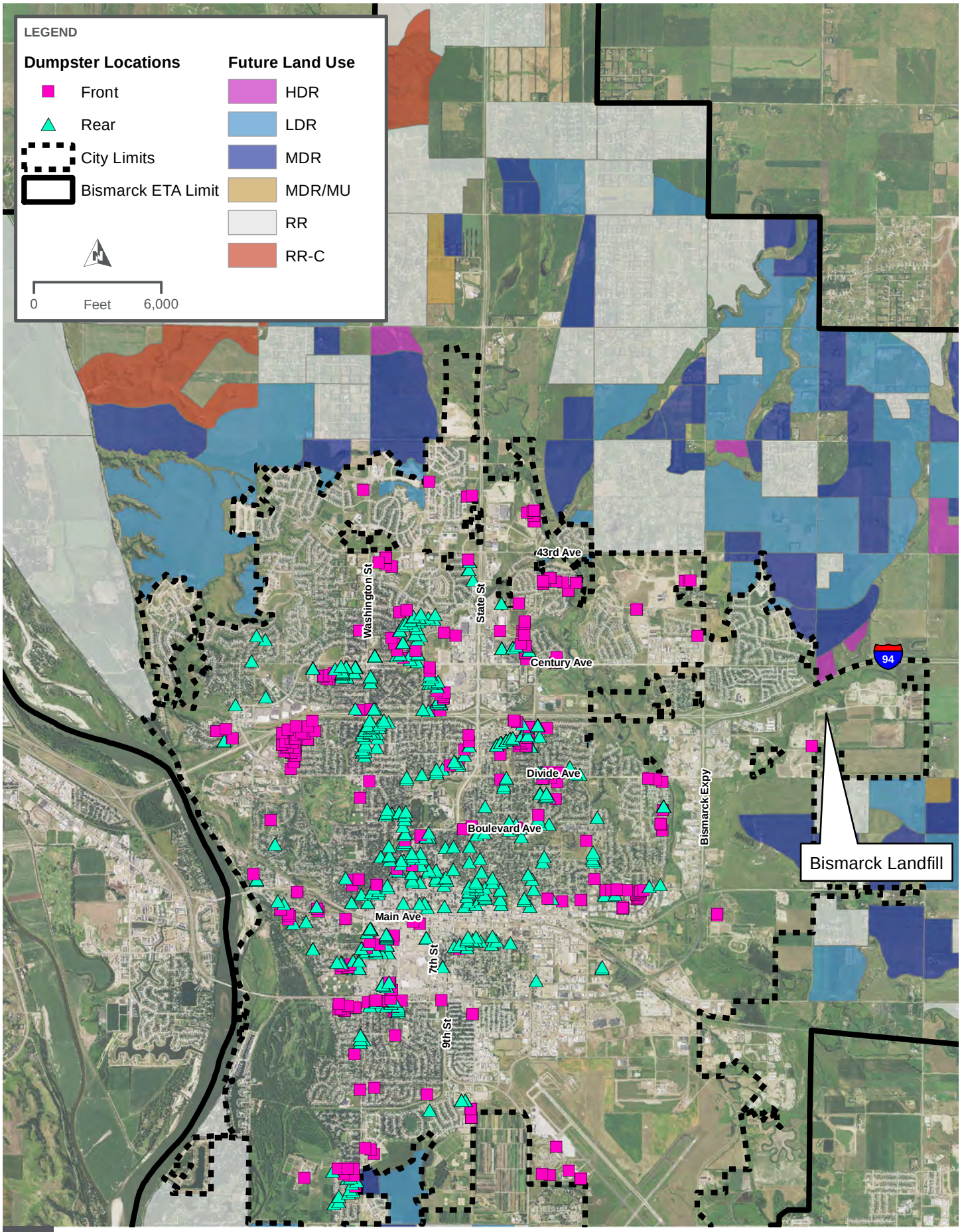


CITY OF BISMARCK

RESIDENTIAL WASTE COLLECTION

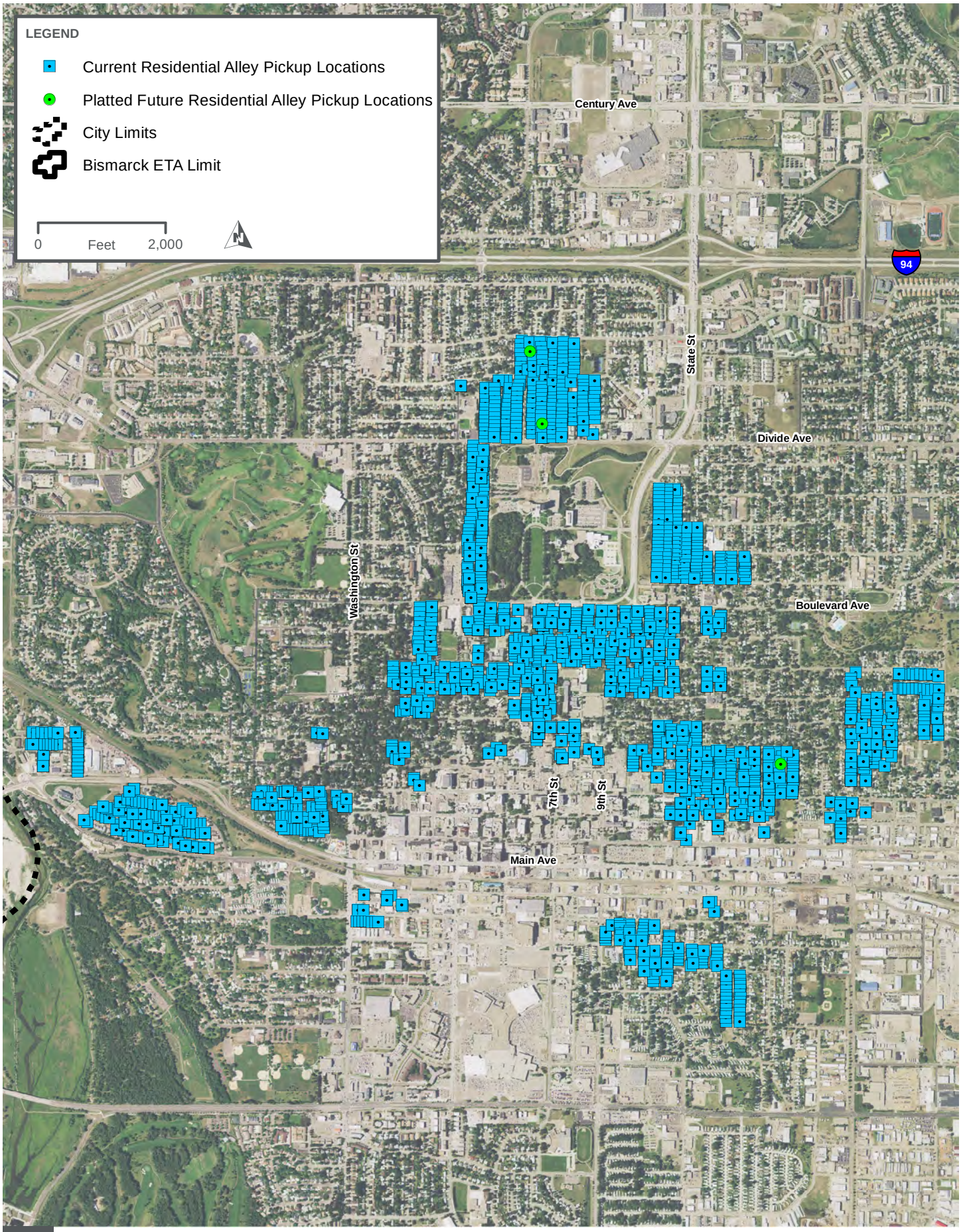
RESIDENTIAL COLLECTION LOCATIONS (EXHIBIT 1)



CITY OF BISMARCK

RESIDENTIAL WASTE COLLECTION

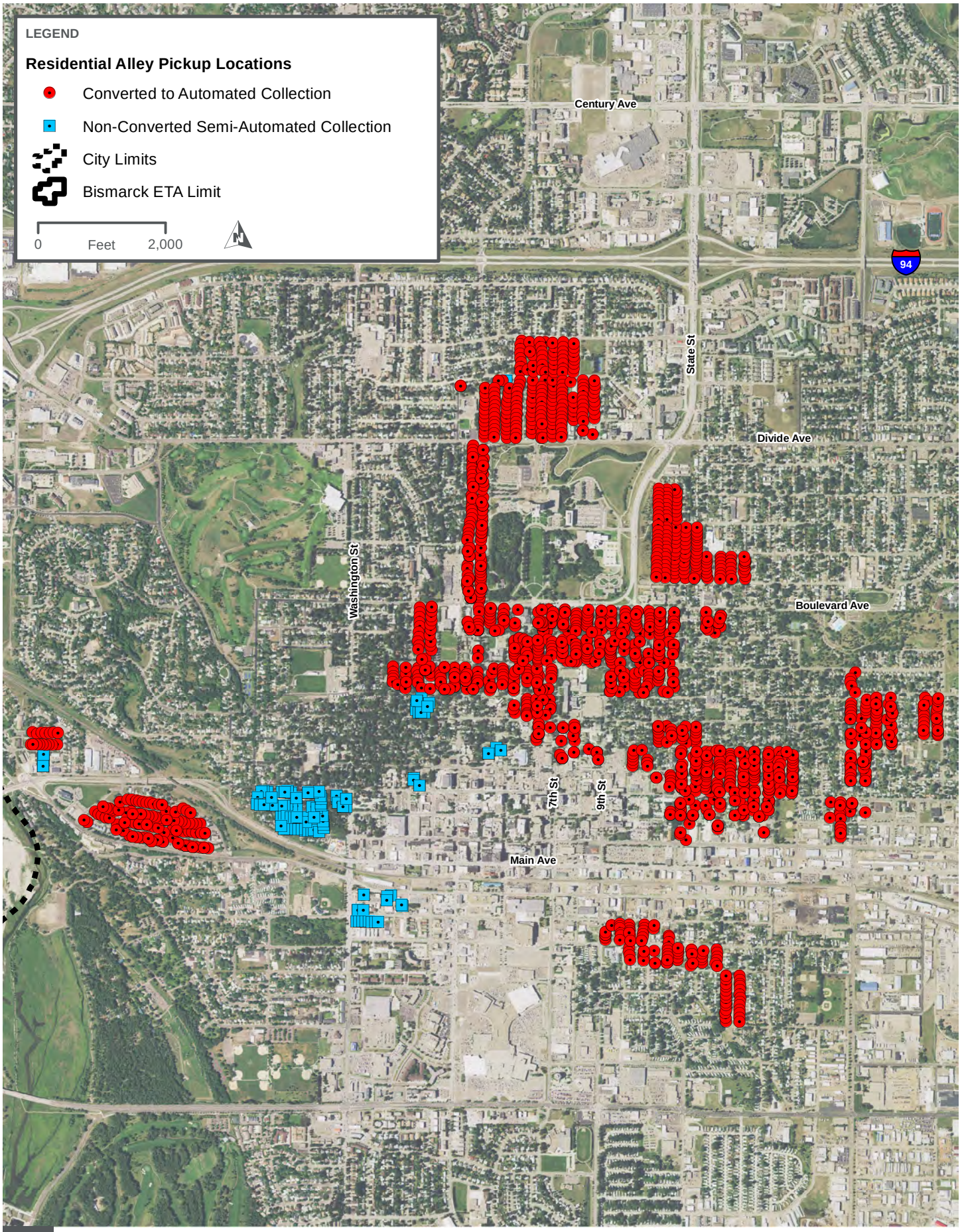
DUMPSTER COLLECTION LOCATIONS (EXHIBIT 2)



CITY OF BISMARCK

RESIDENTIAL WASTE COLLECTION

RESIDENTIAL ALLEY COLLECTION LOCATIONS - SEMI-AUTOMATED SERVICE (EXHIBIT 3)



CITY OF BISMARCK

RESIDENTIAL WASTE COLLECTION

RESIDENTIAL ALLEY COLLECTION LOCATIONS - AUTOMATED SERVICE (EXHIBIT 4)

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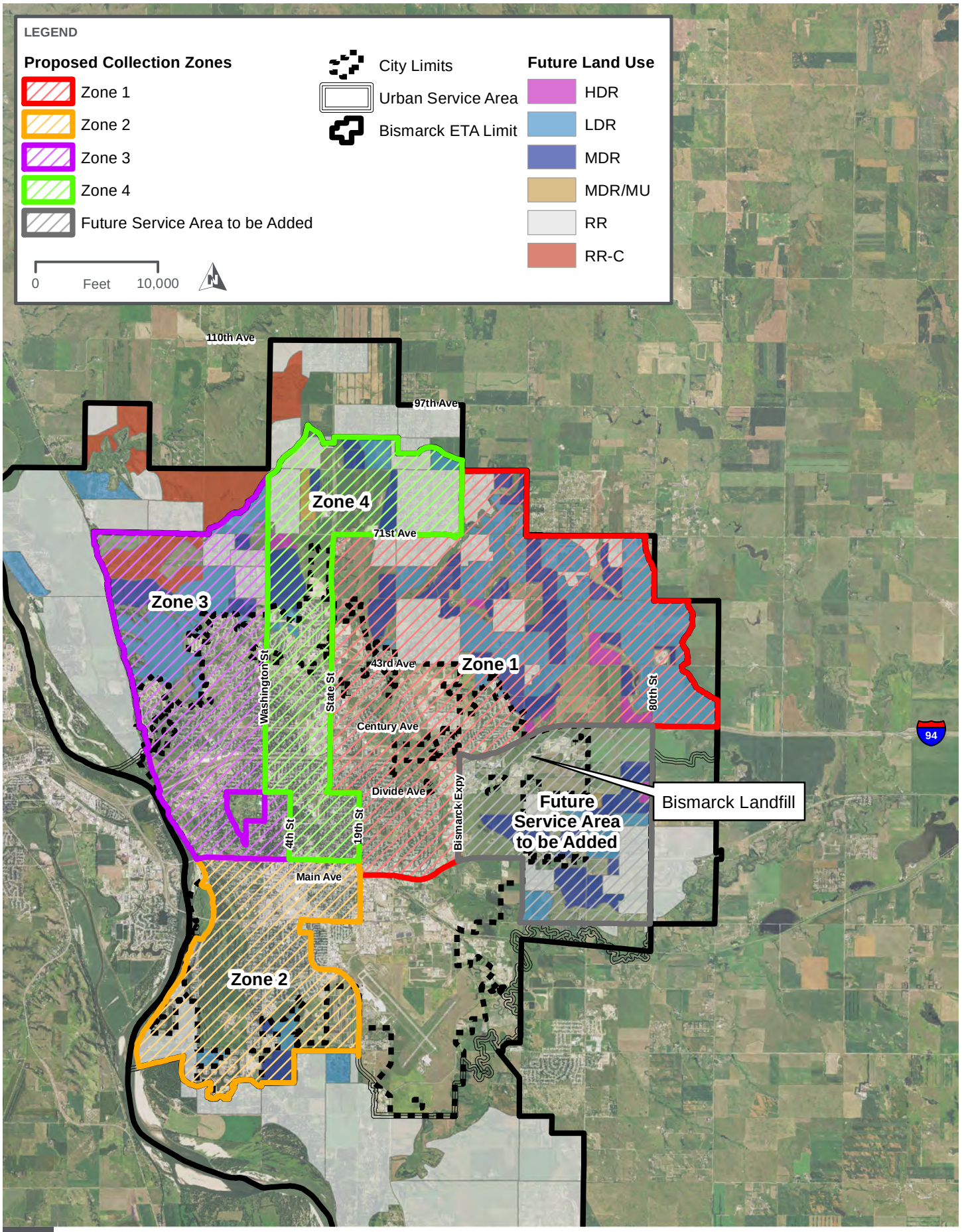
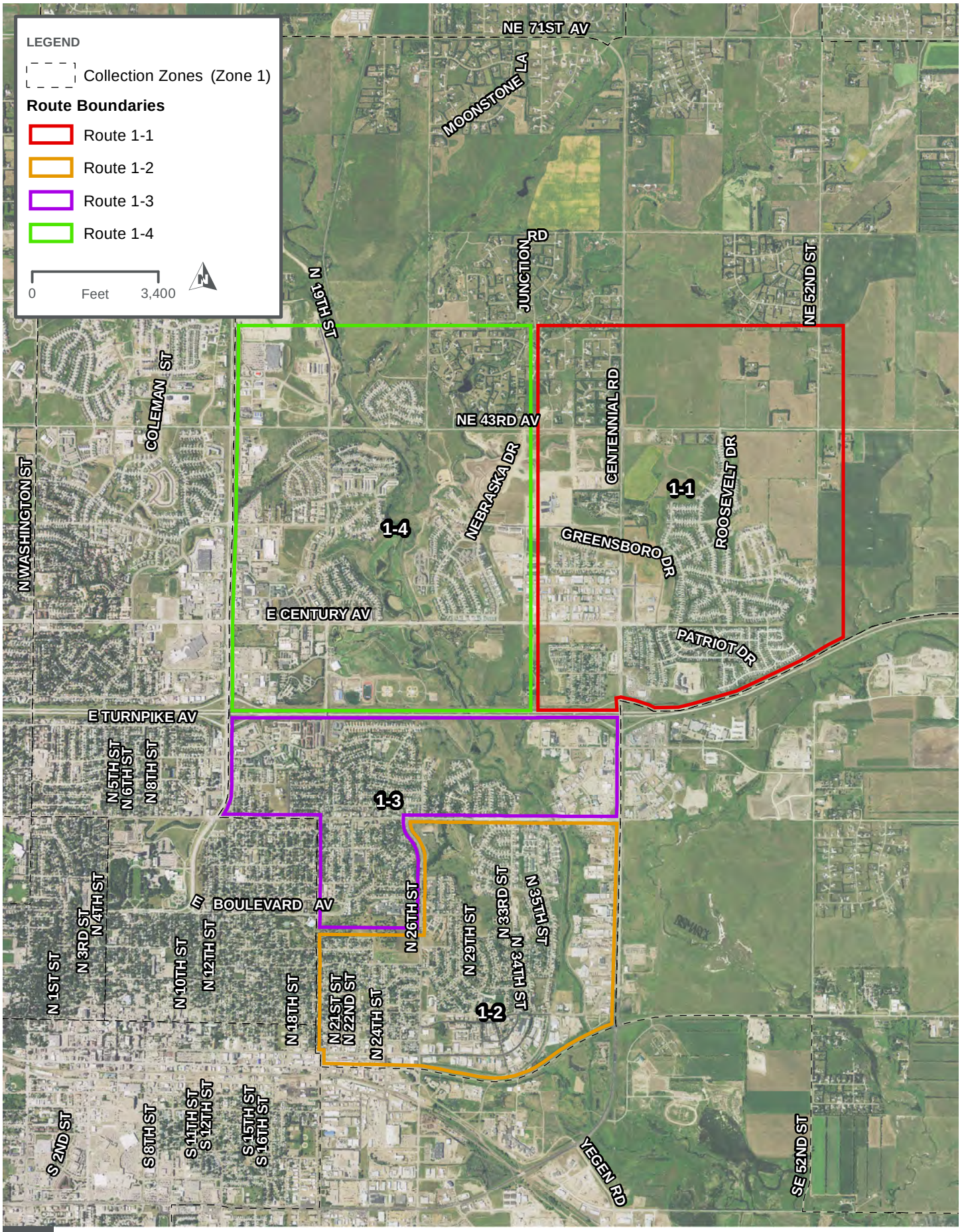


CITY OF BISMARCK

RESIDENTIAL WASTE COLLECTION

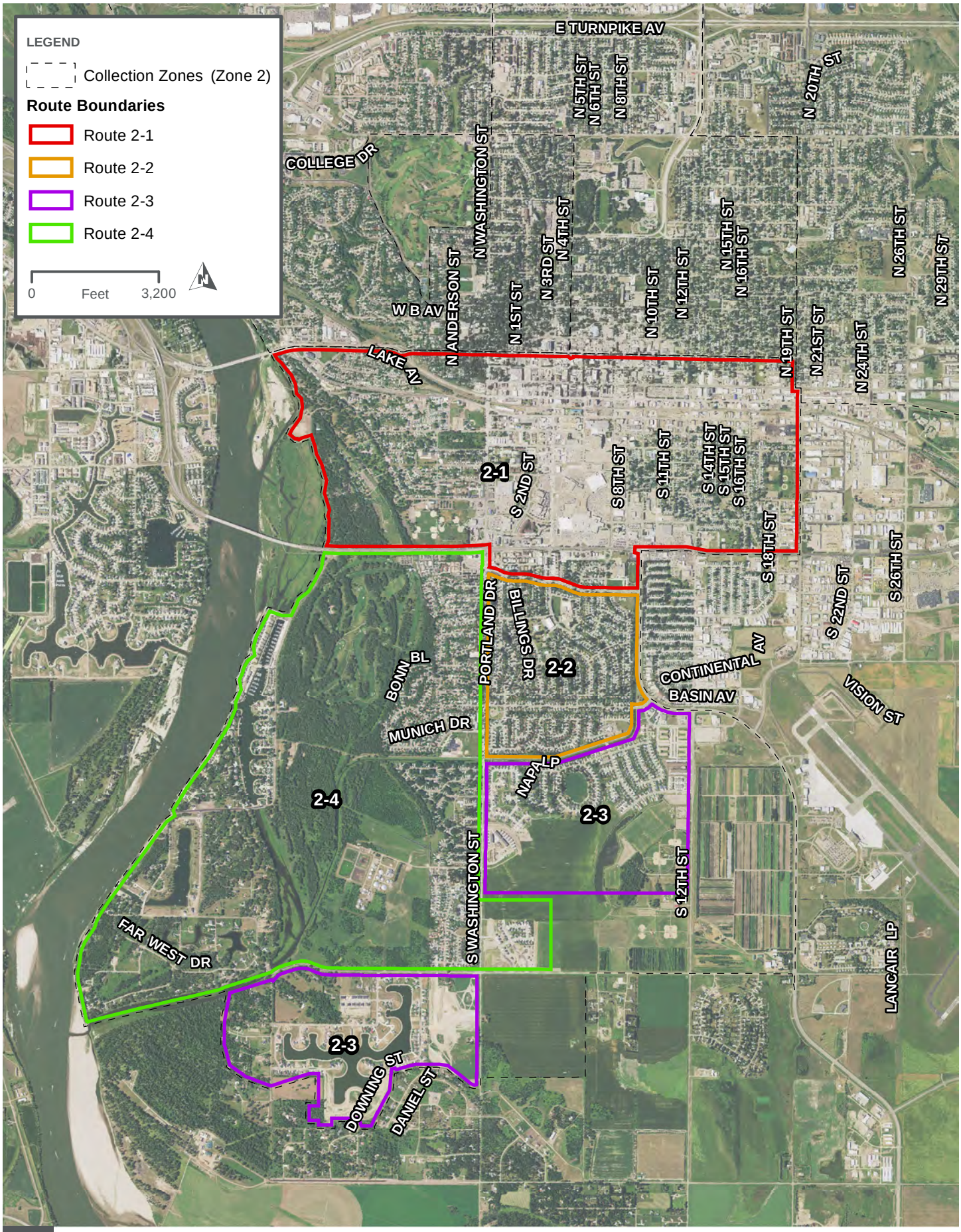
PROPOSED RESIDENTIAL CURBSIDE COLLECTION ZONES (EXHIBIT 5)



