HISTORIC FRANKLIN TENNESSEE

MEMORANDUM

March 5, 2014

TO: Board of Mayor and Aldermen

FROM Eric Stuckey, City Administrator
Russ Truell, ACA Finance and Administration
Becky Caldwell, Director of SES
Jack Tucker, Assistant Director of SES
Nate Ridley, Collection Manager of SES
Patrick Mustell, Information Support Technician of SES

SUBJECT: Data Set-up and Analysis of Residential Curbside Collection Route Optimization Scenarios

This memo reviews the modeling of the current residential curbside waste collection services by the City of Franklin, TN. Scenarios for the optimization of these services are presented. The City's current routes and potential new routes were modeled in the RouteSmart software based on parameters from the City's current operations. The set-up of the model and its parameters required conducting infield reviews of routes, reviewing GPS tracking data, reviewing scale data, and production reports. An assessment of potential collection day changes is provided that would allow for reductions in the number of vehicles used per day, cost savings, while aligning the City for future growth in the number of households served.

This memo addresses these fundamental questions:

1. Are the waste routes currently optimized for Regular and Ground Trash?
2. Are any collection day changes required to optimize the routes?
3. How many routes do we need per week?
4. What are the lowest cost collection routes to operate that accommodate future growth?

It is very important to note that this is an initial run of the RouteSmart models for the purposes of planning potential collection day changes to accommodate future growth and optimize the routes. Once a scenario of collection day changes and truck utilization is selected, the routes will require refinement and finalization prior to implementation.

A primary purpose of running the current routes is to compare the model with the actual times, in order to, modify the parameters and assumptions to calibrate the parameters to match the current route times. The calibrated model of the current routes becomes a baseline for developing the new route scenarios based upon the justification that if the current routes are modeled accurately then the parameters will be accurate for the new route scenarios. Although the actual path currently taken by the drivers is not known, the routes are run with an optimized path, which will result in route times from

the model typically being faster than their actual times. If the route times from the model are higher, this indicates that parameters may need adjustment or that there are inaccuracies with the street or customer data and their associated service requirements (e.g., back down streets, miscoded travel directions).

1. Data Set-up

The data used in modeling the routes consisted of:

- Residential trash customers coordinates points
  - Master customer database, containing records for each household
  - Received on 4/16/2013
  - Total records: 23,174, including stops not serviced by automated collection
  - Actual records used in routing: 19,387 carts

- Street centerline data in GIS shapefile *(Q42012Alias.shp)*

- Collection day boundary polygons in GIS (ExportFromGISHV8_SL.*shp)*

- Address points of parcels
  - Used as a reference dataset to verify locations where cart records are within 100 feet

- Summary of June 2013 Production Reports *(COLLECTION PRODUCTION.xls)*
  - Compilation of Daily Route Sheets providing the weights and times for the current routes

- Route parameters, based on in-field studies of routes, along with Comet GPS tracking software and industry standards
  - Provided set-out weights, service times, driving times, disposal times, pre/post-trip times

1.1 Data Issues

When setting up data for the purpose of modeling the routes, it is typical to encounter issues and challenges with regards to the street and customer data being inaccurate or in complete. A number of issues were discovered and reasonable efforts were made to resolve the issues. The primary method for counteracting issues with the data was to ensure that the modeling of the current route times was congruent with the reasonable time that it takes to complete a route in actuality. These data issues included the following:

- There is an inaccurate count of the number of carts assigned to each resident. Because residents will move or misplace carts, e.g., they take the extra cart with them when they move to a new home, or because maintaining the database of carts assigned to

residents has been inconsistent. The actual number of carts at each household is not 100% accurate. A senior driver with the City has been reviewing the cart data to update its accuracy in the database.

- Driving times do not reflect traffic conditions and other real world anomalies. Route optimization models do not include historical traffic conditions, stoplights, maneuvering times specific to individual streets, which causes the models to be slightly inaccurate on an individual street basis. Actual route times were compared to the model to update its accuracy and account for these missing variables.

- Service times do not individual service issues at a household level. Although an average service time is used, there is actually a range of times that each individual customer takes to be serviced, due to access, maneuver or other individual location issues. An additional service time (10 seconds) was added for locations that were exceptions (Cul-de-sacs and dense problematic collection areas), in addition to, the average time.