CITY OF BISMARCK

RESIDENTIAL WASTE COLLECTION

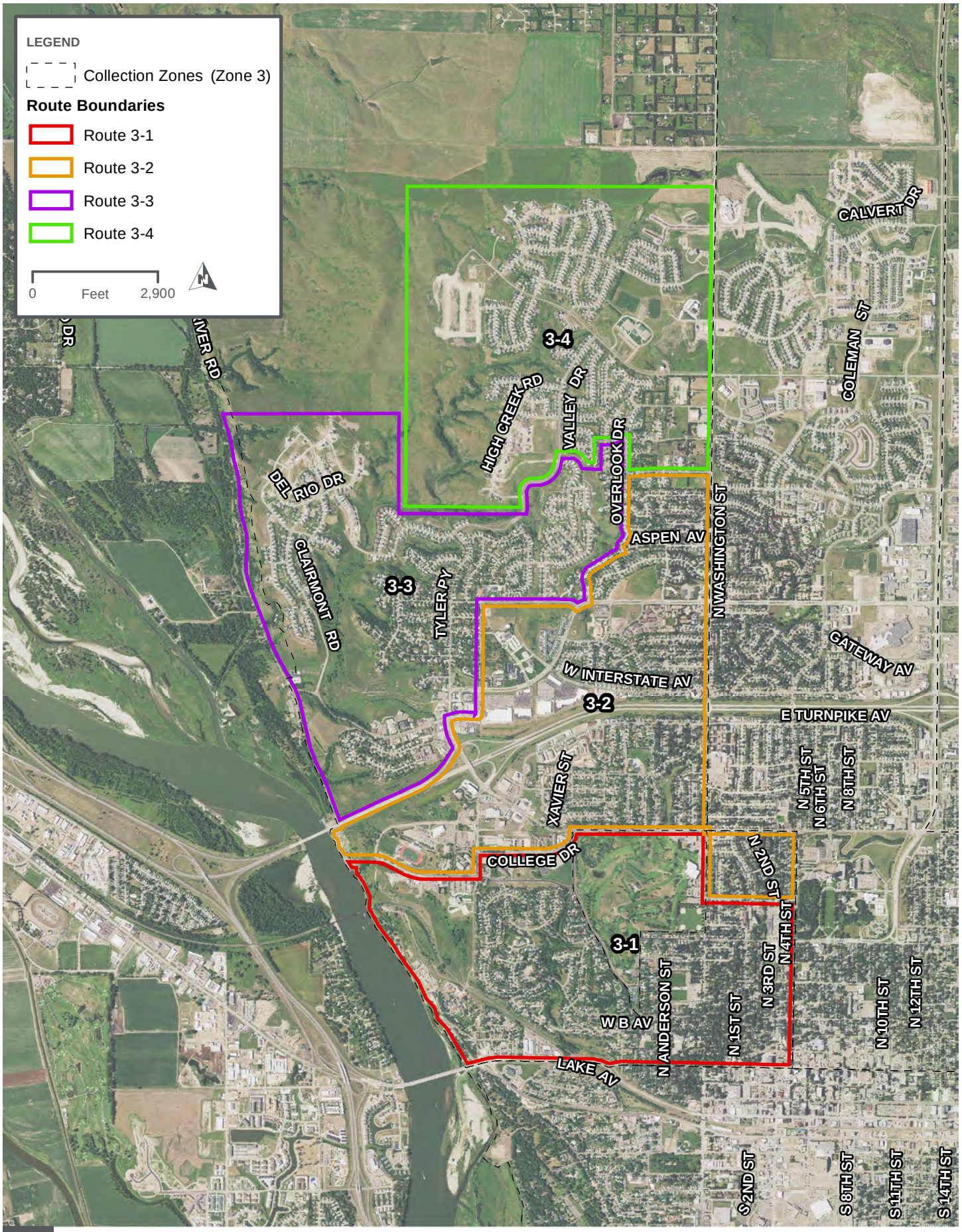
PROPOSED RESIDENTIAL CURBSIDE COLLECTION ROUTES - ZONE 1 (EXHIBIT 6)



CITY OF BISMARCK

RESIDENTIAL WASTE COLLECTION

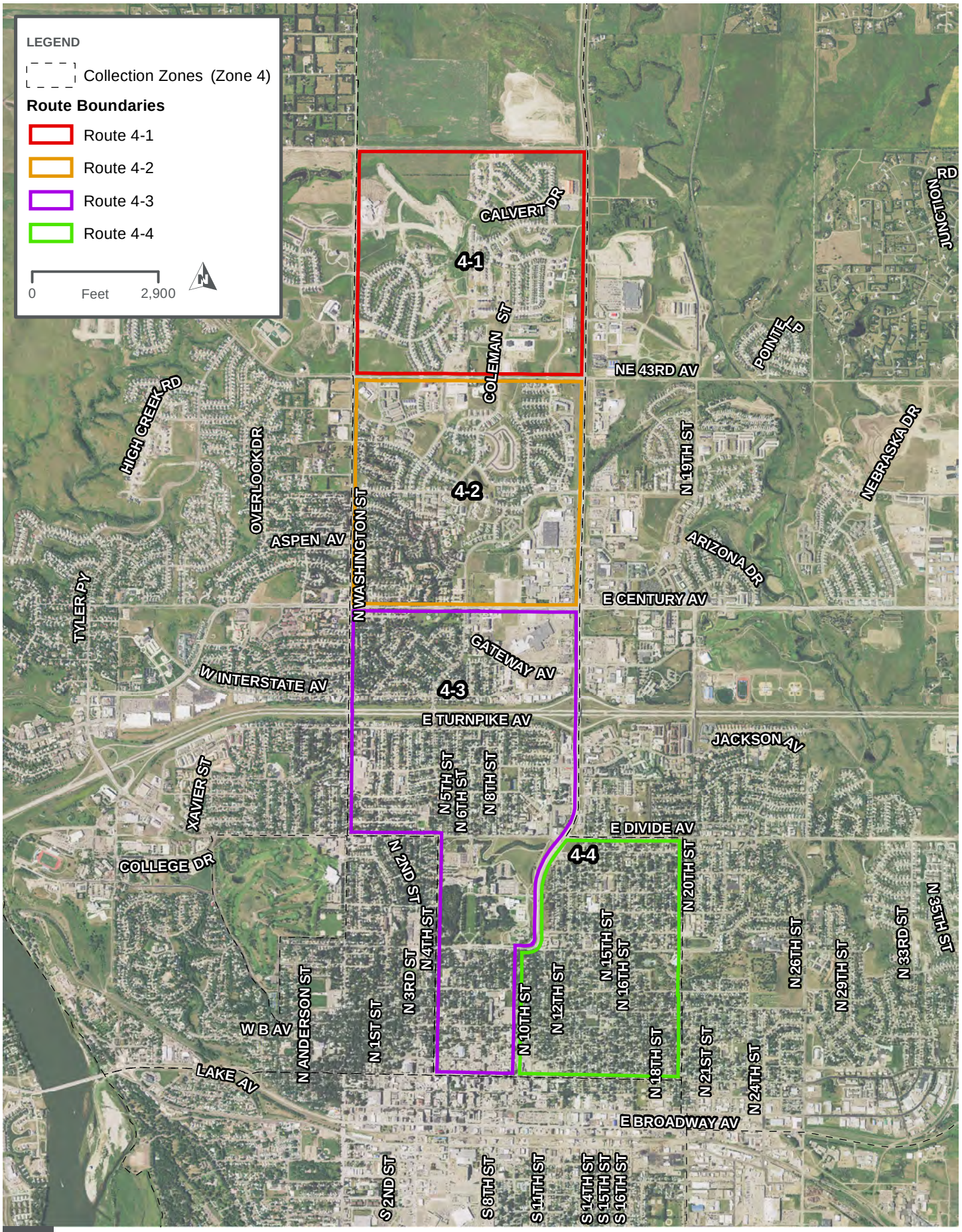
PROPOSED RESIDENTIAL CURBSIDE COLLECTION ROUTES - ZONE 2 (EXHIBIT 7)



CITY OF BISMARCK

RESIDENTIAL WASTE COLLECTION

PROPOSED RESIDENTIAL CURBSIDE COLLECTION ROUTES - ZONE 3 (EXHIBIT 8)



CITY OF BISMARCK

RESIDENTIAL WASTE COLLECTION

PROPOSED RESIDENTIAL CURBSIDE COLLECTION ROUTES - ZONE 4 (EXHIBIT 9)

Appendix B. TM 300 – Evaluation of Current Collection Operations & Identification of Potential System Modifications;

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Technical Memo

Date:	Monday, September 21, 2015
Project:	Solid Waste Management Collection Evaluation
To:	Jeff Heintz, Director of Public Works - Service Operations, City of Bismarck, ND
From:	Bent Erickson, Project Manager, HDR Engineering, Inc.
Subject:	Task 300 – Evaluation of Current Collection Operations & Identification of Potential System Modifications

Introduction

The City of Bismarck (City) contracted with HDR Engineering, Inc. (HDR) to evaluate the City's existing municipal solid waste (garbage) collection system, benchmark the City against other similar communities, and ultimately perform a sensitivity analysis of potential changes to collection services.

The City would like to consider various options for maximizing efficiency and improving services for the municipal collection of residential garbage. The purpose of Task 300 of this Solid Waste Management Collection Evaluation (Study) was to review and evaluate data provided by the City regarding current collection practices with the intent of producing a baseline to allow comparison of the City's current program to other similar municipal operations, as well as identify potential modifications to the City's current program.

The main components of Task 300 included:

- Establishing a baseline of the current collection system;
- Conducting a benchmarking analysis;
- Identifying potential modifications for further evaluation; and
- Preparing a summary memorandum.

This summary memo presents an overview of the results of Task 300 as well as preliminary findings and recommendations for further evaluation of potential modifications to the current residential garbage collection system.

Current System Overview

The Service Operations Division of the Public Works Department for the City is responsible for providing garbage collection to all residential customers in the incorporated area. This includes a combination of curbside collection, alley collection, and collection from apartment complexes.

Residential Curbside Collection - The City provides once a week curbside collection service utilizing 96-gallon carts to approximately 15,423 single-family households. Collection crews are made up of one driver and one collector operating a multi-pack collection vehicle with both an automated side-loading arm and rear-load capabilities (referred to as semi-automated in this memo).

Residential Alley Collection - Once a week alley collection is provided to approximately 3,720 households in the City. Alley customers can set out an unlimited number of containers of up to 35-gallons in size. Alley collection is accomplished using rear-load collection vehicles and crews of one driver and two collectors per vehicle.

Apartment Collection - Collection of waste from apartments is accomplished using a combination of front-load and rear-load collection vehicles to collect from approximately 635 dumpster accounts. Collection of apartment dumpsters occur street side, in parking lot areas, or in alleys, depending on the specific needs and configuration of individual properties.

The City of Bismarck does not provide commercial collection or roll-off containers for construction and demolition debris. Commercial users, mobile home parks, and temporary roll-off container users are serviced by private haulers.

In order to evaluate the efficiency and effectiveness of the current residential collection system and identify opportunities for improvement, HDR first needed to baseline the current system. Our approach involved reviewing data provided by the City. The City provided data including costs and other details relating to labor and equipment used for the residential collection services, which were used in the development of the baseline information.

The baseline development also utilized route observation data collected by City staff. HDR developed a collection route observation form, provided it to the City, and described the process that should be followed by City staff when conducting observations. To date, the summer routes have been observed. (Future tasks will include a winter observation.) City personnel performed the route observations and delivered the completed forms back to HDR for analysis. Over a period of two weeks in June, every route was observed. In total, 38 route observations were performed.

Summary of Route Observation Data

The June route observations yielded the key system metrics shown in Table 1. The first week generally observed curbside services collected with multi-pack trucks that have a side-loading arm as well as rear-loading access. During the second week, observations generally consisted of residential alley and apartment services. It is important to note that the averages related to time and mileage in Table 1 are presented on a per trip basis, and that the collection vehicles made an average of two trips to the disposal facility per collection day.

As shown in Table 1, the average curbside set-out rate is over 90%, which would be expected in a system with once per week collection. The average pounds per set-out for curbside service were approximately 60 pounds, which is consistent with what is seen in other communities. The route observations indicated an average pounds-per-set-out for alley collections of approximately 72 pounds. However, the observations indicated only 1,287 alley units that either had set-outs or were passed by, whereas customer data provided by the City indicated approximately 3,720 residential alley customers. It is believed that the route observations, indicating 1,287 units, were reflecting clusters of alley containers set out and counted as one unit instead of multiple units. As a result, the pounds-per-set-out was estimated under the assumption that the total tons collected on residential alley routes represented 92% of the residential alley customers reflected in the customer data (3,720 units). This resulted in a set-out per household of 25 pounds.

"Average on route time" indicates the amount of time actually spent on the route collecting, and does not include time spent in pre-trip inspections, fueling, traveling to and from the route, breaks/lunch, or time spent at the landfill unloading the vehicles. "Average off route time" indicates the amount of time spent during pre-trip inspections, fueling, traveling to and from the route, and breaks/lunch, but does not include time spent at the landfill unloading the vehicles. "Turnaround time at the landfill" indicates the time it takes to bring loads into the facility, cross the scales, unload the vehicle, and exit the facility. For those employees that had a lunch break while at the landfill, in between loads, the time spent during the lunch/break was not included in the "Turnaround time at the facility" calculation; it was included in "Average off route time".

Table 2 summarizes the curbside collection data gathered during week one of the observations on a per route basis. Table 2 includes the same metrics as Table 1, though on a per "route" basis defined by primary vehicle numbers, and indicates how many vehicles were required to complete the route. While the average on route time per trip for curbside service shown in Table 1 is 1 hour and 53 minutes, and average on route time per trip shown in Table 2 ranges from 1 hour and 38 minutes to 2 hours and 12 minutes, the individual on route time for each trip for curbside service ranged from 1 hour and 25 minutes to 2 hours and 41 minutes. Of the seven routes shown, three of the routes required more than one vehicle to complete the route.

Table 3 and Table 4 summarize the residential alley and apartment dumpster collection data generally gathered during week two of the observations on a per route basis. The route observations determined that the rear-load vehicles are used for both residential alley collection and apartment dumpster routes. Table 3 and Table 4 were created based on the primary customer type serviced by the route. For example, on Monday all of the rear-load trucks were collecting dumpsters. Tuesday through Thursday, the rear-load trucks deployed were primarily collecting residential alley accounts. However, there

were instances of residential alley routes picking up dumpsters from apartment customers.

Table 3 and Table 4 include the same metrics as Table 1 and Table 2, also on a per route basis defined by primary vehicle numbers, and indicate how many vehicles were required to complete the route. While the average on route time per trip for alley service shown in Table 1 is 2 hours and 20 minutes, and average on route time per trip shown in Table 3 ranges from 2 hours and 1 minute to 3 hours and 1 minute, the individual on route time for each trip for residential alley service ranged from 1 hour and 45 minutes to 3 hours and 12 minutes. Of the five routes shown, two of the routes required more than one vehicle to complete the route.

For apartment service, as shown in Table 1, the average on route time per trip is 2 hours and 8 minutes. Table 4 indicates route time per individual trip ranges from 1 hour and 8 minutes to 3 hours and 1 minute.

For curbside and alley/apartment collection, the variance in on route time coupled with the need for multiple trucks to complete certain routes are an indication that there are potential efficiencies to be gained in rebalancing the routes in a manner that would allow one vehicle to complete one route, with more balanced on route times. There may also be potential efficiencies gained in separating alley and apartment collection, where apartments that use dumpsters but are serviced with the same rear-loaders as are used for alley collection, by moving a majority of dumpster service to the front-load route.

Table 1 - Key Metrics Yielded from Route Observations (1)

	Avg. Set-Out Rate	Avg. Lbs./Set-Out	Avg. On Route Miles	Avg. Off Route Miles	Avg. On Route Time hh:mm	Avg. Off Route Time hh:mm	Avg. Turn Around Time at Facility hh:mm	Avg. Trips to Facility per Day
Week 1: **Curbside**	91%	60.2	7.7	8.7	1:53	0:48	0:19	2
Week 2: **Residential Alley**	92%	72.1	6.8	7.5	2:20	0:45	0:22	2
Week 2: **Apartment Dumpsters**	94% (2)	239.6	12.4	9.3	2:08	0:47	0:16	2

Notes:

(1) Miles and times are shown on a per trip basis rather than a per day basis.

(2) The average set-out rate for apartments is not shown as 100% because observations indicated instances where trucks on apartment routes passed by some dumpsters.

Table 2 - Week One Curbside Collection Metrics by Route (1)

Route # Based on Primary Truck #	Avg. Set-Out Rate	Avg. Lbs./Set-Out	Avg. On Route Miles	Avg. Off Route Miles	Avg. On Route Time hh:mm	Avg. Off Route Time hh:mm	Avg. Turn Around Time at Facility hh:mm	Trucks Running Route
3335	89%	59.9	10.4	7.9	2:12	0:48	0:23	1
3409	90%	59.0	8.2	9.7	1:45	0:45	0:14	4
3482	89%	65.1	8.0	7.8	2:05	0:38	0:26	1
3551	92%	59.6	6.6	9.0	1:39	0:57	0:20	5
3552	84%	66.0	5.7	7.5	1:44	0:37	0:27	1
3558	92%	61.4	7.3	9.3	2:04	0:53	0:17	3
3562	95%	48.6	5.5	6.9	1:38	0:41	0:20	1

Notes:

(1) Miles and times are shown on a per trip basis rather than a per day basis.

Table 3 - Residential Alley Metrics by Route (1)

Route # Based on Primary Truck #	Avg. Set-Out Rate	Avg. Lbs./Set-Out	Avg. On Route Miles	Avg. Off Route Miles	Avg. On Route Time hh:mm	Avg. Off Route Time hh:mm	Avg. Turn Around Time at Facility hh:mm	Trucks Running Route
3472	94%	66.0	5.0	11.1	2:20	0:46	0:08	1
3572	94%	62.7	5.3	7.4	2:01	0:44	0:15	2
3573	89%	79.9	7.8	8.1	2:14	0:31	0:26	1
3572-A (2)	98%	66.7	10.0	6.0	3:01	1:03	0:23	2
3573-A (2)	88%	72.1	6.8	4.3	2:53	1:18	0:18	1

Notes:
(1) Miles and times are shown on a per trip basis rather than a per day basis.
(2) On Thursday, trucks 3572 and 3573 drive a primary residential alley route for the first load and an apartment dumpster route for the second load.

Table 4 - Apartment Dumpster Collection Metrics by Route (1)

Route # Based on Primary Truck #	Avg. Set-Out Rate	Avg. Lbs./Set-Out	Avg. On Route Miles	Avg. Off Route Miles	Avg. On Route Time hh:mm	Avg. Off Route Time hh:mm	Avg. Turn Around Time at Facility hh:mm	Trucks Running Route
3472-AA (2)	100%	183.2	Not Available	Not Available	2:39	1:02	0:17	1
3472-BB (2)	95%	207.1	8.0	11.5	1:39	1:16	0:25	1
3478 (rear)	100%	193.2	8.0	9.3	3:01	0:42	0:48	1
3557 (front)	99%	309.3	14.1	9.8	1:56	0:37	0:10	2
3572 (rear)	91%	231.8	16.5	8.9	2:57	0:54	0:12	1
3572-B (3)	100%	156.2	5.9	11.0	1:21	0:45	0:17	2
3573-B (3)	100%	196.5	3.8	6.7	1:08	0:18	Not Available	1

Notes:
(1) Miles and times are shown on a per trip basis rather than a per day basis.
(2) Route 3472-AA was observed on the first week with route 3472-BB observed the second week.
(3) On Thursday, trucks 3572 and 3573 drive a primary residential alley route for the first load and an apartment dumpster route for the second load.

Baseline of Current Operations

The City currently organizes its residential garbage collection routes based on truck type used to collect the materials rather than basing them on customer type served. The City's typical weekly deployment of collection vehicles is illustrated in Table 5.

Table 5 - Typical Truck Deployments, Garbage Collection

	Number of Trucks Deployed				
Truck Type	**Monday**	**Tuesday**	**Wednesday**	**Thursday**	**Friday**
Multi-Pack	3	5	5	5	5
Rear-Load Residential Alley	0	2	2	2 (1)	0
Rear-Load Dumpsters	4	0	0	0	1
Front-Load	1 (2)	1	0	1	1
Total	**8**	**8**	**7**	**8**	**7**

Notes:

(1) On Thursday the two rear-loads deployed were observed to collect residential alley routes for their first load and apartment dumpsters for their second load.
(2) On Monday, a rear-load truck finished early and switched to a front-load truck to help on one of the other routes.

With regard to total trucks, the route observations conducted were related only to garbage collection. However, the City also operates 18 yard debris collection sites around the City that consist of dumpsters that are collected seven days a week during the growing season. As noted in Table 6, the City deploys three rear-load vehicles for yard debris collection from these sites each day from May through October.

Table 6 - Typical Truck Deployments, Yard Debris (1)

	Number of Trucks Deployed						
Truck Type	**Monday**	**Tuesday**	**Wednesday**	**Thursday**	**Friday**	**Saturday**	**Sunday**
Multi-Pack	0	0	0	0	0	0	0
Rear-Load	3	3	3	3	3	3	3
Front-Load	0	0	0	0	0	0	0
Total	**3**	**3**	**3**	**3**	**3**	**3**	**3**

Notes:

(1) May through October only.

Table 7 provides an overview of the City's collection fleet including the total number of collection vehicles by type, the maximum number of each type that is deployed for collection efforts on a given day, the number of spare vehicles, and spare ratios of each type the City has on hand.

Table 7 - Collection Fleet Summary

Truck Type	Total Fleet	Max Deployed	Spare	Spare Ratio
Multi-Pack	9	5	4	80%
Rear-Load	10	7	3	43%
Front-Load	2	1	1	100%

HDR endeavored to model the City's residential garbage collection operations on a customer type basis (i.e. curbside collection, alley collection, and apartment collection). However, the fact that many of the City's collection vehicles commonly pick up material from a variety of customer types on the same route made this difficult to accomplish for apartment collection. The following sections document assumptions and provide metrics used to model the curbside and residential alley collection. However, it was not possible to model the apartment collection in an informative manner.

Residential Curbside Collection

The City's current curbside garbage collection service is provided once a week to each household and is comprised of three routes on Monday and five routes Tuesday through Friday, for a total of 23 routes per week. Two-person crews (one driver and one collector) use multi-pack collection vehicles to collect 96-gallon carts from each household. Table 8 shows the number of set-outs (homes that set out material for collection), pass-by's (homes that did not set out material for collection), and total homes per route defined by primary vehicle number for curbside service, as observed the week of June 8, 2015. As shown, there was an average of 671 homes per curbside garbage collection route.

Table 8 – Household Counts by Semi-Automated Route

Date	Route Based on Primary Truck #	Set-Out	Pass-By	Total	# Trucks
June 8	3335	574	51	625	1
	3409	1020	79	1099	3
	3558	637	35	672	2
June 9	3335	683	51	734	1
	3482	576	78	654	1
	3551	416	32	448	1
	3558	737	63	800	3
	3562	558	22	580	1
June 10	3335	313	64	377	1
	3409	893	134	1027	3
	3482	482	35	517	1
	3551	534	44	578	2
	3558	463	36	499	1
June 11	3335	553	87	640	1
	3409	817	135	952	3
	3482	499	70	569	1
	3551	620	65	685	2
	3558	540	85	625	2
June 12	3335	706	72	778	1
	3409	269	60	329	1
	3482	517	74	591	1
	3551	1120	95	1215	4
	3552	366	63	429	1
Total		**13,893**	**1,530**	**15,423**	**38**
Average		**604.04**	**66.52**	**670.57**	**1.65**

Based on the information provided by the City and data gathered during the summer route observations, curbside garbage collection staff appears to be working an average of 6 hours and 36 minutes per collection day. This time is inclusive of all on-route time, off-route time, turnaround time at the disposal facility, lunches/breaks, and inspection time. (It should be noted that the average hours worked per day is anticipated to be higher in the winter due to additional challenges in collecting in snow and icy conditions.)

In developing the baseline operational model for curbside collection, which will be used in future tasks to evaluate potential operational and cost impacts of proposed changes to the system, HDR used a variety of data provided by the City along with the route observation data to calculate a series of metrics for the existing system. The raw data and calculated metrics presented in Table 9 through Table 13 will be reviewed with City staff prior to modeling potential modifications to the system, which will ultimately show

comparisons of these key elements of the baseline system with the potential modifications.

Table 9 presents raw data and calculated metrics related to residential curbside route service.

Table 9 – Residential Curbside Route Service Metrics

Raw Data	
Number of Accounts	15,423
Number of Collection Days per Week (1)	4.6
Number of Collections per Household per Week	1
Number of Multi-Pack Trucks in Service per Collection Day	5
Avg. Set-out Rate	91%
Avg. Lbs. per Household per Week	60.2
Multi-Pack Truck Load Limit (lbs.) (2)	20,000
Avg. On Route Time per Trip (hrs.)	1.88
Avg. Turn Around Time at Disposal Facility per Trip (hrs.)	0.32
Avg. Off Route Time Per Trip (hrs.) (3)	0.28
Avg. Additional Off Route Time per Day (4)	0.57
Avg. Trips to Disposal Facility per Truck per Day	2

Calculated Metrics	
Number of Stops per Week	14,035
Multi-Pack Stops per Hour	324
Multi-Pack Avg. Stops Per Route	610
Multi-Pack Total Homes per Route	671
Total Pounds per Route	36,735
Avg. Weight per Load (lbs.)	18,367
Avg. Time per Trip (hrs.) (5)	2.48
Avg. Collection Time per Day (6)	5.53
Stops per Day	3,051

Notes:

(1) While the City runs a total of 23 curbside collection routes five days per week (Monday–Friday), it runs five collection routes Tuesday through Friday and just three routes on Monday. For modeling purposes we have assumed 5 routes per collection day, which results in an average of 4.6 collection days.
(2) Assumes a 25 cubic yard vehicle capacity multiplied by an estimated 800 lbs. per cubic yard of waste.
(3) Off Route Time per Trip does not include lunch time as lunch is taken once per shift not once per trip.
(4) Additional off-route time includes daily lunch break and inspection time.
(5) The average time per trip was calculated by adding together the average on-route time per trip (1.88 hrs.), the average turnaround time at disposal facility per trip (0.32 hr.), and the average off-route time per trip (0.28 hr.).
(6) The average collection time per day was calculated by multiplying the average time per trip (2.48 hrs.) by the average number of trips to the disposal facility per truck per day (2) and then adding to that the average additional off-route time per day (0.57 hr.).

Table 10 presents raw data and calculated metrics related to residential curbside labor.

Table 10 – Residential Curbside Labor Metrics

Raw Data	
Number of Routes per Day	5
Sanitation Collectors per Crew	1
Truck Drivers per Crew	1
Total Number of Sanitation Collectors	5
Total Number of Truck Drivers	5
Supervisors	1
Supervisors per Employee	0.10
Total Number of Supervisors	1
Avg. Annual Salary and Benefits - Sanitation Collectors	$56,473
Avg. Annual Salary and Benefits - Truck Drivers	$62,792
Avg. Annual Salary and Benefits - Supervisors	$98,807
Annual Incidentals Cost per Employee (1)	$350

Calculated Metrics	
Annual Salaries and Wages – Sanitation Collectors (2)	$282,365
Annual Salaries and Wages – Truck Drivers (2)	$313,960
Annual Salaries and Wages – Supervisors (2)	$98,807
Total Annual Salaries and Wages (3)	$695,132
Total Annual Incidentals Expense (4)	$3,850
Estimated Annual Labor Related Expense (5)	$698,982

Notes:

(1) HDR assumed an incidentals cost of $350 per employee per year to cover the cost of uniforms, personal protective equipment (PPE), etc.
(2) Annual salaries and wages for each of the three position types were calculated by multiplying the average annual salary and benefits for the position by the total number of employees in the position.
(3) Total annual salaries and wages were calculated by summing the total annual salaries and wages for sanitation collectors ($282,365), truck drivers ($313,960), and supervisors ($98,807).
(4) Total annual incidentals expense was calculated by multiplying the annual incidentals cost per employee ($350) by the total number of employees (11).
(5) Estimated annual labor expense was calculated by summing total annual salaries and wages and total annual incidentals expense.

Table 11 presents raw data and calculated metrics related to residential curbside operations.

Table 11 – Residential Curbside Operations Metrics

Raw Data	
Average Miles per Trip	16.4
Average Fuel Economy (mpg)	4.0
Number of Routes per Day	5
Number Multi-Pack Collection Vehicles Excluding Spares	5
Spare Ratio (%)	80%
Number of Spare Multi-Pack Collection Vehicles	4
Total Number of Multi-Pack Collection Vehicles	9
Maintenance and Repair ($/vehicle/year)	$14,600
Fuel ($/gallon)	$2.69
Insurance ($/vehicle/year)	$276

Calculated Metrics	
Annual Miles per Curbside Collection Vehicle (1)	7,865
Annual Gallons per Curbside Collection Vehicle (2)	1,966
Total Annual Maintenance & Repair Expense (3)	$131,400
Total Annual Fuel Expense (4)	$26,446
Total Annual Insurance Expense (5)	$2,486
Estimated Annual Operating Expense (6)	$160,331

Notes:

(1) Annual miles per curbside collection vehicle = [[average miles per trip (16.4) x average number of trips per truck per collection day (2) x number of routes per week (23)] / number of routes per day (5)]] x 52 weeks per year.
(2) Gallons per curbside collection vehicle were calculated by dividing the annual miles per curbside collection vehicle by the average fuel economy.
(3) Total annual repair and maintenance expense was calculated by multiplying the annual maintenance and repair expense per vehicle ($14,600) by the total number of multi-pack collection vehicles (9).
(4) Total annual fuel expense = fuel price per gallon ($2.69) x annual gallons per curbside collection vehicle (1,966) x number of multi-pack collection vehicles excluding spares (5).
(5) Total annual insurance expense was calculated by multiplying the annual insurance expense per vehicle ($276) by the total number of multi-pack collection vehicles (9).
(6) Estimated annual operating expense was calculated by summing the annual maintenance and repair expense ($131,400), the annual fuel expense ($26,446), and the annual insurance expense ($2,486).

Table 12 presents raw data and calculated metrics related to residential curbside annual capital outlays.

Table 12 – Residential Curbside Capital Metrics

Raw Data	
Cost of Multi-Pack Collection Truck (New)	$305,000
Cost of Automated Cart (New)	$50
Total Number of Multi-Pack Trucks in Fleet	9
Total Number of Automated Carts	15,423

Calculated Metrics	
Annual Vehicle Capital Cost (1)	$392,143
Annual Cart Cost (2)	$77,115
Estimated Annual Capital Outlay (3)	$469,258

Notes:

(1) Annual vehicle capital cost is based on a seven year vehicle life and seven year straight amortization of all vehicle expenses.
(2) Annual cart cost is based on ten year straight amortization of all cart expenses.
(3) Estimated annual capital outlay is calculated by summing the annual vehicle capital cost and annual cart cost.

Table 13 presents a summary of the estimated total annual costs associated with the City's residential curbside collection operations. Total annual expenses for curbside collection are estimated at approximately $1.34 million.

Table 13 – Residential Curbside Estimated Total Annual Cost

Total Annual Labor Cost	$698,982
Total Annual Vehicle Operating Cost	$160,331
Total Annual Operating Cost	**$ 859,313**
Total Annual Vehicle Capital Cost	$392,143
Total Annual Cart Cost	$77,115
Total Annual Capital Cost	**$469,258**
Estimated Total Annual Cost	**$1,328,571**

Residential Alley

As previously described, there are approximately 3,720 homes included in alley collection. The current collection system for residential alley service includes rear-load vehicles that also collect a limited number of dumpsters (a hook is used to unload dumpsters into the rear of the vehicle).

The City's current residential alley collection service is provided once a week to each household and is comprised of two routes on Tuesday, Wednesday and Thursday for a total of six routes each week. On Wednesday, the two routes were observed to be completed by noon. Similarly, on Thursday, the two routes completed a primarily

residential alley trip before collecting apartments in the afternoon. For the purposes of the existing conditions operational model, it was assumed that there is an average of two routes per day two days a week. Three person crews (one-driver and two collectors) use rear-load collection vehicles to collect waste from user provided cans.

Table 14 shows the number of set-outs, pass-by's and total residential alley collections observed. Also shown is the number of dumpsters picked up on the route, as reported by the observers. It should be noted that the total number of residential alley collections (1,287) is significantly lower than the number of estimated accounts (3,720). The difference is assumed to be attributed to the fact that residential alley customers supply their own collection cans and these tend to be grouped together in the alley. Making a determination of the number of households represented in a grouping, or collected at a specific stop, was likely difficult to achieve during the manual observations.

Table 14 – Household Counts by Residential Alley Route

Day	Route Based on Primary Truck #	Residential Alley Set-Out	Residential Alley Pass-By	Residential Alley Total	Dumpsters	# Trucks
Tues.	3572	358	22	380	4	2
	3573	305	17	322	0	1
Wed.	3472	151	9	160	0	1
	3573	110	22	132	17	1
Thur.	3572-A	114	0	114	86	2
	3573-A	169	10	179	30	1
Total		**1207**	**80**	**1287**	**137**	**8**
Average		**201.17**	**13.33**	**214.50**	**22.83**	**1.33**

In developing the baseline operational model for alley collection, which will be used in future tasks to evaluate potential operational and cost impacts of proposed changes to the system, HDR used a variety of data provided by the City along with the route observation data to calculate a series of metrics for the existing system. The raw data and calculated metrics presented in Table 15 through Table 19 will be reviewed with City staff prior to modeling potential modifications to the system, which will ultimately show comparisons of these key elements of the baseline system with the potential modifications.

Table 15 presents raw data and calculated metrics related to residential alley route service.

Table 15 – Residential Alley Route Service Metrics

Raw Data	
Number of Accounts	3,720
Number of Collection Days per Week (1)	2
Number of Collections per Household per Week	1
Number of Multi-Pack Trucks in Service per Collection Day	2
Avg. Set-out Rate	92%
Avg. Lbs. per Household per Week (2)	24.6
Multi-Pack Truck Load Limit (lbs.) (3)	20,000
Avg. On Route Time per Trip (hrs.)	2.33
Avg. Turn Around Time at Disposal Facility per Trip (hrs.)	0.37
Avg. Off Route Time Per Trip (hrs.) (4)	0.27
Avg. Additional Off Route Time per Day (5)	0.57
Avg. Trips to Disposal Facility per Truck per Day	2

Calculated Metrics	
Number of Stops per Week	3,422
Multi-Pack Stops per Hour	367
Multi-Pack Avg. Stops Per Route	855.6
Multi-Pack Total Homes per Route	930
Total Pounds per Route	21,048
Avg. Weight per Load (lbs.)	10,524
Avg. Time per Trip (hrs.) (6)	2.97
Avg. Collection Time per Day (7)	6.51
Stops per Day	1,711

Notes:

(1) While the City runs a total of 6 curbside collection routes three days per week (Tuesday–Thursday), the routes Wednesday and Thursday complete only one trip dedicated to alleys before either collecting dumpsters or finishing for the day. For modeling purposes we have assumed 2 routes per collection day, which results in an average of 2 collection days.

(2) Assumes the total tons collected by the trucks during observations represented 92% (set-out rate) of the total number of accounts (3,270).

(3) Assumes a 25 cubic yard vehicle capacity multiplied by an estimated 800 lbs. per cubic yard of waste.

(4) Off Route Time per Trip does not include lunch time as lunch is taken once per shift not once per trip.

(5) Additional off-route time includes daily lunch break and inspection time.

(6) The average time per trip was calculated by adding together the average on-route time per trip (2.33 hrs.), the average turnaround time at disposal facility per trip (0.37 hr.), and the average off-route time per trip (0.27 hr.).

(7) The average collection time per day was calculated by multiplying the average time per trip (2.97 hrs.) by the average number of trips to the disposal facility per truck per day (2) and then adding to that the average additional off-route time per day (0.57 hr.).

Table 16 presents raw data and calculated metrics related to residential alley labor.

Table 16 – Residential Alley Labor Metrics

Raw Data	
Number of Routes per Day	2
Sanitation Collectors per Crew	2
Truck Drivers per Crew	1
Total Number of Sanitation Collectors	4
Total Number of Truck Drivers	2
Supervisors	1
Supervisors per Employee	0.17
Total Number of Supervisors	1
Avg. Annual Salary and Benefits - Sanitation Collectors	$56,473
Avg. Annual Salary and Benefits - Truck Drivers	$62,792
Avg. Annual Salary and Benefits - Supervisors	$98,807
Annual Incidentals Cost per Employee (1)	$350

Calculated Metrics	
Annual Salaries and Wages – Sanitation Collectors (2)	$225,892
Annual Salaries and Wages – Truck Drivers (2)	$125,584
Annual Salaries and Wages – Supervisors (2)	$98,807
Total Annual Salaries and Wages (3)	$450,283
Total Annual Incidentals Expense (4)	$2,450
Estimated Annual Labor Related Expense (5)	$452,733

Notes:

(1) HDR assumed an incidentals cost of $350 per employee per year to cover the cost of uniforms, personal protective equipment (PPE), etc.
(2) Annual salaries and wages for each of the three position types were calculated by multiplying the average annual salary and benefits for the position by the total number of employees in the position.
(3) Total annual salaries and wages were calculated by summing the total annual salaries and wages for sanitation collectors ($225,892), truck drivers ($125,584), and supervisors ($98,807).
(4) Total annual incidentals expense was calculated by multiplying the annual incidentals cost per employee ($350) by the total number of employees (7).
(5) Estimated annual labor expense was calculated by summing total annual salaries and wages and total annual incidentals expense.

Table 17 presents raw data and calculated metrics related to residential alley operations.

Table 17 – Residential Alley Operations Metrics

Raw Data	
Average Miles per Trip	14.3
Average Fuel Economy (mpg)	4.0
Number of Routes per Day	2
Number Multi-Pack Collection Vehicles Excluding Spares	2
Spare Ratio (%)	50%
Number of Spare Multi-Pack Collection Vehicles	1
Total Number of Multi-Pack Collection Vehicles	3
Maintenance and Repair ($/vehicle/year)	$14,600
Fuel ($/gallon)	$2.69
Insurance ($/vehicle/year)	$276

Calculated Metrics	
Annual Miles per Curbside Collection Vehicle (1)	4,462
Annual Gallons per Curbside Collection Vehicle (2)	1,115
Total Annual Maintenance & Repair Expense (3)	$43,800
Total Annual Fuel Expense (4)	$6,001
Total Annual Insurance Expense (5)	$828
Estimated Annual Operating Expense (6)	$50,629

Notes:

(1) Annual miles per curbside collection vehicle = [[average miles per trip (14.3) x average number of trips per truck per collection day (2) x number of routes per week (6)] / number of routes per day (2)]] x 52 weeks per year.
(2) Gallons per curbside collection vehicle were calculated by dividing the annual miles per curbside collection vehicle by the average fuel economy.
(3) Total annual repair and maintenance expense was calculated by multiplying the annual maintenance and repair expense per vehicle ($14,600) by the total number of rear-load collection vehicles (3).
(4) Total annual fuel expense = fuel price per gallon ($2.69) x annual gallons per curbside collection vehicle (1,115 x number of rear-load collection vehicles excluding spares (2).
(5) Total annual insurance expense was calculated by multiplying the annual insurance expense per vehicle ($276) by the total number of rear-load alley collection vehicles (3).
(6) Estimated annual operating expense was calculated by summing the annual maintenance and repair expense ($43,800), the annual fuel expense ($6,001), and the annual insurance expense ($828).

Table 18 presents raw data and calculated metrics related to residential alley annual capital outlays.

Table 18 – Residential Alley Capital Metrics

Raw Data	
Cost of Rear-Load Collection Truck (New)	$149,500
Total Number of Rear-Load Trucks in Fleet	3

Calculated Metrics	
Annual Vehicle Capital Cost (1)	$64,071
Estimated Annual Capital Outlay (2)	$64,071

Notes:

(1) Annual vehicle capital cost is based on a seven year vehicle life and seven year straight amortization of all vehicle expenses.

(2) Estimated annual capital outlay is calculated by summing the annual vehicle capital cost and annual cart cost. The current system does not utilize carts, and as a result, the annual capital outlay is equivalent to the annual vehicle capital cost; however alternatives modeled in future tasks may include carts.

Table 19 presents a summary of the estimated total annual costs associated with the City's residential alley collection operations. Total annual expenses for residential alley collection are estimated at approximately $567,000.

Table 19 – Residential Alley Estimated Total Annual Cost

Total Annual Labor Cost	$452,733
Total Annual Vehicle Operating Cost	$50,629
Total Annual Operating Cost	**$503,361**
Total Annual Vehicle Capital Cost	$64,071
Total Annual Cart Cost	$0
Total Annual Capital Cost	**$64,071**
Estimated Total Annual Cost	**$567,433**

Apartment Dumpster Collection

There are approximately 635 dumpster accounts for apartments. The current collection system for alley and apartment service includes rear-load vehicles collecting from alleys as well as apartments, including some apartments with dumpsters (a hook is used to unload dumpsters into the rear of the vehicle). There is also one front-load vehicle that collects from apartments with dumpsters. As shown in Table 5, there are typically four rear-load vehicles running on Monday, two rear-load vehicles running Tuesday through Thursday, and one rear-load vehicle running on Friday. As previously described, there is typically one driver and two collectors on each rear-load route. As shown in Table 5,

there is one front-load vehicle that typically runs Monday, Tuesday, Thursday and Friday, which is operated by one driver (with no collectors).

While the route observations gathered the same route data points for apartment collection as was collected for curbside and alley service, there were challenges in calculating similar metrics for apartment customers serviced with dumpsters included in the model due to differences such as unit counts of individual homes versus dumpsters serving multiple units, which impacted our ability to calculate data related to operations, labor and capital for apartments. (The route observation form may be modified prior to winter observations.)

Benchmarking

HDR performed a preliminary search for regional cities with comparable systems in order to benchmark specific operations and financial metrics. The preliminary search included considering population, housing density, service provider, collection style and frequency of service. A preliminary list of communities, as well as a list of questions/metrics, was developed and discussed with the City prior to contacting the benchmarking communities.

Based on the goals for this Study, the benchmarking was focused on determining the major collection metrics of similar sized communities using semi-automated and fully automated methods for residential collection and the total cost of collection service in these communities. With regard to the major collection metrics, the survey focused on the number of residential customers, total weekly collection routes and availability of curbside recycling, yard debris collection and bulk waste disposal. Financial metrics were focused on a break-down of the monthly collection fee charged to residential customers to determine the level of service included and the estimated costs.

The preliminary list included approximately 15 communities in an effort to receive responses from a minimum of six. Any communities that utilize private or contract collection services for residential garbage collection were not included in the benchmarking metrics. Communities with privatized collection that are similarly sized to Bismarck included: Sioux Falls, SD; Vermillion, SD; Rochester, MN; Maple Grove, MN; and Duluth, MN. Benchmarking information was obtained from eight regional communities with varying degrees of completeness and detail. The complete benchmarking matrix is available as an attachment to this memorandum.

Of the communities contacted, Bismarck is unique in using multi-pack vehicles for residential, automated cart collection service. For the purposes of this benchmarking analysis Bismarck’s collection that utilizes multi-pack trucks is considered semi-automated.

Table 20 - Benchmarking Overview – Garbage Collection

Community	Number of Households (1)	Style of Collection	Frequency of Collection	# of Routes per Week	Fee Type
Bismarck, ND	19,180 (2)	Manual & Semi-Automated (5)	1 x week	23 Multi-Pack 8 - Manual	Fixed
Fargo, ND	26,000 (3)	Automated	1 x week	30	Volumetric
Grand Forks, ND	22,000 (3)	Automated & Semi-Automated (6)	1 x week	20	Volumetric
Minot, ND	11,.500	Manual	2 x week	25	Fixed
Mankato, MN	10,000	Automated	1 x week	15	Volumetric
Moorhead, MN	11,000	Automated	1 x week		Volumetric
Fergus Fall, MN	4,400	Automated	1 x week	10	Volumetric
Aberdeen, SD	8,000	Manual	1 x week	16	Fixed
Billings, MT	34,000 (4)	Automated	1 x week	28	Fixed

Notes:

(1) Residential accounts
(2) 15,423 curbside customers and 3,720 alley customers
(3) Includes alley accounts collected via automated service
(4) 17,000 90-gal containers and 8,500 300-gallon containers collected using the same vehicles
(5) Semi-automated is side-load with rear compactors (multi-pack trucks)
(6) Semi-automated is front-load with automated tippers

As shown in Table 20 above, the preferred frequency for residential garbage collection is one time per week. This is largely due to the regional adoption of collection technology utilizing fully automated or semi-automated collection with carts. Similarly the majority of the regional, automated collection services have a volumetric based fee structure, meaning that there are multiple cart sizes available for a range of monthly fees.

Fully automated operations are able to maximize productivity as compared to semi-automated systems. However, fully automated options may not meet the needs of all communities. It is common for municipalities to incorporate a blend of fully automated and semi-automated operations to address specific service requirements unique to their community. For example, it is not uncommon for residential curbside collection to be fully automated and residential alley collection to consist of semi-automated or manual

service. The success of any collection system rests on the establishment of a comprehensive “Code of Ordinances” that can be fairly and uniformly enforced to maximize efficiencies and adherence to the designed service.

Manual Collection Comparison

Table 21 summarizes the benchmarking communities that perform manual residential collection. The City of Bismarck is included in the table for comparison.

Table 21 - Manual Service Metrics

Metric	Bismarck	Minot	Aberdeen
Housing Density (Units/mi^2)	544	659	512
Avg. Households/Route	671 (semi-auto)	575	400
Set-Out Limits	Limited (1)	32 gal containers	In container (2)
Work Week	5 days	4 days	4 days
Hours per Day	8	8	8
Bulk Waste Curbside	Yes	Yes	No
Recycling Curbside	Yes - Contract	No	Yes – Contract
Yard Debris Curbside	No	No	No
Enforcement	Drivers	Drivers	Drivers
Monthly Fee	$16.12	$10.18	$13.50

1) Set-out quantity is limited to truck lifting capability and capacity.
2) Must be contained within the selected size container.

The number of routes required is impacted by a number of variables including set-out rates (the percent of homes that set-out garbage for collection in a given week), average pounds per set out (how much garbage is set out at each home), set-out restrictions (limits on the amount, size, or manner in which garbage can be placed out for collection), the level of enforcement of set-out restrictions, route timing, and staff configuration.

Bismarck’s residential collection service is a mixture of manual collection from alley customers and semi-automated collection from curbside customers. The increased efficiency of the semi-automated curbside collection is reflected in Bismarck’s collection service showing a higher average number households served per route compared to the communities with manual collection.

Based on conversations with the Minot and Aberdeen collections staff, it was determined that neither community had detailed formal metrics for set-out rates or timing of routes. Both communities compared well to Bismarck as each provides residential collection in both newer areas via curbside collection and via alleys in older portions of the community. It should be noted that Minot collects each account twice per week and based on anecdotal observations by the Minot staff, the set-out rate is not consistent for each collection day. It is common for curbside set-outs to drop below 50% on the second collection day in communities that offer twice per week collection.

Automated Collection Comparison

Table 22 below summarizes the benchmarking communities that perform automated or semi-automated residential collection. The City of Bismarck is included in the table for comparison purposes even though the collection system is not considered fully automated for the purposes of this analysis.

The number of routes required is impacted by a number of variables including set-out rates (the percent of homes that set out garbage for collection in a given week), average pounds per set out (how much garbage is set out, on average, at each home), set out restrictions (limit on the amount, size, or manner in which garbage can be placed out for collection), the level of enforcement of set out restrictions, route timing and staff configuration.

As shown in Table 22, the majority of the surveyed automated collection service communities have a higher average number of homes serviced per route when compared to Bismarck. For example, based on the survey, Billings, Fargo and Grand Forks have developed collection routes for curbside residential, alleys and multifamily that is nearly fully automated. This is reflected in the number of accounts that an average route can service each day. Each of these communities has a volumetric collection fee structure that forces the users to limit refuse collection to dedicated containers or pre-purchased bags.

The communities surveyed did not have formal set-out rates or time metrics for their collection systems. All reported that observed set-out rates were over 90%. Based on the published data and conversations with the collection staff of each community, Billings, Fargo and Grand Forks have similar solid waste systems to the City of Bismarck as each community provides collection services and owns the landfill where the waste is disposed. The Minnesota communities only operated a collection system and disposal occurs at a private landfill or transfer station.

It is anticipated that the City of Bismarck could realize similar average households per route as Fargo, Grand Forks and Billings by implementing fully automated residential curbside collection and refined semi-automated alley collection.

Table 22 - Automated Service Metrics

Metric	Bismarck	Fargo	Grand Forks	Mankato	Fergus Falls	Moorhead	Billings
Housing Density (Units/mi^2)	544	532	1,095	547	286	555	585
Avg. Households/Route	671	866	1,100	666	440	No Response	910
Set-Out Limits - Garbage	Limited (1)	Must be in container (2)	Must be in container (2)	Must be in container or pre-purchased bag (2)	Must be in container (2)	Must be in container or pre-purchased bag (2)	Must be in container (2)
Work Week	5 days	5 days	5 days	5 days	5 days	5 days	4 days
Hours per Day	8	8	8	8	8	8	10
Bulk Waste Curbside	Yes	Fee	Fee	Fee	Fee	Fee	Yes
Recycling Curbside	Yes - Contract	Yes	Yes - Contract	Yes - Contract	Yes - Contract	Yes	No
Yard Debris Curbside	No	No	Yes	Yes	No	Yes	Yes
Enforcement	Drivers	Drivers/Admin	Drivers/Admin	Drivers/Admin	Drivers/Admin	Drivers/Admin	Drivers/Admin
Monthly Fee	$12.31 (96 Gal) $3.81 (Recycle) $16.12 Total	$6 (48 Gal) $9 (64 Gal) $14 (96 Gal)	$15.82 per 60 Gal Container	$11 (35 Gal) $16 (65-Gal) $25 (95 Gal)	$16 (65-Gal) $25 (95 Gal)	$11 (35 Gal) $16 (65-Gal) $25 (95 Gal)	$8.98

1) Set-out quantity is limited to truck lifting capability and capacity.
2) Must be contained within the provided, selected size (if available) container.

Monthly Fee Summary

Table 23 below summarizes the monthly residential collection fee for each community surveyed. The table summarizes the total fee charged to the residential user class, indicates which services are provided and summarizes if the cost of service for collection and disposal is being covered by the fee collected. Many of the communities surveyed that performed both collections and operated a landfill indicated that the residential collection cost of service was subsidized by the commercial tipping fee from the landfill or the general fund.

Table 23 - Monthly Fee Summary

Community	Monthly Fee (1)	Fee Type	Services Included (2)	Costs Included (3)	Notes
Bismarck, ND (7)	$16.12	Fixed	G, R, B	G, R, B, D	(5)
Fargo, ND (7)	$14	Volumetric	G, R	G, R	(5)
Grand Forks, ND (7)	$15.82	Volumetric	G, R, Y	G, R, Y	(5)
Minot, ND (7)	$10.18	Fixed	G	G, D	(6)
Mankato, MN (8)	$25	Volumetric	G, R, Y	G, R, Y, D	(4)
Moorhead, MN (8)	$25	Volumetric	G, R, Y	G, R, Y, D	(4)
Fergus Fall, MN (8)	$25	Volumetric	G, R	G, R, Y, D	(4)
Aberdeen, SD (8)	$13.50	Fixed	G, R, B	1 x week	(4)
Billings, MT (7)	$8.98	Volumetric	G, R, B	G, R, B, D	(6)

Notes:

(1) For volumetric fee structures, this is the largest container fee.
(2) Curbside services: G=Garbage, R=Recycling, Y=Yard Debris, B=Bulk Waste.
(3) Costs of service: G=Garbage, R=Recycling, Y=Yard Debris, B=Bulk Waste, D=Disposal.
(4) Fee covers cost of service for collections and disposal.
(5) Fee covers cost of service for collections; Disposal costs are covered by other income.
(6) Fee does not cover full cost of service for collection and disposal.
(7) Municipality owns and operates a municipal solid waste landfill.
(8) Municipality hauls waste for disposal at a third part municipal solid waste landfill.

Key Findings & Potential System Modifications

This section provides general discussion on key findings from the route observations and benchmarking tasks, and provides some general industry standard metrics to compare to the City's metrics. This section also identifies potential system modifications to be considered for residential garbage collection, based on the results of the baseline efforts, route observations, and benchmarking tasks, as well as discussions with City staff. As previously noted, at the time of this writing, only the summer route observations have been completed; results of winter route observations may impact certain aspects of the potential modifications described in this section.

General System Key Findings

Based on the review of the system data and route observations, the following general system key findings were identified:

- Residential curbside collection consists of a semi-automated service with limited collection restrictions placed on the customers.
- Residential alley collection consists of manual service with limited collection restrictions placed on the customers.
- Apartment collection service consists of dumpster collections. Collection restrictions are provided by the fee charged for dumpster size and frequency of collection.
- Currently, the collection service is managed by collection truck type and not customer service type. For example residential alley collection occurs on the same routes as apartment collection.
- Collection routes are not documented in a graphic format (maps).
- Customer account numbers and types were difficult to determine based on the current process used to manage the data.
- Asset management of containers and dumpsters is limited. It was difficult to determine the location of City owned dumpsters and the locations where City containers have been deployed.
- The City currently has an 80% spare ratio for multi-pack vehicles, which is higher than a typical 30% spare ratio that is generally recommended for automated/semi-automated vehicles.
- Collection crews return to the landfill for lunch breaks, which means vehicles are not necessarily at or near capacity when returning to the landfill. Changing this practice has the potential to make routes more efficient by only having collection vehicles return to the landfill when they are at or near capacity or at the end of a collection day.

Potential over-arching utility modifications that could benefit the system include:

- Implement a refined asset management mechanism utilizing the City's GIS databases to track deployed containers, track customer pickup locations, summarize customer service type by property, and document individual collection routes.
- Rebalance and document collection routes.
- Revise vehicle replacement policies to more efficiently manage spare ratios.
- Revise collection routes by customer service type.
- Adopt and enforce residential set-out limits (amount of waste) and restrictions (how waste is containerized) for the purpose of increasing the number of accounts that can be collected by individual routes.
- Change collection technology for the purpose of increasing the number of accounts that can be collected by individual routes.

General Recommendations

HDR recommends that the City implement an asset management program for the solid waste utility that includes:

- Tracking customer service type (i.e. curbside, alley or apartment) and type/size of deployed containers (carts or dumpster), by property.
- Delineating individual residential collection routes, by customer type (e.g. curbside, alley, dumpster).

The City could expand the existing GIS data sets to include these items. Having a solid foundation of assets, customer locations and collection routes will allow for the refinement and optimization of the utility, regardless of future changes.

The following sections describe the detailed findings and potential system modifications, by customer class.

Curbside Service Key Findings & Potential Modifications

- The City's current curbside garbage collection system covers an average of 671 homes per route as shown by the route observations, which is well within the range of 500 to 800 homes per route that is typically observed in manual and semi-automated collection systems. (In fully automated systems, garbage routes typically cover between 1,000 and 1,300 homes per route.)
- With the City's current semi-automated system, where residents have carts but are also allowed to place items outside of the carts, the City uses multi-pack vehicles that have side-arm loading capabilities in addition to rear-loading capabilities.
- It was observed that three of the seven curbside routes required more than one vehicle to complete the route. It was also observed that the time spent on the routes varied widely.

These metrics indicate the following potential modifications should be considered for curbside service:

- **Rebalance** curbside garbage routes (with existing vehicles) to allow for more efficient and equitable routes, balancing homes covered by each route and time spent on each route, with one vehicle completing each route without the need for additional vehicles to assist in completing routes.
- **Fully automate** curbside garbage routes, which would require enforcing a set-out limit of collecting only materials that are placed inside the cart.
    - A fully automated system would allow the City to convert from the current multi-pack vehicles to fully automated side-loading vehicles. A change in vehicle technology would potentially allow for savings on vehicle cost in two ways:
        1. Fully automated side-loaders are potentially less expensive than the current multi-pack vehicles, on a per truck basis;
        2. With a higher number of homes covered on each route with a fully automated system, the City may need fewer vehicles to complete curbside collection each week.
    - Labor cost savings could also be achieved in two ways:
        1. Fewer trucks may be necessary to complete the routes; and
        2. Fully automated vehicles only require one driver with no collectors.

Alley & Apartment Service Key Findings & Potential Modifications

- The City's current alley and apartment collection system uses rear-load vehicles to collect bags or cans from alley customers, and a hook system on the rear-load vehicle to collect dumpsters from apartments.
- There is also one front-load vehicle route that collects dumpsters from apartments.
- It is believed that a majority of the 635 dumpster accounts are covered on the single front-load route that runs four days per week, and approximately 180 dumpster accounts are covered on the rear-load routes that also service alley customers.
- It is recommended that City staff and HDR discuss potential modifications to the route observation form prior to the winter observations in order to more accurately capture key data for alley and apartment collection.
- Similar to curbside service, it was observed that two of the five alley/apartment collection routes required more than one vehicle to complete the route. It was also observed that time spent on each route varied widely.

These metrics indicate the following potential modifications should be considered for alley and apartment services:

- **Rebalance** alley and apartment collection (with existing vehicles) to allow for more equitable and efficient routes.
    - Rebalancing should include evaluating whether it is possible to move all dumpster accounts to the current one front-load vehicle route, which may mean the front-load route would need to run five days per week, rather than the current four days per week.
    - If all dumpster accounts can be serviced with one front-load route, without the need for adding more front-load vehicles, alley collection could be made more efficient without adding inefficiencies, or extra vehicles, to the front-load apartment collection.
- **Semi-automate** alley collection by retrofitting existing vehicles or transitioning to a different collection technology.
    - This could allow the City to require alley customers to use carts and require enforcement for all materials to be placed in a cart by the customers, but would lower labor costs and associated workers compensation insurance.
    - This approach would require one driver and at least one collector, but could potentially speed up the collection process, allowing for more homes to be collected on each route.

Volume-Based Collection Service

For the purposes of increasing efficiency, balancing cost of service, and creating an incentive to recycle more, the City could consider a volume-based garbage collection system for curbside customers and residential alley customers. In a volume-based system, residents are charged for the collection of garbage based on the amount they throw away. This creates a direct economic incentive to recycle more and to generate less waste. A volume-based rate structure treats garbage services like electricity, gas, and other utilities, where households pay a variable rate depending on the amount of service they use. Volumetric programs can be implemented in several ways; however, three main approaches include:

- **Variable rate cart program**: This approach uses fully automated vehicles, and residents select from among varying sizes of carts. Residents selecting larger carts are charged higher rates, while residents selecting smaller carts are charged lower rates for collection and disposal. This approach would allow the City to fully automate collection, but would no longer allow residents to place additional materials outside of the cart.
    - It has been reported in communities using the variable rate cart system that waste was reduced by 15%.
    - This system utilizes automated collection technology with an anticipated 1,000+ curbside accounts serviced per route.

- Residential alley accounts can be serviced with semi-automated tipping technology on front- or rear-load trucks.

- **Bag program** (or stickers/tags): Residents dispose of their waste in specialized bags (or with special stickers/tags affixed to regular garbage bags) approved by the municipality and clearly marked with the municipal seal or other unique instructions or information. In a bag program, a flat fee can be charged to residents on a utility bill to cover fixed costs, but a majority of the costs are built into the cost of the bags (or stickers/tags).
  - It has been reported in communities using a bag program that waste was reduced by 25% or more.
  - If the City pursued a bag program, the existing carts could potentially be repurposed for a new curbside yard waste collection service.
  - A bag program could work for curbside and alley collection; though it would be more challenging to enforce with multifamily homes served by dumpsters.
  - Residential curbside and alley could be collected utilizing manual rear-load trucks, which could allow for efficiencies to be gained in collecting from both customer types on the same route.
- **Combination of carts and bags:** This approach uses carts for collection in combination with pre-paid bags (or stickers/tags) for additional garbage. This method would be very similar to the curbside collection program that the City is currently utilizing, with the exception that any additional bags set outside the cart would need to be specially purchased bags (or sticker/tags) prior to being set out at the curb.
  - This system would require the least changes to the City's current operations, though it would require some administrative efforts to get the specially marked bags (stickers/tags) developed and distributed to convenient locations (i.e. grocery stores), and to re-stock the stores as needed.
  - While the additional charge for materials set outside of the cart will deter some residents from setting additional materials outside of the cart, some residents would continue to set materials outside of the cart, using the pre-paid bags, for the convenience.
  - Residential alley accounts could be serviced with the same system as curbside, and therefore could be serviced with the same vehicles.
  - While this approach could reduce the amount of waste set-out by customers, it is not anticipated to have a meaningful impact on waste reduction.

Based on our experience in other communities, the majority of recent volumetric based fee systems have been formed using the variable rate cart system. From the regional

benchmarking, there are instances of a combination of automated container and excess bag systems. In the region, a manual collection pre-paid bag system was not found to benchmark.

Next Steps

The next step in this study is to coordinate with City staff to “short-list” three of the system modifications from the options presented above, to be further evaluated in Task 400. It is anticipated that a meeting/conference call will be conducting in the near future to allow City and HDR staff to review this memo, discuss drivers and goals that should be considered when short-listing system modifications and work together to determine which modifications make the most sense for further evaluation.

City staff, after review of the draft TM 300 memo and discussion, directed HDR to prepare operational models for the following two scenarios for comparison to the existing condition operational model:

1. **Variable Rate Cart** - Residential variable rate structure using City provided carts for both curbside and alley customers.
2. **Variable Rate Cart + Bag** - Residential variable rate structure using City provided carts with the option for additional waste placed in pre-paid bags. This option would be for both curbside and alley customers.

Additionally, City staff requested the operational model costs for:

1. Feasibility of completing residential curbside and alley grass clipping collection.

The results of these three modeling runs will be presented in technical memorandum 401.

Appendix C. TM 401 – Evaluation of Potential System Modifications

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Technical Memo

Date:	Thursday, November 05, 2015
Project:	Solid Waste Management Collection Evaluation
To:	Jeff Heintz, Director of Public Works - Service Operations, City of Bismarck, ND
From:	Brent Erickson, Project Manager, HDR Engineering, Inc.
Subject:	Subtask 401 – Evaluation of Potential System Modifications, Update Operational Model

Introduction

The City of Bismarck (City) contracted with HDR Engineering, Inc. (HDR) to evaluate the City's existing municipal solid waste (garbage) collection system, benchmark the City against other similar communities, and ultimately perform a sensitivity analysis of potential changes to collection services.

The City would like to consider various options for maximizing efficiency and improving services for the municipal collection of residential garbage. The purpose of Task 400 of this Solid Waste Management Collection Evaluation (Study) was to review and evaluate potential modifications to the City's current program. Subtask 401 includes updating the operational model used in Task 300 in order to compare certain operational metrics of potential modifications shortlisted in Task 300 to the current case. Subtask 402 includes route rebalancing, which is not anticipated to occur until the City has made final decisions on which system configuration to rebalance. Subtask 403 includes route optimization, which, like Subtask 402, is not anticipated to occur until the City has made a final decision on which system configuration to optimize. The remainder of this memo summarizes the results of Subtask 401.

The main components of Subtask 401 included:

- Updating the operational model used in Task 300 to show the potential modifications side-by-side with the current case, for comparison; and
- Evaluating each potential modification as compared to the current case, using certain planning level estimates of financial and operational impacts.

Identification of Potential System Modifications

Based on discussions with City staff, the City and HDR identified the following potential modifications to be evaluated in Subtask 401:

- Variable Rate Cart structure for both curbside and alley customers;
- Variable Rate Cart and Bag structure for both curbside and alley customers; and
- Residential curbside and alley grass clipping collection.

For each of the alternative scenarios identified, HDR evaluated the scenarios based on the following set of criteria, compared to the current case:

- Estimated route metric impacts;
- Estimated labor cost impacts;
- Estimated operating and maintenance cost impacts; and
- Estimated capital cost impacts.

Residential Curbside Garbage Collection

The City's current curbside garbage collection service is provided once a week to each household and is comprised of three routes on Monday and five routes Tuesday through Friday, for a total of 23 routes per week. Two-person crews (one driver and one collector) use multi-pack collection vehicles to collect 96-gallon carts from each household. While curbside customers are provided with a 96-gallon cart, set-outs are not currently limited to what is placed in the cart. Materials are required to be properly containerized, but may be placed in the cart, in bags, or in other customer provided containers of up to 35-gallons in size with lids.

Based on discussions with other communities that have implemented variable rate cart programs that include additional, specially marked and purchased, bags for out-of-cart set-outs, it has been observed that initially, there are higher numbers of additional bags set out by residents. However, over time, the number of additional bags set out for collection decreases dramatically. For example, a number of communities reported that during the initial 18-24 months of operation, a majority of customers set-out additional bags for collection. However, after this initial period, customer set-outs of additional bags reduced sharply and eventually approached zero additional bags during an average week.

For these reasons, a “Variable Rate Cart + Bag - Mature” scenario as well as a “Variable Rate Cart + Bag – Initial” scenario have been included in this analysis in order to show differences in certain metrics (though some metrics are identical) between a mature system and a recently implemented (Initial) system. Therefore, the model was designed to evaluate estimated, planning level cost and operational impacts under the following scenarios:

1. No change in services offered (“Current Case”);
2. Changing to a Variable Rate Cart program collected by a fully-automated side-loader (“Variable Rate Cart”), with no allowance for out-of-cart set-outs;
3. Changing to a Variable Rate Cart program with specially marked bags for purchase by customers for out-of-cart set-outs, collected by a fully-automated side-loader, in a mature system (“Variable Rate + Bag – Mature”); and
4. Changing to a Variable Rate Cart program with specially marked bags for purchase by customers for out-of-cart set-outs, collected by a fully-automated side-loader, initially (“Variable Rate + Bag - Initial).

The anticipated impact on number of vehicles and routes for the potential system modifications compared to the Current Case for curbside garbage collection service is shown in Table 1. With each of the potential modifications, the number of vehicles/routes could be reduced to 4, from the Current Case that uses 5 vehicles.

Table 1 – Residential Curbside Alternative Scenarios

Scenario	Vehicle Type	Number of Vehicles	Routes per Week
Current Case	Multi-Pack	5	23
Variable Rate Cart	Fully-Automated Side-Loader	4	20
Variable Rate Cart + Bag - Mature	Fully-Automated Side-Loader	4	20
Variable Rate Cart + Bag - Initial	Fully-Automated Side-Loader	4	20

Residential Curbside Garbage - Route Metrics

The results of the impacts to key route metrics are shown in Table 2. With a change to variable rate carts, a higher set-out rate (95%) is assumed due to the likelihood of residents setting out more frequently with set-out limits in place. The pounds per set-out are estimated to be reduced by 15% based on observed reductions in waste disposed in other communities with similar systems. For the Variable Rate Cart + Bag – Initial scenario, the set-out rate is estimated to remain at 91% and the pounds per set-out are only slightly reduced compared to the Current Case. The average on route time per trip is increased in each of the alternative scenarios in order to move closer to an 8 hour day, while leaving a little extra time to accommodate winter months, as well as growth in number of homes served per route.

Table 2 - Residential Curbside Route Model Results

Metric	Base	Variable Rate Cart	Variable Rate Cart + Bag - Mature	Variable Rate Cart + Bag - Initial
Set-Out Rate (1)	91%	95%	95%	91%
Lbs./Set-Out	60.2	51.2	51.2	57.0
Avg. On Route Time per Trip (hrs.) (2)	1.88	2.25	2.25	2.25
Avg. Weight per Load	18,367	18,743	18,743	20,000
Hours per Day	6.43	7.17	7.17	7.17
Stops per Hour (3)	162	163	163	156
Stops per Route	610	733	733	702
Total Homes Per Route (4)	671	771	771	771
Number Stops per Day	3,051	2,930	2,930	2,807

Notes:

(1) Set-out rate for alternatives is anticipated to increase due to restrictions on items being placed outside the cart.
(2) On Route Time is expected to increase with increased set-outs and increased efficiency.
(3) Stops per Hour is calculated by dividing the number of set-outs per day by the total on-route time per day. This metric is used to ensure the number of stops per hour is reasonable. It is estimated that in a fully automated system, the City of Bismarck could achieve 180 to 200 stops per hour.
(4) A mature fully automated system is estimated to realize maximum Total Homes per Route of between 850 and 950 in the City of Bismarck, which allows for growth compared to the base case and alternatives currently modeled.

Residential Curbside Garbage - Labor Costs

By switching to fully-automated side-loaders, sanitary collectors are not required. It is expected that for the Variable Rate Cart + Bag – Mature scenario, the use of additional bags will be rare, which will allow the vehicle driver to collect the bags with minimal effect on efficiency, and no need for a collector. For the Variable Rate Cart + Bag – Initial scenario, it is assumed that one collector will be used in order to assist with collecting the extra bags, expected to be more frequent in the initial system.

Each of the three proposed scenarios will result in a decrease in the number of sanitary collectors required for the utility. Reducing the number of required sanitary collectors does not indicate the recommendation, or requirement, to downsize City staff. Any changes to the collections operations will require multiple years to fully implement and it is expected that excess staff will be relocated to other positions or handled through attrition.

Table 3 summarizes the raw data used to calculate labor impacts for each scenario. The estimated annual incidentals per employee as well as the salary and benefits per employee are assumed to remain the same across each of the scenarios.

Table 3 - Residential Curbside Garbage Labor Metrics – Raw Data

Metric	Current	Variable Rate Cart	Variable Rate Cart + Bag - Mature	Variable Rate Cart + Bag – Initial
Number of Routes per Day	5	4	4	4
Sanitation Collector per Crew	1	-	-	1
Vehicle Drivers per Crew	1	1	1	1
Total Number of Sanitation Collectors	5	-	-	4
Total Number of Vehicle Drivers	5	4	4	4
Number of Supervisors	1	1	1	1
Estimated Annual Incidentals Cost per Employee	$350	$350	$350	$350
Average Annual Salaries and Benefits – Per Collector	$56,473	$56,473	$56,473	$56,473
Average Annual Salaries and Benefits – Per Driver	$62,792	$62,792	$62,792	$62,792
Average Annual Salaries and Benefits – Per Supervisor	$98,807	$98,807	$98,807	$98,807

Table 4 summarizes the calculated key metrics including total estimated labor costs and estimated annual labor related savings for each scenario.

Table 4 - Residential Curbside Garbage Labor Metrics – Calculated Data

Metric	Current	Variable Rate Cart	Variable Rate Cart + Bag - Mature	Variable Rate Cart + Bag – Initial
Total Estimated Annual Salaries and Wages – Sanitation Collectors	$282,365	-	-	$225,892
Total Estimated Annual Salaries and Wages – Vehicle Drivers	$313,960	$251,168	$251,168	$251,168
Total Estimated Annual Salaries and Wages – Supervisors	$98,807	$98,807	$98,807	$98,807
Total Estimated Annual Salaries and Wages (1)	$695,132	$349,975	$349,975	$575,867
Total Estimated Annual Incidentals Expense	$3,850	$1,750	$1,750	$3,150
Estimated Annual Labor Related Expense	$698,982	$351,725	$351,725	$579,017
Estimated Annual Labor Related Savings	**-**	**$347,257**	**$347,257**	**$119,965**

Notes:

(1) Total Annual Salaries and Wages were calculated by summing the product of the per-employee salary and number of workers for each labor type.

As shown in Figure 1, all three alternative scenarios result in labor related savings, though the Variable Rate Cart + Bag – Initial scenario shows slightly less savings than the other alternative scenarios, compared to the Current Case.

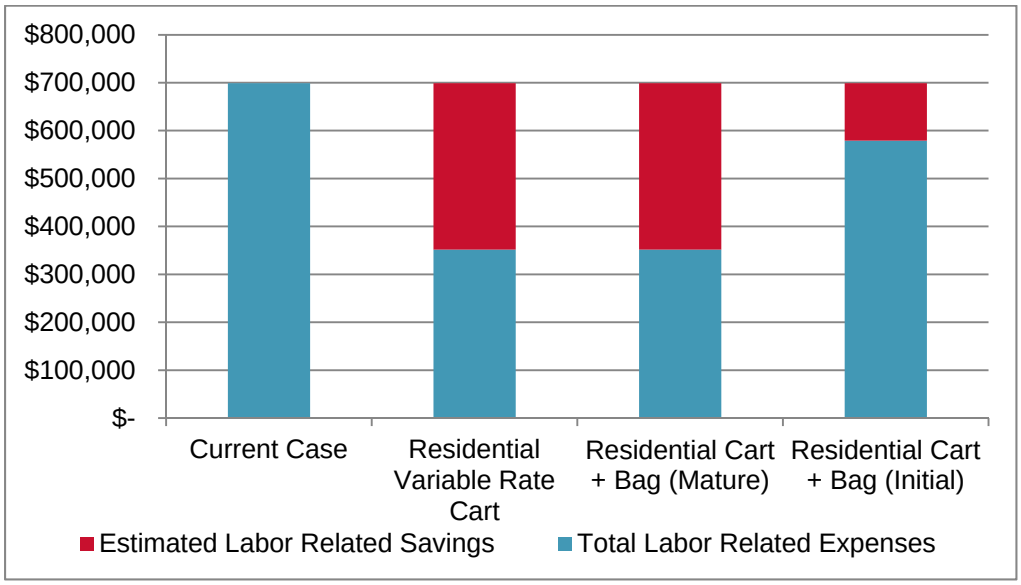

Figure 1 - Residential Curbside Garbage - Labor Costs

Residential Curbside Garbage - Vehicle Operations and Maintenance Costs

Table 5 summarizes the raw data used in the model as well as the calculated metrics for the current case and the alternative scenarios. Although the fully-automated side-loader has a higher annual maintenance and repair cost, the smaller fleet size results in an overall annual savings of approximately $12,000.

Table 5 - Residential Curbside Garbage - Operations Model Results

Metric	Current	Variable Rate Cart	Variable Rate Cart + Bag - Mature	Variable Rate Cart + Bag - Initial
Average Miles per Trip (1)	16.44	18.91	18.91	18.91
Average Fuel Economy (mpg)	4.0	4.0	4.0	4.0
Number of Routes per Day	5	4	4	4
Number Collection Vehicles Excluding Spares	5	4	4	4
Spare Ratio (%) (2)	80%	35%	35%	35%
Maintenance and Repair ($/vehicle/year) (3)	$14,600	$20,000	$20,000	$20,000
Estimated Annual Operating Expense	$160,331	$148,103	$148,103	$148,103
Estimated Annual Operating Savings	**-**	**$12,229**	**$12,229**	**$12,229**

Notes:

(1) Miles per trip increases for the alternative scenarios due to the increase in average homes per route and fewer total routes.

(2) HDR recommends a 35% spare ratio for fully-automated side-loader vehicles. However, the City may decide to hold a higher number of spares in order to address holiday collection.

(3) Annual vehicle maintenance and repair is estimated to increase for the fully-automated side-load vehicles.

As shown in Figure 2, the alternative scenarios result in minor savings in operations and maintenance costs compared to the current case.

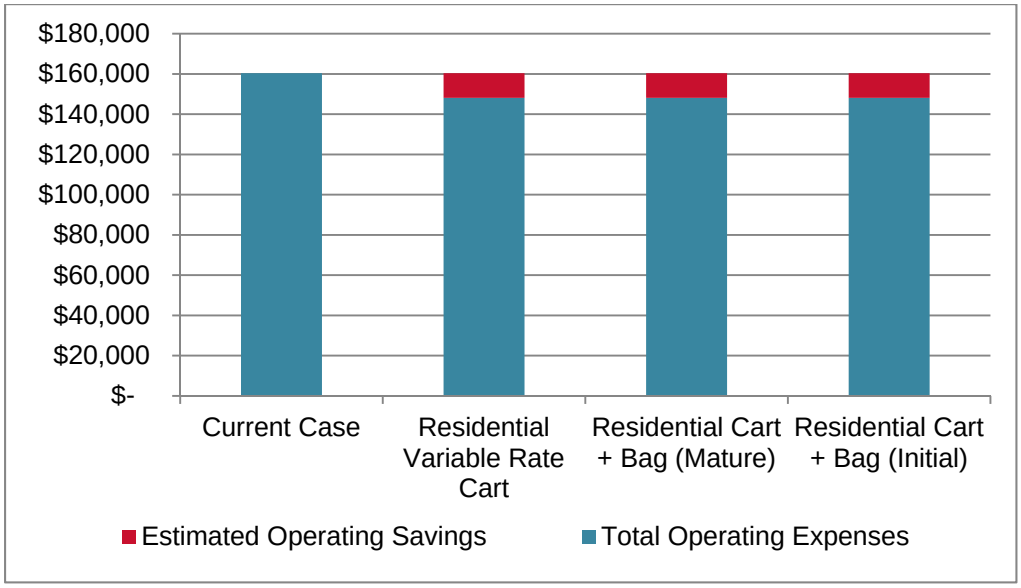

Figure 2 – Residential Curbside Garbage - Operating Costs

Residential Curbside Garbage - Capital Costs

Table 6 presents the raw data and estimates used to model the capital costs associated with the alternative scenarios as well as calculated metrics, as compared to the current case. It is important to note that the cost to produce and distribute specially marked bags is not included in the capital calculations. In similar cart + bag systems, the cost to produce and distribute the bags is covered entirely by the purchase price paid by the customer. As a result, while the City would have a cost associated with production and distribution of the bags, that cost would be offset by revenues generated when customers purchase the bags.

Table 6 - Residential Curbside Garbage - Capital Model Results

Metric	Current	Variable Rate Cart	Variable Rate Cart + Bag - Mature	Variable Rate Cart + Bag - Initial
Cost of Multi-Pack Collection Vehicle (New)	$305,000	-	-	
Cost of Fully-Automated Side-Loader Collection Vehicle (New)	-	$275,000	$275,000	$275,000
Cost of Automated Cart: 96-gal. (New)	$50	$55	$55	$55
Cost of Automated Cart: 65-gal. (New)	-	$50	$50	$50
Cost of Automated Cart: 35-gal. (New)	-	$45	$45	$45
Total Number of Vehicles in Fleet	9	6	6	6
Total Number of Carts: 96-gal. (1)	15,423	3,856	3,856	3,856
Total Number of Carts: 65-gal. (1)	-	7,712	7,712	7,712
Total Number of Carts: 35 gal. (1)	-	3,856	3,856	3,856
Annual Vehicle Capital Cost (2)	$392,143	$235,714	$235,714	$235,714
Annual Cart Cost (3)	$77,115	$77,115	$77,115	$77,115
Estimated Annual Capital Outlay	$469,258	$312,829	$312,829	$312,829
Estimated Annual Capital Savings	**$-**	**$156,429**	**$156,429**	**$156,429**

Notes:

(1) The cart distribution for the variable rate scenarios is based on discussion with regional communities. Experience of these communities was that the default container size dictates the most common cart size selected by residents. For this study it was assumed that 25% of customers selected 96-gallon carts, 50% selected 65-gallon carts, and 25% selected 35-gallon carts.

(2) Vehicles amortized over 7 year period.

(3) Carts amortized over 10 year period.

As shown in Figure 3, the alternative scenarios result in an estimated savings of nearly $160,000 in capital costs. The fully-automated side-load vehicles are believed to be available at a lower cost than the current multi-pack vehicles. Additionally, the alternative scenarios require fewer vehicles.

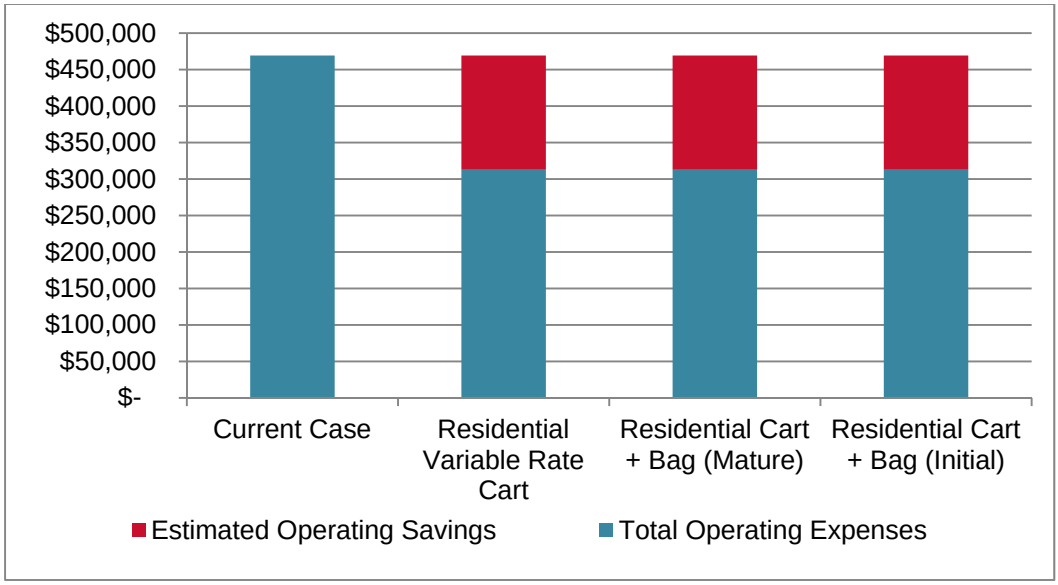

Figure 3 – Residential Curbside Garbage - Capital Costs

Summary of Residential Curbside Garbage Alternatives

Table 7 summarizes the total annual estimated costs associated with the current system and the alternative scenarios. Due to the planning level nature of this evaluation, which is intended to be used to demonstrate the relative magnitude of potential changes to the system, the estimated total annual costs have been rounded to the nearest hundred.

Table 7 - Residential Curbside Garbage - Estimated Total Annual Cost

Metric	Current	Variable Rate Cart	Variable Rate Cart + Bag - Mature	Variable Rate Cart + Bag - Initial
Estimated Total Annual Labor Cost	$699,000	$352,000	$352,000	$579,000
Estimated Total Annual Vehicle Operating Cost	$160,000	$148,000	$148,000	$148,000
Estimated Total Annual Operating Cost	**$859,000**	**$500,000**	**$500,000**	**$727,000**
Estimated Total Annual Vehicle Capital Cost	$392,000	$236,000	$236,000	$236,000
Estimated Total Annual Cart Cost	$77,000	$77,000	$77,000	$77,000
Estimated Total Annual Capital Cost	**$469,000**	**$313,000**	**$313,000**	**$313,000**
Estimated Total Annual Cost	**$1,328,000**	**$813,000**	**$813,000**	**$1,040,000**
Estimated Total Annual Savings	**$-**	**$515,000**	**$515,000**	**$288,000**

As shown in Figure 4, each of the alternative scenarios results in an overall estimated savings compared to the current case.

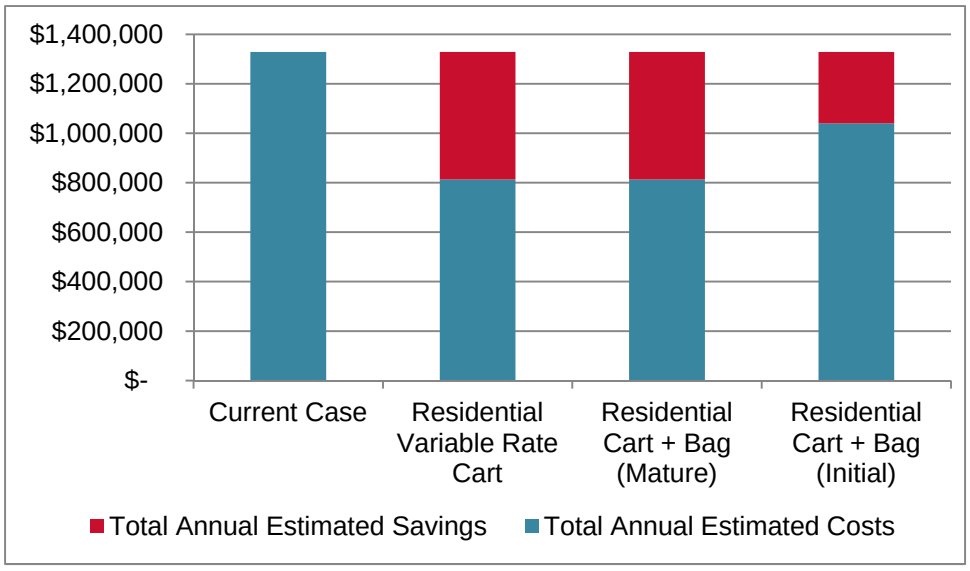

Figure 4 – Residential Curbside Garbage - Estimated Total Annual Costs

Residential Alley Garbage Collection

The City's current alley garbage collection service is provided once a week to each household using rear-load collection vehicles, and is comprised of two routes on Tuesday and two routes Wednesday and Thursday that complete one trip designated as alley before collecting apartments, for a total of 4 complete routes per week. Two-person crews (one driver and one collector) use rear-load collection vehicles to collect garbage from each household. The residential alley customers provide their own garbage cans and are not limited to the amount of garbage that can be set out.

The selection of potential system modifications, similar to the curbside system, resulted in three alternative scenarios for alley garbage collection service, as shown in Table 8. In each alternative scenario, a 20 cubic yard rear-load vehicle with a tipper is recommended, rather than the 25 cubic yard rear-load vehicles that are used in the Current Case. The recommendation of a smaller vehicle size is due to the fact that the Current Case vehicles are estimated to be only half full when arriving at the facility each trip. The alternative scenarios also include a recommendation to complete two full days of residential alley routes, instead of the existing system which consists of one full day and two partial days, each with two vehicles. The model was designed to evaluate estimated, planning level cost and operational impacts under the following scenarios:

1. No change in services offered (Current Case);
2. Changing to a Variable Rate Cart program collected by rear-load vehicles with tippers (Variable Rate Cart);
3. Changing to a Variable Rate Cart program with specially marked bags for purchase collected by rear-load vehicles with tippers (Variable Rate Cart + Bag – Mature);
4. Changing to a Variable Rate Cart program with specially marked bags for purchase collected by rear-load vehicles with tippers (Variable Rate Cart + Bag – Initial)

Table 8 - Residential Alley Garbage Alternative Scenarios

Scenario	Vehicle Type	Number of Vehicles	Routes per Week	Vehicle Capacity
Base Case	Rear-Load	2	4	25 CY
Variable Rate Cart	Rear-Load with Tipper	2	4	20 CY
Variable Rate Cart + Bag - Mature	Rear-Load with Tipper	2	4	20 CY
Variable Rate Cart + Bag - Initial	Rear-Load with Tipper	2	4	20 CY

Residential Alley Garbage - Route Metrics

The results of the impact to key route metrics are shown in Table 9. With a change to variable rate carts, a higher set-out rate (95%) is assumed due to the likelihood of residents setting out more frequently with set-out limits in place. The pounds per set-out are estimated to be reduced by 15% based on observed reductions in waste disposed in other communities with similar systems. For the Variable Rate Cart + Bag – Initial scenario, the set-out rate is estimated to remain at 92% and the pounds per set-out are assumed to be only slightly less than the Current Case. The average on route time per trip remains the same as the current case in each of the alternative scenarios in order to accommodate winter months, as well as growth in number of customers.

Table 9 - Residential Alley Garbage - Route Model Results

Metric	Base	Variable Rate Cart	Variable Rate Cart + Bag - Mature	Variable Rate Cart + Bag - Initial
Set-Out Rate (1)	92%	95%	95%	92%
Lbs/Set-Out	24.6	20.9	20.9	24.6
Avg. On Route Time per Trip (hrs.) (2)	2.33	2.33	2.33	2.33
Avg. Weight per Load (3)	10,524	9,237	9,237	10,524
Hours per Day	7.23	7.23	7.23	7.23
Stops per Hour (4)	183	190	190	184
Stops per Route	856	884	884	856
Total Homes Per Route	930	930	930	930
Number Routes per Day	2	2	2	2

Notes:

(1) Set-out rate for alternatives is anticipated to increase due to restrictions on items being placed outside the cart.
(2) On Route Time is expected to increase with increased efficiency.
(3) Alternatives utilized a 20-CY capacity vehicle which results in a reduced weight per load. However, the vehicles are returning to the landfill closer to capacity than the current case.
(4) Stops per Hour is calculated by dividing the number of set-outs per day by the total on-route time per day. This metric is used to ensure the number of stops per hour is reasonable. It is estimated that the City of Bismarck could achieve up to 200 stops per hour for alley collection.

Residential Alley Garbage - Labor Costs

Table 10 shows the raw data and estimates used in calculating the labor impacts of each of the scenarios. The alternative scenarios assume the same number of routes, drivers, and collectors as the current case.

Table 10 - Residential Alley Garbage Labor Metrics – Raw Data

Metric	Base	Variable Rate Cart	Variable Rate Cart + Bag - Mature	Variable Rate Cart + Bag - Initial

Metric	Base	Variable Rate Cart	Variable Rate Cart + Bag - Mature	Variable Rate Cart + Bag - Initial
Number of Routes per Day	2	2	2	2
Sanitation Collector per Crew	2	2	2	2
Vehicle Drivers per Crew	1	1	1	1
Total Number of Sanitation Collectors	4	4	4	4
Total Number of Vehicle Drivers	2	2	2	2
Number of Supervisors	1	1	1	1
Annual Incidentals Cost per Employee	$350	$350	$350	$350
Annual Salaries and Wages – Sanitation Collectors (1)	$56,473	$56,473	$56,473	$56,473
Annual Salaries and Wages – Vehicle Drivers	$62,792	$62,792	$62,792	$62,792
Annual Salaries and Wages – Supervisors	$98,807	$98,807	$98,807	$98,807

Notes:

(1) Does not include potential reduction in workers compensation insurance.

Table 11 shows the calculated labor metrics for each of the scenarios. As shown, without a reduction in crew size, there are no anticipated annual labor related savings.

Table 11 – Residential Alley Garbage Labor Metrics – Calculated Data

Metric	Base	Variable Rate Cart	Variable Rate Cart + Bag - Mature	Variable Rate Cart + Bag - Initial
Total Annual Salaries and Wages (1)	$450,283	$450,283	$450,283	$450,283
Total Annual Incidentals Expense	$2,450	$2,450	$2,450	$2,450
Estimated Annual Labor Related Expense	$452,733	$452,733	$452,733	$452,733
Estimated Annual Labor Savings	$-	$-	$-	$-

Notes:

(1) Total Annual Salaries and Wages were calculated by summing the product of the salary and number of workers for each labor type.

As shown in Figure 5, the total estimated labor costs remain the same for all scenarios.

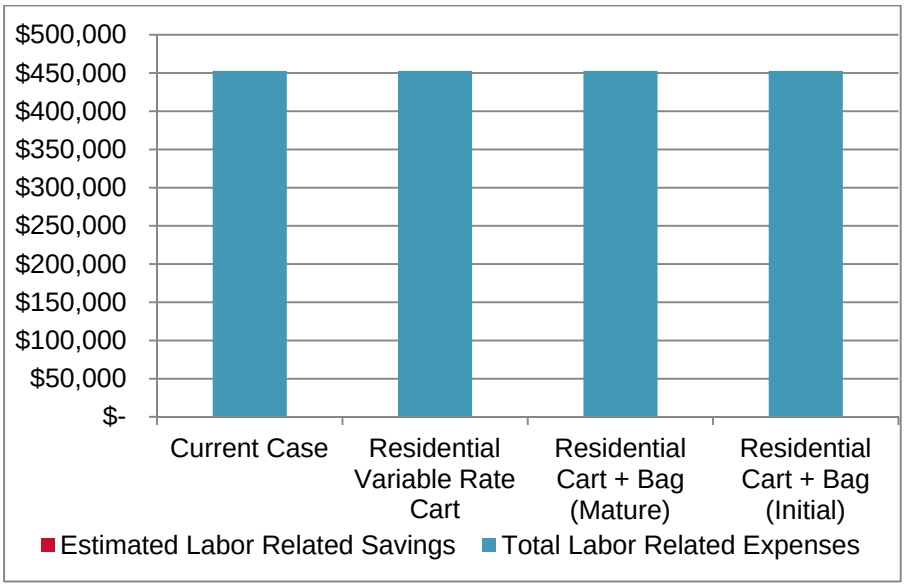

Figure 5 – Residential Alley Garbage - Labor Costs

Residential Alley Garbage - Vehicle Operations and Maintenance Costs

Table 12 summarizes the operations and maintenance metrics estimated in the model for each of the alternatives. The anticipated savings for switching to a smaller vehicle size is approximately $13,800 annually. Each of the alternative scenarios indicates the same amount of savings because they each assume the use of smaller (20 cubic yard) vehicles and a reduced estimate of maintenance cost per vehicle.

Table 12 - Residential Alley Garbage - Operations Model Results

Metric	Current	Variable Rate Cart	Variable Rate Cart + Bag - Mature	Variable Rate Cart + Bag - Initial
Average Miles per Trip	14.3	14.3	14.3	14.3
Average Fuel Economy (mpg)	4.0	4.0	4.0	4.0
Number of Routes per Day	2	2	2	2
Number Rear-Load Collection Vehicles Excluding Spares	2	2	2	2
Spare Ratio (%)	50%	25%	25%	25%
Maintenance and Repair ($/vehicle/year)	$14,600	$10,000	$10,000	$10,000
Estimated Annual Operating Expense	$48,629	$34,829	$34,829	$34,829
Estimated Annual Operating Savings	**$-**	**$13,800**	**$13,800**	**$13,800**

Figure 6 shows the total estimated operations and maintenance costs are lower for the alternative scenarios.

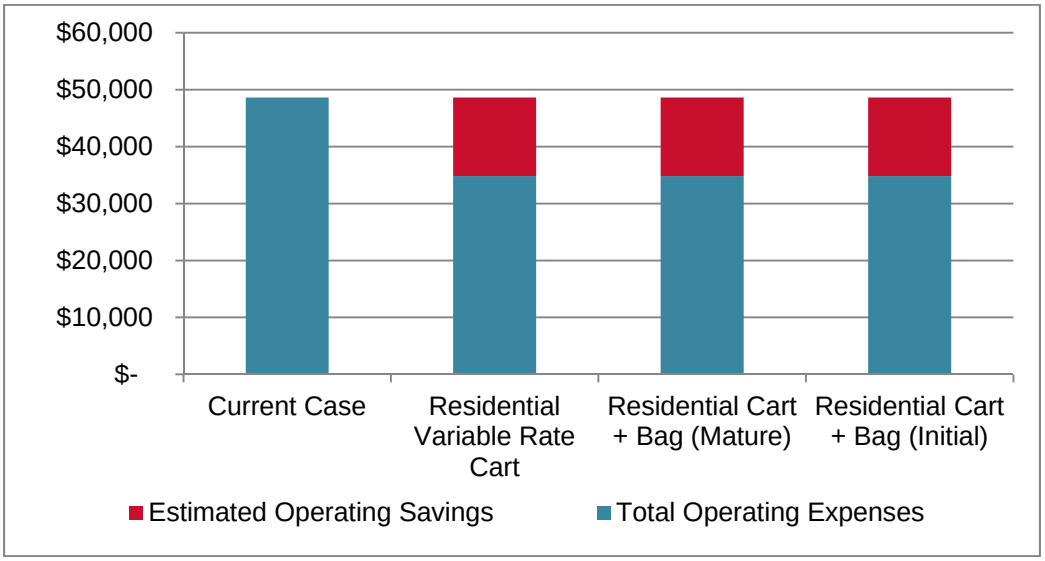

Figure 6 - Residential Alley Garbage - Operating Costs

Residential Alley Garbage - Capital Costs

Table 13 indicates the metrics used to model the estimated residential alley capital outlay. As discussed for curbside collection, The Variable Rate Cart + Bag systems do not show the costs associated with purchasing and distributing the bags due to the belief that the cost for production and distribution of the specially marked bags would be recovered through the sale of the bags to customers.

Table 13 - Residential Alley Garbage - Capital Model Results

Metric	Base	Variable Rate Cart	Variable Rate Cart + Bag - Mature	Variable Rate Cart + Bag - Initial
Cost of Rear-Load Collection Vehicle (New)	$149,500	NA	NA	NA
Cost of Rear-Load Collection Vehicle with Tipper (New)	-	$155,000	$155,000	$155,000
Cost of Automated Cart: 96-gal. (New)	-	$55	$55	$55
Cost of Automated Cart: 65-gal. (New)	-	$50	$50	$50
Cost of Automated Cart: 35-gal. (New)	-	$45	$45	$45
Total Number of Vehicles in Fleet	3	3	3	3
Total Number of Carts: 96-gal. (1)	NA	930	930	930
Total Number of Carts: 65-gal. (1)	NA	1,860	1,860	1,860
Total Number of Carts: 35-gal. (1)	NA	930	930	930
Annual Vehicle Capital Cost (2)	$64,071	$66,429	$66,429	$66,429
Annual Cart Cost (3)	-	$5,115	$5,115	$5,115
Estimated Annual Capital Outlay	$64,071	$71,544	$71,544	$71,544
Estimated Annual Capital Savings	**$-**	**$(7,472)**	**$(7,472)**	**$(7,472)**

Notes:

(1) The cart distribution for the variable rate scenarios is based on City of Fargo distribution where 25% of customers selected 96-gallon carts, 50% selected 65-gallon carts, and 25% selected 35-gallon carts

(2) Vehicles amortized over 7 year period.

(3) Carts amortized over 10 year period.

As shown in Figure 7, the alternative scenarios have a slightly larger capital outlay than the current case due to the purchase of carts as well as the slightly more expensive vehicles that include tippers.

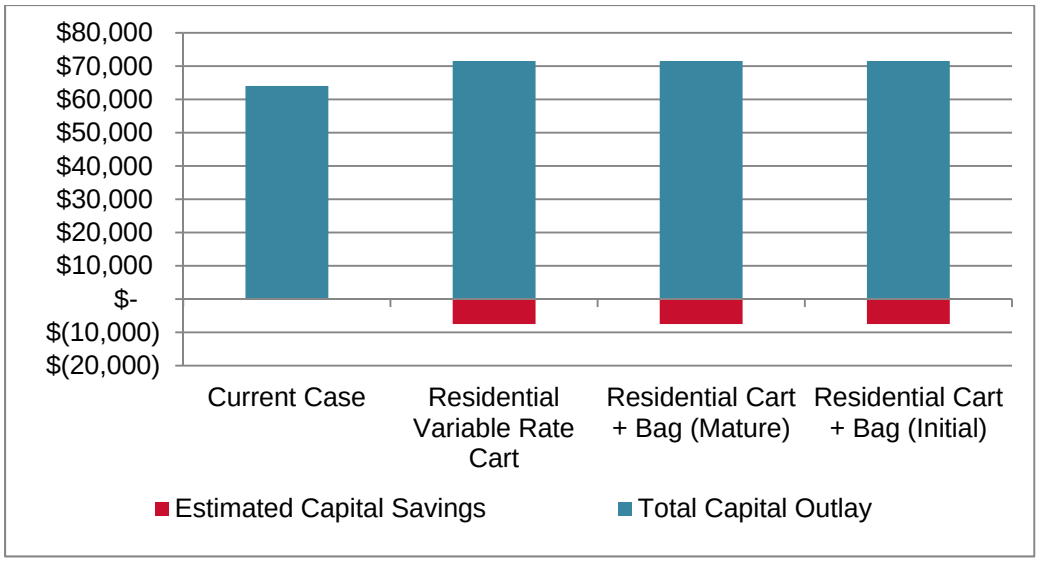

Figure 7 - Residential Alley Garbage - Captial Costs

Summary of Residential Alley Garbage Collection Alternatives

As shown in Table 14, although the alternative scenarios have initially higher estimated capital costs due to the added cost of tippers and carts for the alley residents, the alternative scenarios result in a slight overall estimated savings compared to the Current Case, based on slightly lower estimated maintenance costs. Due to the planning level nature of this evaluation, which is intended to be used to demonstrate the relative magnitude of potential changes to the system, the estimated total annual costs have been rounded to the nearest hundred.

Table 14 - Residential Alley Garbage - Estimated Total Annual Cost

Metric	Current	Variable Rate Cart	Variable Rate Cart + Bag – Mature	Variable Rate Cart + Bag – Initial
Total Annual Labor Cost	$453,000	$453,000	$453,000	$453,000
Total Annual Vehicle Operating Cost	$49,000	$35,000	$35,000	$35,000
Total Annual Operating Cost	**$502,000**	**$488,000**	**$488,000**	**$488,000**
Total Annual Vehicle Capital Cost	$64,000	$66,000	$66,000	$66,000
Total Annual Cart Cost	$-	$5,000	$5,000	$5,000
Total Annual Capital Cost	**$64,000**	**$71,000**	**$71,000**	**$71,000**
Estimated Total Annual Cost	**$566,000**	**$559,000**	**$559,000**	**$559,000**
Estimated Total Annual Savings	**$-**	**$7,000**	**$7,000**	**$7,000**

As illustrated in Figure 8, the Variable Rate Cart scenario, the Variable Rate Cart + Bag – Mature scenario and the Variable Rate Cart + Bag – Initial scenario offer an estimated $7,000 in annual savings compared to the Current Case.

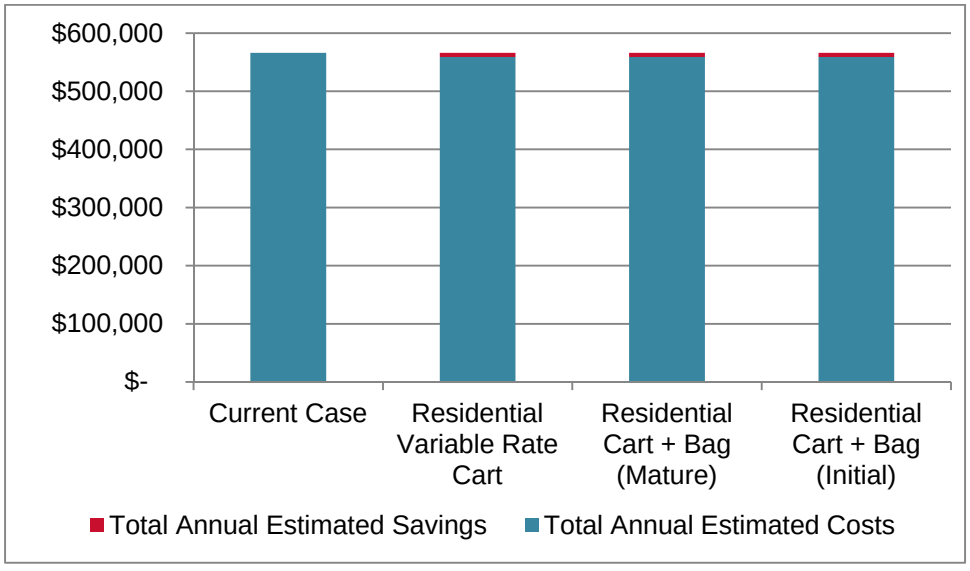

Figure 8 - Residential Alley Garbage - Estimated Total Annual Costs

Residential Curbside Yard Waste Collection

The City currently operates 18 yard debris collection sites around the City that consist of dumpsters that are collected seven days a week during the growing season. The City deploys three rear-load vehicles for yard debris collection from these sites each day from May through October. An operational model was developed to estimate the operational and financial impacts of implementing a curbside yard waste collection service for residential curbside customers under the following assumptions:

- The yard waste collection would utilize the same vehicle type as garbage collection (25 cubic yard fully-automated side-loaders);
- Each resident would receive an additional 96-gallon cart to use for yard waste.
- The yard waste collection would occur May through October.

It is important to note that the modeling exercise estimates annual metrics for route, labor, operations and maintenance, and capital. However, as the City would only offer the service for five months out of the year, for the summary metrics, a 41.66% ratio has been applied to show the seasonal estimated cost of offering curbside yard waste collection.

Table 15 presents the key metrics assumed for the potential residential curbside yard waste collection service. As shown in the raw data, the model assumes a 75% set-out rate and 60 pounds per set-out. Because yard waste is anticipated to compact more readily than garbage, a ratio of 1,000 pounds-per-cubic-yard is assumed for the vehicle capacity, resulting in a 25,000 pounds-per-load limit for each vehicle. It is estimated that the City would need to run three vehicles per day, five days per week.

Table 15 - Residential Curbside Yard Waste - Route Model Results

Raw Data	
Number of Accounts	15,423
Number of Collection Days per Week	5
Number of Collections per Household per Week	1
Number of Fully-Automated Side-Load Vehicles in Service per Collection Day	3
Avg. Set-out Rate	75%
Avg. Lbs. per Household per Week (1)	60.0
Fully-Automated Side-Load Vehicle Load Limit (lbs.) (2)	25,000
Avg. On Route Time per Trip (hrs.)	2.25
Avg. Turn Around Time at Disposal Facility per Trip (hrs.)	0.32
Avg. Off Route Time Per Trip (hrs.)	0.73
Avg. Additional Off Route Time per Day (3)	0.57
Avg. Trips to Disposal Facility per Vehicle per Day	2

Calculated Metrics	
Number of Stops per Week	11,567
Fully-Automated Side-Load Stops per Hour	171
Fully-Automated Side-Load Avg. Stops Per Route	771
Fully-Automated Side-Load Total Homes per Route	1,028
Total Pounds per Route	46,269
Avg. Weight per Load (lbs.)	23,135
Avg. Time per Trip (hrs.) (4)	3.30
Avg. Collection Time per Day (5)	7.16
Stops per Day	2,313

Notes:

(1) Based on a 96-gallon container being nearly full.
(2) Assumes a 25 CY capacity vehicle multiplied by an estimated 1000 lbs/CY of compacted grass.
(3) Additional Off Route Time includes daily lunch break and inspection time.
(4) The average time per trip was calculated by adding together the on-route time, turn around time, and off-route time.
(5) The average collection time per day was calculated by multiplying the average time per trip by the average number of trips to the disposal facility per vehicle per day and then adding the average additional off-route time per day.

Residential Curbside Yard Waste - Labor Costs

Table 16 presents the estimated labor metrics associated with residential curbside yard waste collection. Using fully-automated side-load vehicles eliminates the need for collectors, as the vehicle driver is able to collect the carts without exiting the vehicle. Using the same salary and benefit estimates as were used for curbside garbage collection, the labor costs are associated with three drivers only. It is assumed that the supervisor used for curbside garbage collection could also serve as the supervisor for seasonal yard waste collection.

Table 16 – Residential Curbside Yard Waste - Labor Metrics

Raw Data	
Number of Routes per Day	3
Sanitation Collectors per Crew (1)	-
Vehicle Drivers per Crew	1
Total Number of Sanitation Collectors	-
Total Number of Vehicle Drivers	3
Supervisors (2)	-
Avg. Annual Salary and Benefits - Vehicle Drivers	$62,792
Annual Incidentals Cost per Employee	$350

Calculated Metrics	
Annual Salaries and Wages – Vehicle Drivers (3)	$188,376
Total Annual Salaries and Wages (4)	$188,376
Total Annual Incidentals Expense (5)	$1,050
Estimated Annual Labor Related Expense (6)	$189,426

Notes:

(1) Use of a fully-automated side-loader will not require sanitary collectors.
(2) Assumes supervisor for garbage collection will also be responsible for yard waste collection.
(3) Annual salaries and wages for each of the position types were calculated by multiplying the average annual salary and benefits for the position by the total number of employees in the position.
(4) Total annual salaries and wages were calculated by summing the total annual salaries and wages for sanitation collectors and vehicle drivers. In this case, sanitary collectors are not required for the fully-automated side-load vehicles.
(5) Total annual incidentals expense was calculated by multiplying the annual incidentals cost per employee ($350) by the total number of employees (3).
(6) Estimated annual labor expense was calculated by summing total annual salaries and wages and total annual incidentals expense.

Residential Curbside Yard Waste - Vehicle Operations and Maintenance Costs

Table 17 presents the estimated vehicle operations and maintenance metrics related to residential curbside yard waste collection operations. The average miles per trip was estimated based on the miles per home ratio of the Current Case for garbage collection, applied to the estimated number of homes per route for yard waste collection. The maintenance for fully-automated side-loaders is estimated to be slightly higher than the current multi-pack vehicles.

Table 17 – Residential Curbside Yard Waste - Operations Metrics

Raw Data	
Average Miles per Trip	25.21
Average Fuel Economy (mpg)	4.0
Number of Routes per Day	3
Number Fully-Automated Side-Load Collection Vehicles Excluding Spares	3
Spare Ratio (%)	35%
Number of Spare Fully-Automated Side-Load Collection Vehicles	1
Total Number of Fully-Automated Side-Load Collection Vehicles	4
Maintenance and Repair ($/vehicle/year)	$20,000
Fuel ($/gallon)	$2.69
Insurance ($/vehicle/year)	$276

Calculated Metrics	
Annual Miles per Curbside Collection Vehicle (1)	13,108
Annual Gallons per Curbside Collection Vehicle (2)	3,277
Total Annual Maintenance & Repair Expense (3)	$80,000
Total Annual Fuel Expense (4)	$26,446
Total Annual Insurance Expense (5)	$1,105
Estimated Annual Operating Expense (6)	$107,550

Notes:

(1) Annual miles per curbside collection vehicle = average miles per trip (25.21) x average number of trips per vehicle per collection day (2) x number of collection days per week (5) x 52 weeks per year.
(2) Gallons per curbside collection vehicle were calculated by dividing the annual miles per curbside collection vehicle by the average fuel economy.
(3) Total annual repair and maintenance expense was calculated by multiplying the annual maintenance and repair expense per vehicle ($20,000) by the total number of collection vehicles (4).
(4) Total annual fuel expense = fuel price per gallon ($2.69) x annual gallons per curbside collection vehicle (3,277 x number of collection vehicles excluding spares (3)).
(5) Total annual insurance expense was calculated by multiplying the annual insurance expense per vehicle ($276) by the total number of collection vehicles (4).
(6) Estimated annual operating expense was calculated by summing the annual maintenance and repair expense ($80,000), the annual fuel expense ($26,446), and the annual insurance expense ($1,105).

Residential Curbside Yard Waste - Capital Costs

Table 18 presents the estimated capital metrics for residential curbside yard waste collection. The potential new collection service assumes the purchase of fully-automated side-load vehicles, as well as the purchase of 96-gallon carts specifically designated for yard waste for curbside customers.

Table 18 – Residential Curbside Yard Waste - Capital Metrics

Raw Data	
Cost of Fully-Automated Side-Load Vehicle	$275,000
Cost of Automated Cart, 96-gal	$55
Total Number of Fully-Automated Side-Load Vehicles in Fleet	4
Total Number of Automated Carts (1)	15,423

Calculated Metrics	
Annual Vehicle Capital Cost (2)	$157,143
Annual Cost Cart (3)	$84,827
Estimated Annual Capital Outlay (4)	$241,969

Notes:

(1) Assumes each residential curbside customer will be given a 96-gallon yard waste cart.
(2) Annual vehicle capital cost is based on a seven year vehicle life and seven year straight amortization of all vehicle expenses.
(3) Annual cart cost is based on a ten year straight amortization of all cart expenses.
(4) Estimated annual capital outlay is calculated by summing the annual vehicle capital cost and annual cart cost.

Summary of Residential Curbside Yard Waste Model Results

Table 19 presents a summary of the estimated total seasonal costs (41.66% of annual estimated costs) associated with implementing a residential curbside yard waste collection operation. (Note the cart costs are not seasonal.)

Due to the planning level nature of this evaluation, which is intended to be used to demonstrate the relative magnitude of potential changes to the system, the estimated total seasonal costs have been rounded to the nearest hundred.

Table 19 - Residential Yard Waste Curbside - Estimated Total Seasonal Cost

Metric	Curbside Yard Waste Collection (Seasonal)
Total Seasonal Labor Cost	$79,000
Total Seasonal Vehicle Operating Cost	$45,000
Total Seasonal Operating Cost	**$124,000**
Total Seasonal Vehicle Capital Cost	$65,000
Total Annual Cart Cost	$85,000
Total Capital Cost	**$150,000**
Estimated Total Annual Cost	**$274,000**

Residential Alley Yard Waste Collection

As previously stated, the City currently operates 18 yard debris collection sites around the City that consist of dumpsters that are collected seven days a week during the growing season. The City deploys three rear-load vehicles for yard debris collection from these sites each day from May through October. An operational model was developed to estimate the operational and financial impacts of implementing an alley yard waste collection service for residential alley customers under the following assumptions:

- The yard waste collection would utilize the same vehicle type as garbage collection (20 cubic yard rear-loaders with tippers);
- Each resident would receive an additional 96-gallon cart to use for yard waste.
- The yard waste collection would occur May through October.

It is important to note that the modeling exercise estimates annual metrics for route, labor, operations and maintenance, and capital. However, as the City would only offer the service for five months out of the year, for the summary metrics, a 41.66% ratio has been applied to show the seasonal estimated cost of offering curbside yard waste collection.

Table 20 presents the key metrics assumed for the potential residential alley yard waste collection service. As shown in the raw data, the model assumes a 75% set-out rate and 50 pounds per set-out (slightly less than curbside customers). Because yard waste is anticipated to compact more readily than garbage, a ratio of 1,000 pounds-per-cubic-

yard is assumed for the vehicle capacity, resulting in a 20,000 pounds-per-load limit for each vehicle. It is estimated that the City would need to run one vehicle per day, four days per week.

Table 20 - Residential Alley Yard Waste - Route Model Results

Raw Data	
Number of Accounts	3,720
Number of Collection Days per Week	4
Number of Collections per Household per Week	1
Number of Rear-Load Vehicles in Service per Collection Day	1
Avg. Set-out Rate	75%
Avg. Lbs. per Household per Week	50.0
Rear-Load Vehicle Load Limit (lbs.) (1)	20,000
Avg. On Route Time per Trip (hrs.)	2.33
Avg. Turn Around Time at Disposal Facility per Trip (hrs.)	0.37
Avg. Off Route Time Per Trip (hrs.)	0.63
Avg. Additional Off Route Time per Day (2)	0.57
Avg. Trips to Disposal Facility per Vehicle per Day	2

Calculated Metrics	
Number of Stops per Week	2,790
Rear-Load Stops per Hour	150
Rear-Load Avg. Stops Per Route	697.5
Rear-Load Total Homes per Route	930
Total Pounds per Route	34,875
Avg. Weight per Load (lbs.)	17,438
Avg. Time per Trip (hrs.) (3)	3.33
Avg. Collection Time per Day (4)	7.22
Stops per Day	698

Notes:

(1) Assumes a 20 CY capacity vehicle multiplied by an estimated 1000 lbs/CY of compacted grass.
(2) Additional Off Route Time includes daily lunch break and inspection time.
(3) The average time per trip was calculated by adding together the on-route time, turn around time, and off-route time.
(4) The average collection time per day was calculated by multiplying the average time per trip by the average number of trips to the disposal facility per vehicle per day and then adding on route time and the average additional off-route time per day.

Residential Alley Yard Waste - Labor Costs

Table 21 presents the labor related calculated metrics for residential alley yard waste collection. The crew is assumed to be made up of one driver and two collectors, similar to the current alley garbage collection. Using the same salary and benefit estimates as were used for alley garbage collection, the labor costs are associated with one driver and one collector. It is assumed that the supervisor for alley garbage collection could also serve as the supervisor for seasonal yard waste collection.

Table 21 – Residential Alley Yard Waste - Labor Metrics

Raw Data	
Number of Routes per Day	1
Sanitation Collectors per Crew	1
Vehicle Drivers per Crew	1
Total Number of Sanitation Collectors	1
Total Number of Vehicle Drivers	1
Supervisors (1)	-
Avg. Annual Salary and Benefits - Sanitation Collectors (2)	$56,473
Avg. Annual Salary and Benefits - Vehicle Drivers	$62,792
Annual Incidentals Cost per Employee	$350

Calculated Metrics	
Annual Salaries and Wages – Sanitation Collectors (3)	$56,473
Annual Salaries and Wages – Vehicle Drivers (3)	$62,792
Total Annual Salaries and Wages (4)	$119,265
Total Annual Incidentals Expense (5)	$700
Estimated Annual Labor Related Expense (6)	119,965

Notes:

(1) Assumes supervisor for the garbage collection will also be responsible for yard waste collection.
(2) Does not account for potential savings due to reduced workers compensation insurance.
(3) Annual salaries and wages for each of the position types were calculated by multiplying the average annual salary and benefits for the position by the total number of employees in the position.
(4) Total annual salaries and wages were calculated by summing the total annual salaries and wages for sanitation collectors and vehicle drivers.
(5) Total annual incidentals expense was calculated by multiplying the annual incidentals cost per employee by the total number of employees (2).
(6) Estimated annual labor expense was calculated by summing total annual salaries and wages and total annual incidentals expense.

Residential Alley Yard Waste - Vehicle Operations and Maintenance Costs

Table 22 presents the estimated operations and maintenance metrics related to residential alley yard waste collection. The average miles per trip was estimated based on the miles per home ratio of the Current Case for alley garbage collection, applied to the estimated number of homes per route for yard waste collection. It is estimated that switching to a smaller body rear-load vehicle will result in a reduction in annual maintenance and repair costs.

Table 22 – Residential Alley Yard Waste - Operations Metrics

Raw Data	
Average Miles per Trip	14.3
Average Fuel Economy (mpg)	4.0
Number of Routes per Day	1
Number Rear-Load Collection Vehicles Excluding Spares	1
Spare Ratio (%)	25%
Number of Spare Rear-Load Collection Vehicles (1)	1
Total Number of Rear-Load Collection Vehicles	2
Maintenance and Repair ($/vehicle/year)	$10,000
Fuel ($/gallon)	$2.69
Insurance ($/vehicle/year)	$276

Calculated Metrics	
Annual Miles per Collection Vehicle (2)	5,949
Annual Gallons per Collection Vehicle (3)	1,487
Total Annual Maintenance & Repair Expense (4)	$20,000
Total Annual Fuel Expense (5)	$4,001
Total Annual Insurance Expense (6)	$552
Estimated Annual Operating Expense (7)	$24,553

Notes:

(1) Assumes that spare vehicles will be taken from garbage collection fleet.
(2) Annual miles per curbside collection vehicle = average miles per trip (14.3) x average number of trips per vehicle per collection day (2) x number of collection days per week (4) x 52 weeks per year.
(3) Gallons per curbside collection vehicle were calculated by dividing the annual miles per curbside collection vehicle by the average fuel economy.
(4) Total annual repair and maintenance expense was calculated by multiplying the annual maintenance and repair expense per vehicle ($10,000) by the total number of rear-load collection vehicles (2).
(5) Total annual fuel expense = fuel price per gallon ($2.69) x annual gallons per curbside collection vehicle (1,487) x number of collection vehicles excluding spares (1)).
(6) Total annual insurance expense was calculated by multiplying the annual insurance expense per vehicle ($276) by the total number of rear-load alley collection vehicles (2).
(7) Estimated annual operating expense was calculated by summing the total annual maintenance and repair expense ($20,000), the annual fuel expense ($4,001), and the annual insurance expense ($552).

Residential Alley Yard Waste - Capital Costs

Table 23 presents the estimated capital metrics for residential alley yard waste collection. The potential new collection service assumes the purchase of 20 cubic yard rear-loaders with tippers, as well as the purchase of 96-gallon carts specifically designated for yard waste for alley customers.

Table 23 – Residential Alley Yard Waste - Capital Metrics

Raw Data	
Cost of Rear-Load Collection Vehicle with Tipper (1)	$155,000
Cost of Automated Cart, 96-gal (New)	$55
Total Number of Rear-Load Vehicles in Fleet	2
Total Number of Automated Carts (2)	3,720

Calculated Metrics	
Annual Vehicle Capital Cost (3)	$44,286
Annual Cost Cart (4)	$20,460
Estimated Annual Capital Outlay (5)	$64,746

Notes:

(1) 20 cubic yard capacity with tipper.
(2) Assumes each residential alley customer will be given a 96-gallon yard waste cart.
(3) Annual vehicle capital cost is based on a seven year vehicle life and seven year straight amortization of vehicle capital expenses.
(4) Annual cart cost is based on a ten year straight amortization of cart purchase expenses.
(5) Estimated annual capital outlay is calculated by summing the annual vehicle capital cost and annual cart cost.

Summary of Residential Alley Yard Waste Model

Table 24 presents a summary of the estimated total seasonal costs (41.66% of annual estimated costs) associated with implementing a residential alley yard waste collection operation. (Note the cart costs are not seasonal.)

Due to the planning level nature of this evaluation, which is intended to be used to demonstrate the relative magnitude of potential changes to the system, the estimated total seasonal costs have been rounded to the nearest hundred.

Table 24 - Residential Alley Yard Waste - Estimated Total Seasonal Cost

Metric	Alley Yard Waste Collection (Seasonal)
Total Seasonal Labor Cost	$50,000
Total Seasonal Vehicle Operating Cost	$10,000
Total Seasonal Operating Cost	**$60,000**
Total Seasonal Vehicle Capital Cost	$18,000
Total Annual Cart Cost	$20,000
Total Capital Cost	**$38,000**
Estimated Total Cost	**$98,000**

Conclusions

The following main conclusions can be drawn from the modeling exercise for each of the alternative scenarios identified.

Curbside Garbage Collection

- Both the Variable Rate scenario and the Variable Rate + Bag – Mature scenario are estimated to provide the City with the greatest savings, at roughly $515,000 in annual savings, compared to the Current Case. Estimated savings are largely due to a switch to fully-automated side-load collection vehicles that would require only one driver and no collectors, and would allow the City to complete collections with 4 routes per day instead of the current 5 routes per day.
- The Variable Rate + Bag – Initial scenario is estimated to provide the City with some savings (nearly $290,000 annually), compared to the Current Case. Estimated savings are largely due to the use of fully-automated side-load collection vehicles, which would allow the City to complete collections with 4 routes per day instead of the current 5 routes per day. However, the initial system would likely require one driver and one collector until the use of the extra bags by residents is diminished.

Alley Garbage Collection

- Significant operational cost savings cannot be achieved for the alley collection without a change to automated collection technology. The Variable Rate scenario, the Variable Rate + Bag – Mature scenario and the Variable Rate + Bag – Initial scenario are estimated to provide the City with minimal savings (roughly $7,000 annually) compared to the Current Case. Estimated savings are largely due to lower vehicle costs associated with the 20 cubic yard rear-loaders with tippers. The initial system would likely require one driver and two collectors until the use of the extra bags by residents is diminished.

Yard Waste Collection

- The City's current yard waste collection system consists of 18 yard debris collection sites with dumpsters located around the City that are collected seven days a week during the growing season.
- The City deploys three rear-load vehicles for yard waste collection from these sites each day from May through October. The City estimates the current yard waste collection system costs are between $190,000 and $250,000 per year.
- If the City were to offer fully-automated 96-gallon cart collection of yard waste to curbside customers, the seasonal cost is estimated to be nearly $275,000 per year.
- If the City were to offer semi-automated 96-gallon cart collection of yard waste to alley customers, the seasonal cost is estimated to be nearly $100,000 per year.

- Total curbside and alley yard waste collection service is estimated to cost roughly $375,000 per year.

Recommendations

Based on the evaluations conducted in Subtask 401, HDR provides the following recommendations, by service type.

Curbside Garbage Collection

With the potential for significant savings on curbside garbage collection by implementing a fully-automated system, the City should consider making the change in collection technology. Given the current practice of out-of-cart set-outs, the City could use the Variable Rate Cart + Bag approach, which would allow residents some time to adjust to using only the cart to set out garbage. Using specially marked bags purchased by the residents in order to place material out of the cart will increase awareness for the residents. It is believed that over time, fewer and fewer residents will continue to use the out-of-cart specially marked bags, and the City's curbside garbage collection system will eventually realize the full benefit of efficiencies associated with fully-automated collection.

It should be noted that there may be certain streets within the City where the fully-automated side-loaders may not be able to effectively operate, though the number of streets where it may be an issue is expected to be very low. (Based on route observations, we anticipate low hanging limbs and wires to affect less than 1% of the homes.) It may be possible to include these areas on alley collection routes in order to use rear-loaders with tippers for collection. It may also be possible to leave these streets on the fully-automated route, but require the driver to move the carts to an area where the side-loader can be used.

If the City decides to implement fully-automated collection using side-loaders, a phased approach to purchase the vehicles over time could be considered in order to accommodate the City's vehicle replacement schedule. Variable sized carts would need to be purchased to have on-hand for the residents electing to move to a smaller cart. A pricing structure for the variable rate carts would need to be developed and applied to the City's billing system. Education and outreach efforts would also need to be initiated in order to explain the new system to the affected residents.

Alley Garbage Collection

Converting residential customers to a variable rate will require that the alley customers also have the choice of size container.

If the City decides to implement cart-based collection for alley garbage customers, it is recommended that the City use 20 cubic yard rear-loaders, fitted with tippers. The smaller sized vehicle will allow for greater efficiency than the current use of 25 cubic yard vehicles that are not reaching capacity on each trip. As with the curbside recommendation, a phased approach to purchase the vehicles over time could be considered in order to accommodate the City's vehicle replacement schedule. Variable sized carts would need to be purchased to have on-hand for residents electing to move to a smaller cart. A pricing structure for the variable rate carts would need to be developed and applied to the City's billing system. Education and outreach efforts would also need to be initiated in order to explain the new system to the affected residents.

It is also recommend that the number of residential alley customers be reviewed. As demonstrated by the operational analysis, moving additional customers to automated curbside collection has the benefit of reducing operational costs and increasing the collection efficiency. A detailed analysis and review of the alley routes could likely identify customers currently served by manual collection that could potentially be converted to automated curbside collection.

Ancillary Recommendations

As previously mentioned, implementing the above recommended volumetric residential collection system will require the users to become accustom to limiting the amount of garbage placed at the curb. Education of the users to understand the reasons for modifying the City's policy on garbage collection will be integral to the acceptance of the volumetric program. Based on communications with regional communities that have switched to volumetric based collection the following utility operational measures are recommended to be considered by the City:

- **Volumetric Collection Public Education**: Prior to implementing a volumetric collection system it is recommended that the City implement an education program that 1) informs the users of the size containers available, 2) the typical number of bags of garbage each container holds on average and 3) requests that the user selects a container size for the program. Based on previous experience the majority of the users will not respond and will be assigned the default container size. Prior to the request, the City will need to determine the default container size for the utility.

- **Bulk Waste Collection**: Regional communities have reported success in implementing a fee based bulk collection program. Under this program users would schedule a bulk item pick-up, for a reasonable fee, from the City. Communities have reported that utilizing a bulk waste collection program has

reduced the amount of large items set-out during spring/fall clean-up weeks and illegal dumping at public drop sites.

- **Residential Holiday Collection**: With once per week collection, there is the need to have holiday collection days on the next collection day when a City-recognized holiday falls on a scheduled collection day. Currently, the City deploys additional crews to complete two days of collection in a single day in order to make up for the collections missed on the holiday the previous day. Under any of the alternative scenarios reviewed, the practice of deploying extra crews on the next collection day will likely need to continue. Therefore, the City may consider holding additional spare vehicles in order to accommodate holidays.

- **Residential Holiday Excess Waste Collection**: Communities have implemented a residential holiday collection time frame where extra waste at the curb is collected without additional charge. Typically the time period is the first collection after Thanksgiving until the first collection of the New Year. This type of program benefits users that have typically limited garbage quantities to have an increase from hosting holiday visitors.

- **Landfill Disposal Vouchers**: Provide users with disposal vouchers that allow passenger vehicle sized loads to dispose at the landfill without paying the typical tipping fee. Vouchers can be distributed on an annual basis, or as a coupon included with each utility bill. It is recommended that the program be based on vouchers, or coupons, that must be turned in at the landfill scale instead of based on address or showing a utility bill. Use of a voucher will mitigate the potential of abuse from commercial or non-City resident users.

- **Spring/Fall Cleanup Collection**: It is recommended that the City continue the practice of cleanup weeks for large items and excessive waste. Other communities have reported that when these weeks are eliminated that illegal dumping increases.

Yard Waste Collection

Based on the planning level cost and operational estimates made for curbside and alley yard waste collection, it appears that offering this separate service would be more expensive than the City's current system of collecting from 18 different drop-off locations around the City. However it appears that implementing a volumetric residential collection service would realize enough savings to the utility to offset the increased costs of providing residential yard debris collection. Offering residential yard debris collection would allow for the closure of the drop-off sites resulting in additional total savings to the utility.

Appendix D. TM 402 – Recommended Curbside Residential Collection Boundaries

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Technical Memo

Date:	Tuesday, March 15, 2016
Project:	Solid Waste Management Collection Evaluation
To:	Jeff Heintz, Director of Public Works - Service Operations, City of Bismarck, ND
From:	Brent Erickson, Project Manager, HDR Engineering, Inc.
Subject:	Subtask 402 – Recommended Residential Collection Boundaries

Introduction

The City of Bismarck (City) contracted with HDR Engineering, Inc. (HDR) to evaluate the City's existing municipal solid waste (garbage) collection system, benchmark the City against other similar communities, and ultimately perform a sensitivity analysis of potential changes to collection services.

The City would like to consider various options for maximizing efficiency and improving services for the municipal collection of residential garbage. The purpose of Task 400 of this Solid Waste Management Collection Evaluation (Study) was to review and evaluate potential modifications to the City's current program. Subtask 401 included updating the operational model used in Task 300 (evaluation of current system) in order to compare certain operational metrics of potential modifications shortlisted in Task 300 to the current system. Subtask 402 includes route rebalancing and Subtask 403 includes route optimization. The remainder of this memo summarizes the results of Subtask 402. It is anticipated that Subtask 403 will be completed after City concurrence with the proposed residential route boundaries presented in this memorandum.

The main components of Subtask 402 included:

- Identifying the residential curbside and alley pick-up locations; and
- Prepare residential collection boundaries that balance the current and future pick-up locations

Background

Currently, Bismarck operates a five-day per week collection schedule, with the City divided into five zones for residential collection. The current zones are setup to include both alley and curbside collection on Tuesday, Wednesday and Thursday and only curbside collection on Monday and Friday. During weeks with holidays, the schedule is modified, resulting in either the collection of two zones on one day, or the Friday zone being collected the following Monday.

Curbside service is completed with the Heil multi-pack vehicles and consists of 96-gallon carts collected with the automated arm of the vehicle, and additional bags manually loaded into the rear compactor. Alley collection is competed via rear-load manual service. Details of the residential collection service are included in Technical Memorandum (TM) 300 and TM 401.

Existing Residential Customers & Collection Zones

Table 1 summarizes the weekly number of pick-ups per customer class used in this analysis. As of July 2015 the total number of residential pick-up locations, 19,182, reflects the number of individual households currently serviced by the collection utility.

TM 300 and 401 utilized a lower number of pick-up locations, based on information that was available at that time. The number of customers has been updated to reflect instances where several units, collected individually, are listed under a single account. After the completion and review of TM 300 & TM 401, the number of alley customers and pick-up locations was further refined based on the additional data developed from City billing databases, GIS layers, and analysis of the collection vehicle wheel paths as monitored by the GPS equipment in the trucks. The wheel track data, provided in GIS format, was used to refine the number of alley customers.

Table 1 – Revised Weekly Pick-ups by Customer Class

Customer Class	Weekly Pick-ups
Residential Curbside	17,270
Residential Alley	1,912
Total	**19,182**

The City currently serves the 17,270 curbside customers on a five-day per week basis. The collection schedule is comprised of three routes on Monday and five routes Tuesday through Friday. Table 2 indicates the number of pick-ups per weekday.

Table 2 - Existing Residential Curbside Pick-ups

	Existing Units	Platted Future Units	Total Future Units
Monday	2,900	632	3,532
Tuesday	3,638	214	3,852
Wednesday	3,348	460	3,808
Thursday	3,900	73	3,973
Friday	3,484	463	3,947
Total	17,270	1,842	19,112

The platted future units per zone were estimated by assigning a pick-up to currently undeveloped, platted lots. Although Mondays contain fewer existing pick-ups than the other zones, Table 2 indicates that, with the addition of platted future units, the five existing zones will become more balanced over time.

Exhibits

Exhibit 1 Residential Collection Locations, included as an attachment to this TM, documents the existing and platted future pick-up locations that were used to develop the revised collection zone boundaries. The GIS layer used to create Exhibit 1 is included in the project GIS data that will be transferred to the City with the final report.

Exhibit 2 Existing Residential Collection Zones, included as an attachment to this TM shows the existing residential collection zones summarized in Table 2. Exhibit 2 was created from the City GIS database provided during the data request portion of this task.

Recommended Revised Residential

The existing collection zones were revised under the assumption that the City would perform the collection throughout the course of four days during the week instead of five days, and assuming changes in technology for curbside collection would enable the City to collect more efficiently. Under these assumptions, the maximum number of pick-ups per zone is approximately 4,800. The residential boundaries were revised with the following objectives and assumptions:

1. Collection would be performed on a 4-day per week basis;
2. Curbside collection would be converted to fully automated technology with the requirement that all waste is contained in a cart or prepaid bag,
3. The number of units would be balanced per zone;

4. The number of units would remain balanced with the addition of platted, but currently undeveloped, parcels;
5. Minimizing the need for rebalancing in the future in order to minimize changes in customer collection days over time;
6. Alley customers would not be represented as they make up a minority of the customer base and are collected by a rear load truck.

The zones were revised in order to accommodate growth to the northwest and northeast without requiring major boundary changes. Table 3 contains the number of pick-ups within each of the revised zones.

Table 3 – Revised Residential Curbside Pick-ups Zones

	Existing Units	Platted Future Units	Total Future Units
Zone 1	4,442	337	4,779
Zone 2	3,818	662	4,480
Zone 3	4,779	431	5,210
Zone 4	4,231	412	4,643
Total	**17,270**	**1,842**	**19,112**

The recommended collection zones maintain an overall balanced number of daily pick-ups for the existing and future conditions. Additionally, the boundaries were established to accommodate the anticipated growth to the north with minimal changes to the boundaries. As the customer base extends north, it is recommended that the northern boundary of Zone 2 also moves north to the next major street. This allows the east and west boundary lines to remain the same, minimizing the impact to customer collection day changes for future boundary modifications.

Providing collection service in a four day week provides flexibility to the operations by allowing all customers to receive weekly service, regardless of the presence of holidays or other delays in service. During a week with a holiday, the City employees can recognize the holiday and then the remainder of the collection days will be pushed one day back in the week. For example, when a holiday falls on a Tuesday, Monday will be collected as usual. Tuesday will be the holiday with no collection. Normal Tuesday service will occur on Wednesday. Normal Wednesday service will occur on Thursday. Normal Thursday service will occur on Friday.

Exhibit 3 Proposed Residential Collection Zones, included as an attachment to this TM, shows the recommended revised collection boundaries. The GIS layer used to create this exhibit is included in the project GIS data that will be transferred to the City with the final report.

Growth Management for Future Collection Zones

Using the Growth Management Plan developed by the City, the revised boundaries were also evaluated to determine the long-range planned customers. It was assumed that for Low Density Residential, there would be an average of 6 units per acre. Table 4 contains the number of low density units within each zone.

Table 4 - Growth Management Curbside Pick-ups by Proposed Zone

	Low Density Residential Acres	Growth Management Units	Total Estimated Future Units
Zone 1	3,370	20,220	24,999
Zone 2	303	1,818	6,298
Zone 3	1,627	9,762	14,972
Zone 4	265	1,590	6,233
Total	5,565	33,390	52,502

As previously mentioned, it is recommended that as the City continues to develop to the north, the northern boundary of Zone 2 be moved further north to maintain balanced routes on a daily basis.

Table 5 summarizes the total estimated future units including current platted units and the Growth Management Plan estimated units. The total estimated future units will occur over a significant time period, likely greater than 30-years, and is intended to be a planning projection for continued revision of the collection zones.

Table 5 – Total Estimated Curbside Pick-ups by Proposed Zone

	Existing Units	Platted Future Units	Growth Management Units	Total Estimated Future Units
Zone 1	4,442	337	20,220	24,999
Zone 2	3,818	662	1,818	6,298
Zone 3	4,779	431	9,762	14,972
Zone 4	4,231	412	1,590	6,233
Total	**17,270**	**1,842**	**33,384**	**52,496**

Residential Curbside Collection System Capacity

After the completion of TM 300 and TM 401, City staff requested that analysis of the collection technology change include an estimate of the total number of pick-ups that could be collected. This estimate could be used to determine when additional routes (trucks) would need to be added to the system.

Table 6 demonstrates the estimated total number of residential curbside units that could be serviced by the four routes per day, four days per week, operating 10-hours per day. As shown, the automated system would have the ability to potentially service an additional 2,000 to 3,000 curbside units. It is important to note that the collection zones would need to be marginally rebalanced to continue to provide service.

The “Bismarck and Mandan North Dakota Housing Demand Analysis – 2030”, prepared by Hanna:Keelan Associates in October of 2015, predicted that on average Bismarck will add 350 new single family homes per year between 2015 and 2030. For planning purposes, it is estimated that an additional curbside residential route will need to be added in approximately 5 to 8 years. It is estimated that the City should plan to add a route to each zone (resulting in a total of five routes) between 2021 and 2024.

Table 6 - Residential Curbside System Capacity

Stops per Hour (1)	Hours per Day	No. of Units	Increased Capacity (Units) (2)
190	9.75	19,307	2,037
200	9.75	20,323	3,053

Notes:

1) Estimated stops per hour were base on a range of 190 to 200 based on experience with similar communities using automated collection. Actual stops per hour metrics should be measured and documented as the utility transitions to automated collection.
2) The increased capacity is the number of units exceeding the existing 17,270 units currently serviced.

Conclusion

The attached exhibits document the proposed residential collection boundaries. After review and comment by the City, individual route boundaries (collection areas for individual trucks inside of the collection zones) will be developed and included in the project GIS data to be transferred to the City with the final report.

Exhibits

Exhibit 1 Residential Collection Locations

Exhibit 2 Existing Residential Collection Zones

Exhibit 3 Proposed Residential Collection Zones

Appendix E. TM 403 – Recommended Curbside Residential Collection Routes

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Technical Memo

Date:	Wednesday, June 01, 2016
Project:	Solid Waste Management Collection Evaluation
To:	Jeff Heintz, Director of Public Works - Service Operations, City of Bismarck, ND
From:	Brent Erickson, Project Manager, HDR Engineering, Inc
Subject:	Subtask 403 – Recommended Residential Route Boundaries

Introduction

The City of Bismarck (City) contracted with HDR Engineering, Inc. (HDR) to evaluate the City's existing municipal solid waste (garbage) collection system, benchmark the City against other similar communities, and ultimately perform a sensitivity analysis of potential changes to collection services.

The City would like to consider various options for maximizing efficiency and improving services for the municipal collection of residential garbage. The purpose of Task 400 of this Solid Waste Management Collection Evaluation (Study) was to review and evaluate potential modifications to the City's current program. Subtask 401 included updating the operational model used in Task 300 (evaluation of current system) in order to compare certain operational metrics of potential modifications shortlisted in Task 300 to the current system. Subtask 402 included route rebalancing in order to identify optimum zones for collection. Subtask 403 includes route optimization, which identifies routes within the collection zones. The remainder of this memo summarizes the results of Subtask 403.

The purpose of Subtask 403 is to determine curbside residential collection route boundaries within the previously identified collection zones that balance the current and platted pick-up locations within each previously determined collection zone. For the purpose of this TM, 'collection zone' is defined as the area serviced by a fleet of vehicles. As a result, there are four collection zones previously identified in TM 402. 'Route boundary' is defined as the area serviced by a single truck within a single collection zone. Within each collection zone are four route boundaries, resulting in a total of 16 route boundaries.

Background

Currently, Bismarck operates a five-day per week collection schedule, with the City divided into five zones for residential collection. The current zones are setup to include

both alley and curbside collection on Tuesday, Wednesday and Thursday and only curbside collection on Monday and Friday. During weeks with holidays, the schedule is modified, resulting in either the collection of two zones on one day, or the Friday zone being collected the following Monday.

Curbside service is completed with the Heil multi-pack vehicles and consists of 96-gallon carts collected with the automated arm of the vehicle, and additional bags manually loaded into the rear compactor. Alley collection is competed via rear-load manual service. Details of the residential collection service are included in Technical Memorandum (TM) 300 and TM 401.

TM 402 recommended performing collection throughout the course of four days during the week instead of the current five day schedule. The collection zones were revised with the following assumptions:

1. Collection would be performed on a 4-day per week basis;
2. Curbside collection would be converted to fully automated technology with the requirement that all waste is contained in a cart or prepaid bag,
3. The number of units would be balanced per zone;
4. The number of units would remain balanced with the addition of platted, but currently undeveloped, parcels;
5. Minimizing the need for rebalancing in the future in order to minimize changes in customer collection days over time;
6. Alley customers would not be represented as they make up a minority of the customer base and are collected by a rear load truck.

The proposed collections zones, agreed upon through discussions of TM 402, are included in TM 403 Exhibit 1. The “Future Service Area to be Added” (as shown in TM 403 Exhibit 1) does not contain any existing pickups or platted units. This area is not expected to need service within the next 5-10 years, and will eventually be an added route to a collection zone.

Existing Residential Collection Routes

For the purposes of this TM, it was assumed that the City services approximately 17,270 residential curbside customers on a weekly basis. The pick-ups are distributed amongst 23 routes, with three trucks being deployed Monday and five trucks deployed Tuesday through Friday. As summarized in TM 300, the route observations indicated each route has an average of 671 homes.

Based on the information provided by the City and data gathered during the route observations, the curbside garbage collection staff appears to be actively engaged in

collecting waste an average of 6 hours and 26 minutes per collection day. This time is inclusive of all on-route time, off-route time, turnaround time at the disposal facility, lunches/breaks, and inspection time.

Recommended Residential Collection Routes

The existing collection routes were revised under the assumption the City would perform the collection throughout the course of four days during the week. The routes within the collection zones were revised with the following objectives and assumptions:

1. Four, fully-automated vehicles would perform the collection;
2. The work day for the collection staff would begin at 7:00 am and end at 5:30 pm, allowing for a half-hour lunch and three fifteen-minute breaks;
3. The number of units, including existing units and platted, currently undeveloped units, would be balanced per route;
4. Growth Management Units were not represented as they will occur over a significant time period, likely greater than 10-years; and
5. Residential Alley customers would not be represented as they make up a minority of the customer based and are collected by a rear load truck.

The boundaries were created in order to accommodate growth to the northwest and northeast without requiring major boundary changes. By balancing the existing units and platted, currently undeveloped units, the route boundaries will require minimum rebalancing within the next two to three years. Table 1 through Table 4 contain the number of pickups within each route boundary per collection zone. In these tables, the “Existing Units” are the estimated collection points as of the July 2015 billing listing and GIS analysis of the truck routes. “Platted Units” are lots that have been created by existing plats, are zoned residential, and will be a garbage collection location after a structure is built. “Total Units” is the sum of the “Existing Units” and “Platted Units”.

Table 1 - Zone 1 Route Boundaries

Route	Existing Units	Platted Units	Total Units[(1)]	Trips to Landfill
Route 1-1	817	156	973	3
Route 1-2	1,485	34	1,519	3
Route 1-3	1,335	37	1,372	3
Route 1-4	805	110	915	3
Total	**4,442**	**337**	**4,779**	-
	Notes: (1) Total Units refers to the combination of Existing Units and Platted Units presented in TM 402. Total Units is the number of existing collection points plus the undeveloped platted single family parcels that will eventually be curbside collection points.			

The recommended route boundaries for Zone 1 provide additional capacity to Route 1-1 and Route 1-4. These route boundaries were established to accommodate the anticipated growth to the northeast with minimal changes to the route boundaries.

Table 2 - Zone 2 Route Boundaries

Route	Existing Units	Platted Units	Total Units	Trips to Landfill
Route 2-1	1,069	9	1,078	3
Route 2-2	1,095	2	1,097	3
Route 2-3	675	529	1,204	3
Route 2-4	979	122	1,101	3
Total	**3,818**	**662**	**4,480**	-

As described in TM 402, Zone 2 is expected to have minimal growth compared to the other collection zones as indicated in the Growth Management Plan. As a result, the recommended route boundaries for Zone 2 are overall balanced.

Table 3 - Zone 3 Route Boundaries

Route	Existing Units	Platted Units	Total Units	Trips to Landfill
Route 3-1	1,332	3	1,335	4
Route 3-2	1,470	6	1,476	4
Route 3-3	1,126	179	1,305	4
Route 3-4	851	243	1,094	3
Total	**4,779**	**431**	**5,210**	-

The recommended route boundaries for Zone 3 provide additional capacity to Route 3-4 in order to accommodate the anticipated growth to the northwest with minimal changes to the route boundaries. The four routes operate in a high-density population area. As a result, the trucks are expected to reach weight capacity in less time, resulting in an additional trip to the landfill, without exceeding the overall collection time frame.

Table 4 - Zone 4 Route Boundaries

Route	Existing Units	Platted Units	Total Units	Trips to Landfill
Route 4-1	708	264	972	3
Route 4-2	947	137	1,084	3
Route 4-3	1,234	4	1,238	4
Route 4-4	1,342	7	1,349	4
Total	**4,231**	**412**	**4,643**	-

The recommended route boundaries for Zone 4 also provide additional capacity to Route 4-1 and Route 4-2 in order to accommodate the anticipated growth to the north with minimal changes to the route boundaries.

TM 403 Exhibit 2 through TM 403 Exhibit 5, included as attachments, show the recommended route boundaries. The GIS layer used to create these exhibits is included in the project GIS data that will be transferred to the City with the final report.

Conclusion

The attached exhibits document the proposed residential collection route boundaries. Utilization of these route boundaries is dependent on the City adopting setout limits and converting residential curbside service to fully automated collection.

After review and comment by the City on the route boundaries, the recommended turn-by-turn routes will be developed and included in the project GIS data to be transferred to the City with the final report.

Exhibits

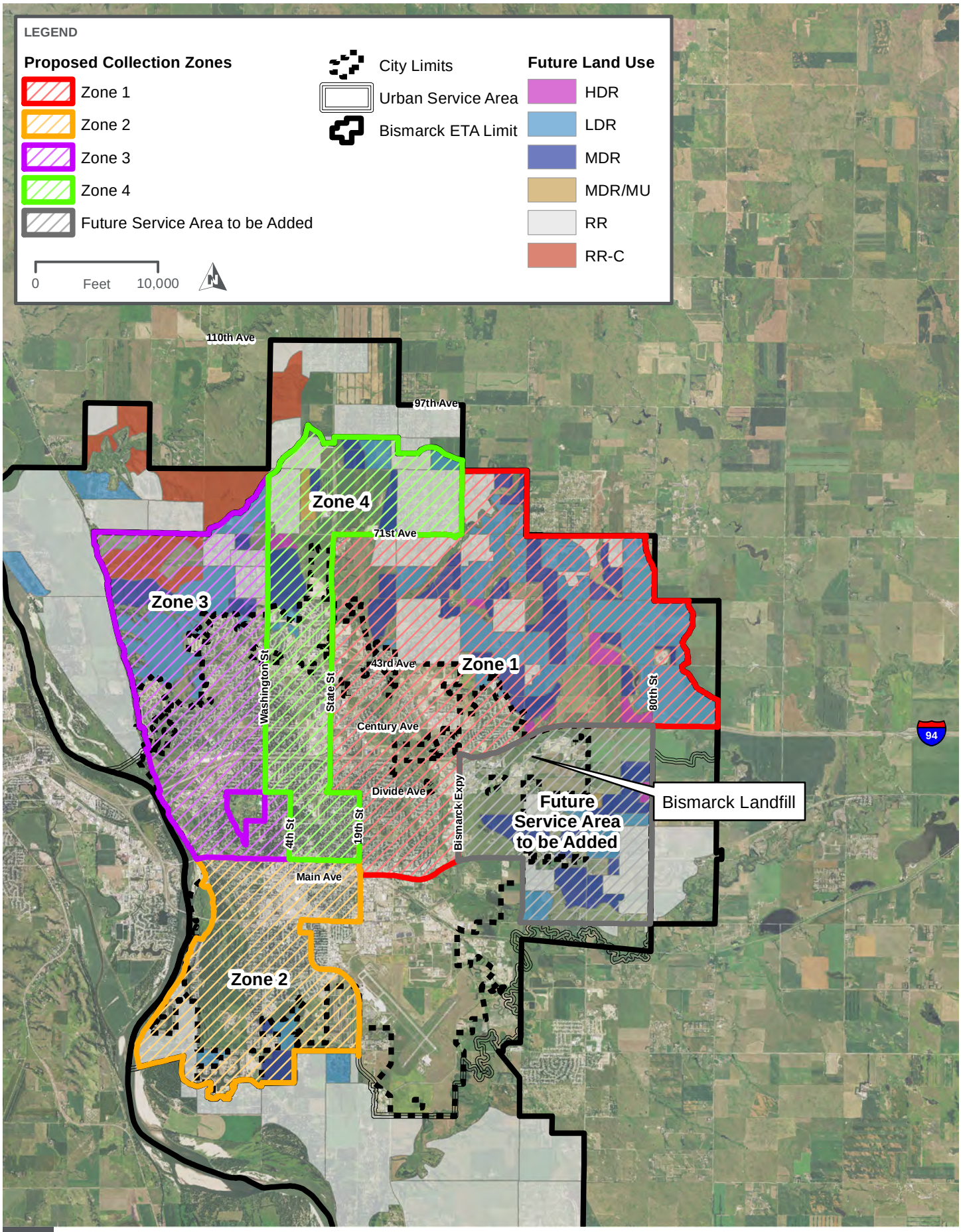
TM 403 Exhibit 1 Proposed Residential Collection Zones

TM 403 Exhibit 2 Proposed Residential Collection Routes – Zone 1

TM 403 Exhibit 3 Proposed Residential Collection Routes – Zone 2

TM 403 Exhibit 4 Proposed Residential Collection Routes – Zone 3

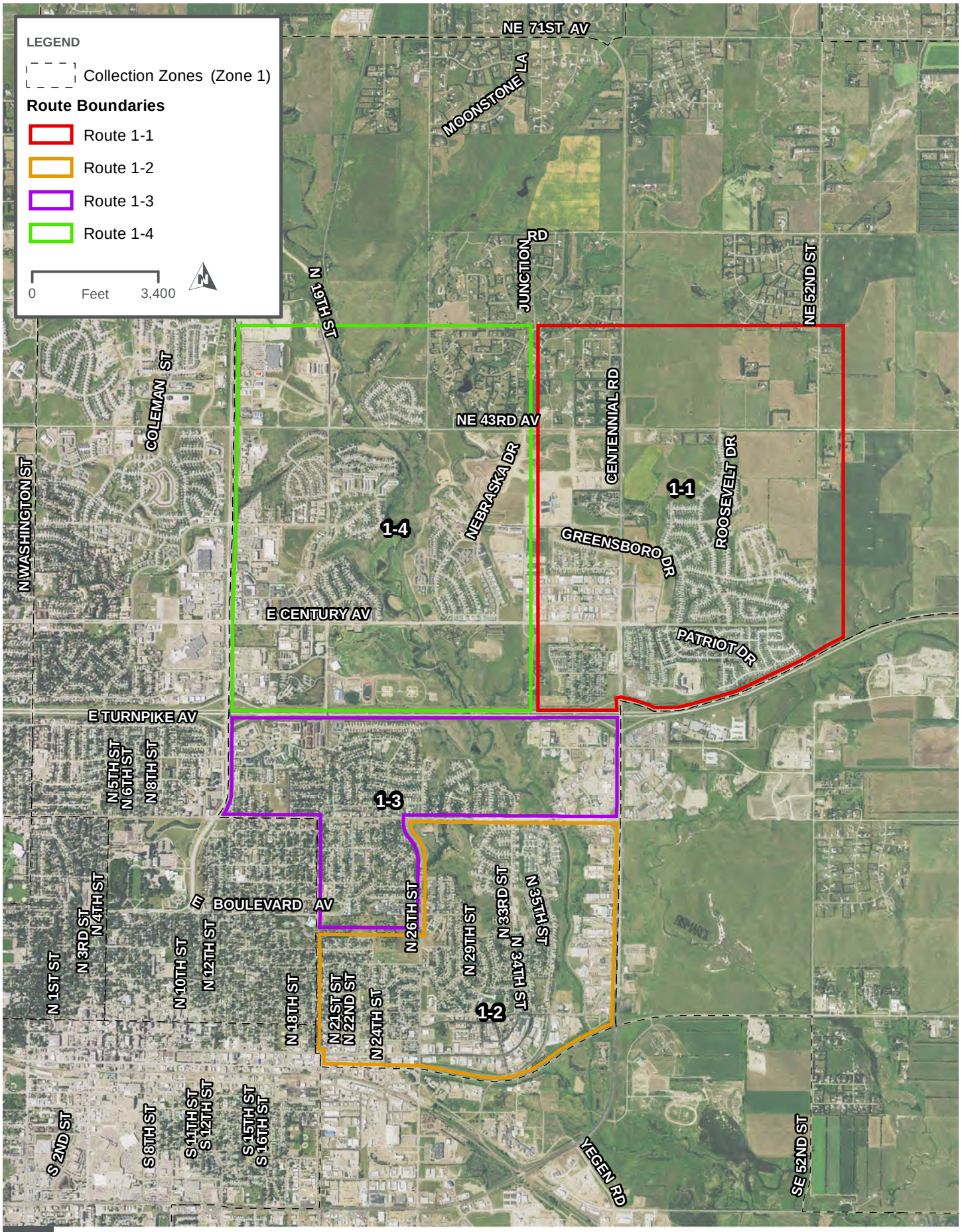
TM 403 Exhibit 5 Proposed Residential Collection Routes – Zone 4



CITY OF BISMARCK

RESIDENTIAL WASTE COLLECTION

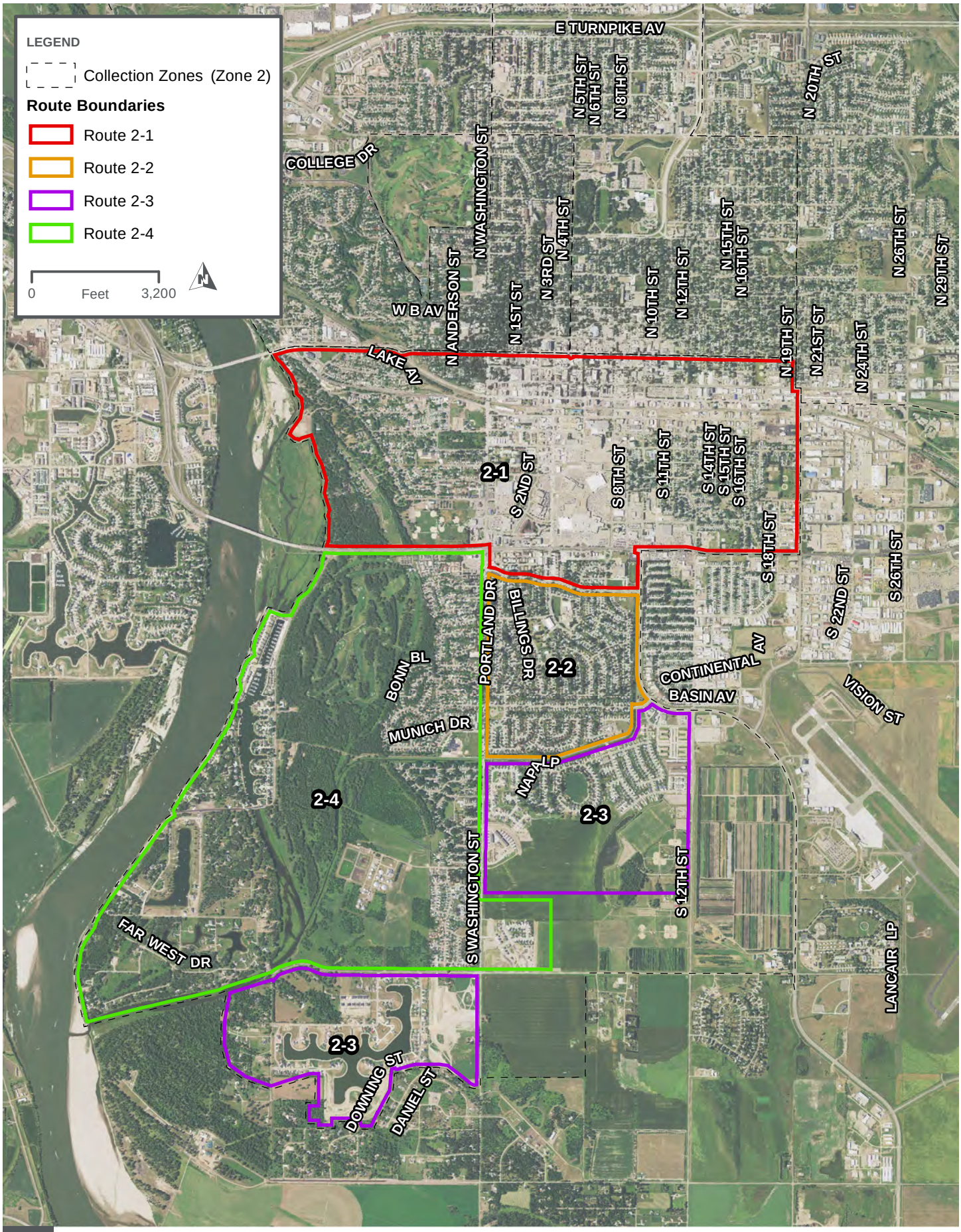
PROPOSED RESIDENTIAL COLLECTION ZONES (TM 403 EXHIBIT 1)



CITY OF BISMARCK

RESIDENTIAL WASTE COLLECTION

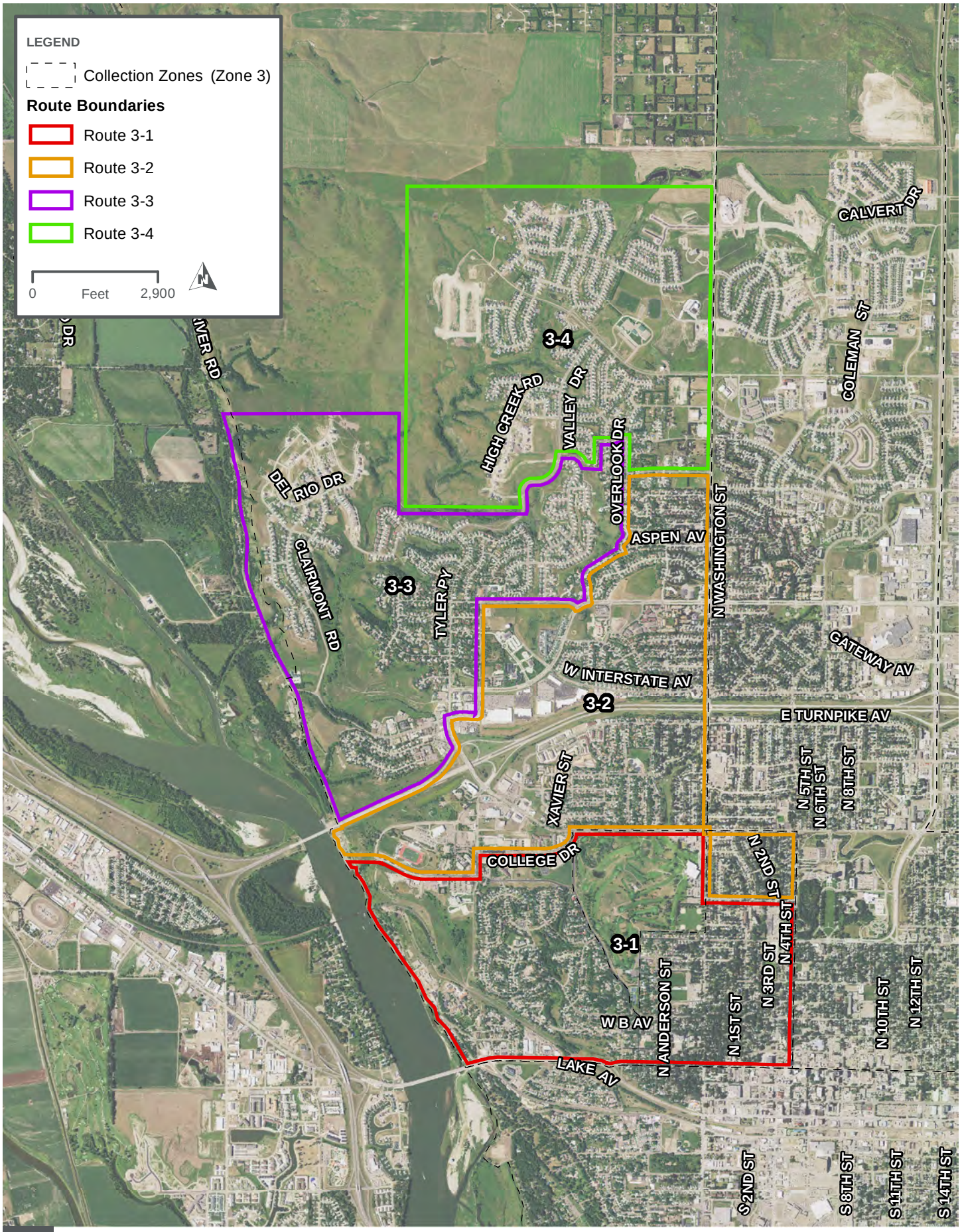
PROPOSED RESIDENTIAL COLLECTION ROUTES - ZONE 1 (EXHIBIT 2)



CITY OF BISMARCK

RESIDENTIAL WASTE COLLECTION

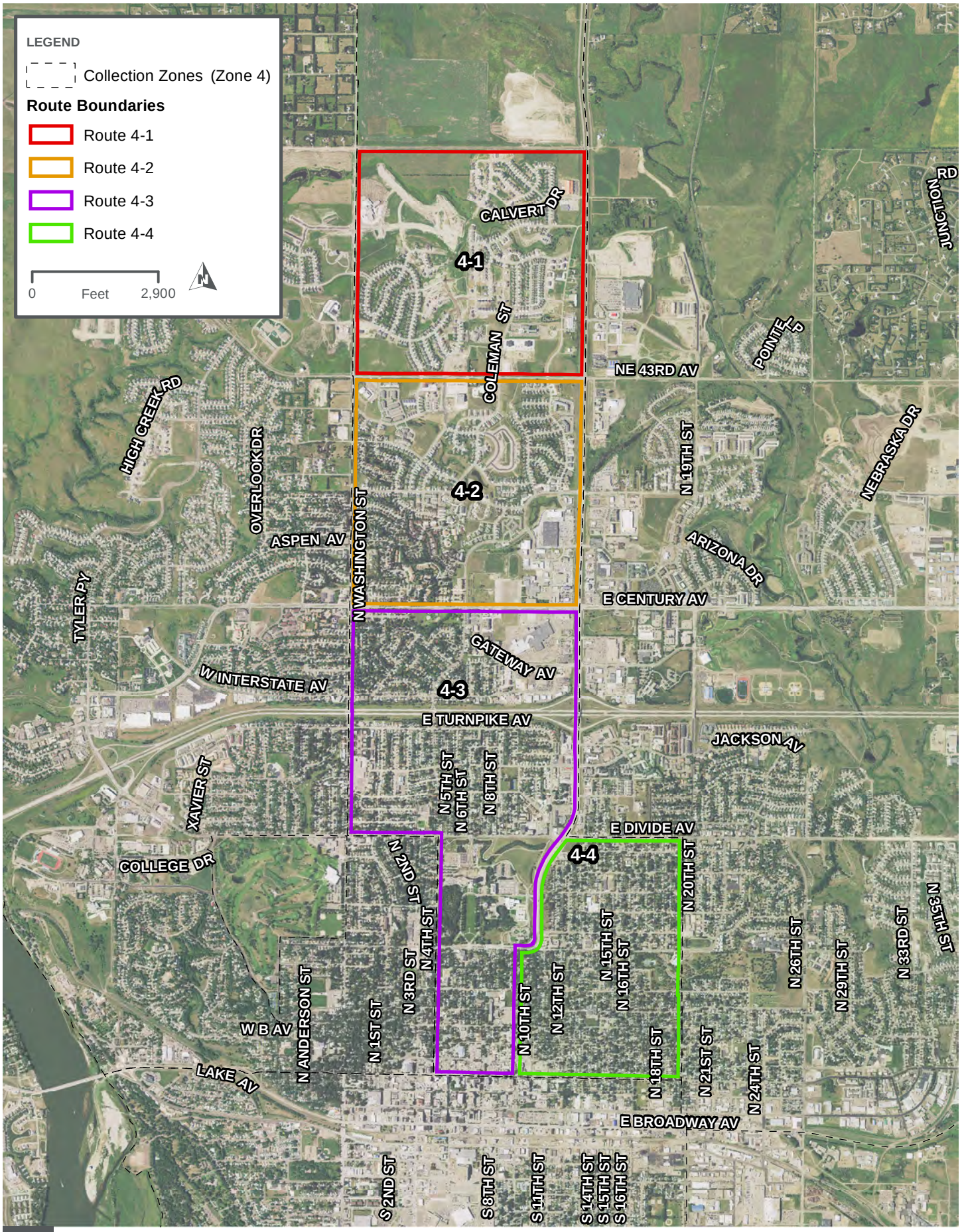
PROPOSED RESIDENTIAL COLLECTION ROUTES - ZONE 2 (EXHIBIT 3)



CITY OF BISMARCK

RESIDENTIAL WASTE COLLECTION

PROPOSED RESIDENTIAL COLLECTION ROUTES - ZONE 3 (EXHIBIT 4)



CITY OF BISMARCK

RESIDENTIAL WASTE COLLECTION

PROPOSED RESIDENTIAL COLLECTION ROUTES - ZONE 4 (EXHIBIT 5)