- The GIS street centerline data was missing streets or had inaccurate street representation that had to be manually adjusted to match actual street geographies.

1.2 Seasonal Variances

The City of Franklin, like many other cities, has seasonal variances in the amount of waste collected. During school breaks for the end of the year holidays and during the months from May through July as vegetation is growing, areas such as Westhaven, Forrest crossing, McKays Mill and Fieldstone Farms subdivisions, have more waste to collect. During these peak seasons, there is an increase in the number of carts set-out and the total amount of waste collected. There are also conditions that make waste collection more difficult during these times of the year, such as heavy traffic, parking, collection time windows, and narrow streets. The specific increases in weights in these subdivisions could not be accurately determined, due to the use of the "helper" system where drivers assist with other routes after they are finished their own route. On a city-wide basis, the tons collected per month increases by 8.2% from 1,255 to 1,358 tons during the months of May, June and July. Although the peak season only accounts for a one third of the year and mostly affects certain subdivisions, the model was based on the peak season by utilizing parameters from the June Production Report data.

1.3 Field Time Study and GPS Time Study

Franklin Project Team conducted three in-field time studies of specific areas to verify the routing model parameters. Trucks were followed and timed to gauge an assessment of an average stop time and travel time on specific streets. During these field studies, a variety of different collection circumstances were presented, including tandem-axle trucks, single-axle trucks, high density areas, narrow streets, heavy parking, alleys, and back-down streets. Based on the times collected from the study, it was deemed that an average stop time of 16 seconds be applied to the routing model.

1.4 Route Performance Parameters

The route performance parameters provide the fundamental constraints to the routing model, in regards to workdays, working hours, service times, set-out weights, vehicle capacities, etc. The parameters used in the modeling were assessed from scale data, Production Reports, derived from field work, or based on benchmarks from previous waste collection routing experience. These parameters may be further refined and calibrated during subsequent runs of the routing model when creating the final routes for implementation. Figure 1 provides values for the key parameters for the City of Franklin's waste collection (which are further detailed in City of Franklin Project Specifications Forms in the Appendix).

Figure 1: Key Routing Parameters

Parameter	Trash Collection
Total Number of Carts	19,387
Stop Time Per Collection	16 seconds
Stop Time Per Collection Exception (Dead-end Streets and Dense Problematic Areas)	26 seconds
Average Weight Per Household	36.1 pounds
Maximum Quantity Per Vehicle	Tandem Axle: 12 tons Single Axle: 8 tons
Maximum Allowed Workday	8 or 10 hours
Collection Days Per Week	4 or 5 days
Daily Break Time	30 minutes
Pre/Post Trip Time	15 minutes/15 minutes
Dump Time	15 minutes
Average Daily Breakdown Time	22 minutes

2. Analysis Current Routes and Collection Days

2.1 Current Routes

Currently, there are 28 residential waste collection routes run per week with automated side loader collection, which are operated by one driver. There are also an additional 15 routes run each week to collect "ground trash" utilizing manual rear load collection vehicles with a crew consisting of one driver and one to two helpers. Of these automated collection routes, a combination of both tandem axle trucks and single axle trucks are utilized as seen in Figure 2. The

tandem axle trucks have a higher capacity of 28 cubic yards compared to the single axle trucks with 24 cubic yards.

Figure 2: Current Truck Utilization

Day	Single Axle	Tandem Axle	Total
Monday	2	4	6
Tuesday	2	4	6
Wednesday	2	4	6
Thursday	2	3	5
Friday	2	3	5
Total	**10**	**18**	**28**

The current route boundaries and their respective collection days are shown in Figure 3. Performance statistics of the current routes from the production Reports and as modeled in RouteSmart are shown in Figure 4.

The current routes have a wide variance in time to complete the routes. According to the RouteSmart model, the times range from 3.6 hours to 7.4 hours (see Figure 4). The unbalanced routes are, in part, a result of growth in the City. As new housing developments were added, the adjacent route was given the additional work without re-routing all of the other routes for that collection day.

Figure 3: Current Routes and Collection Days

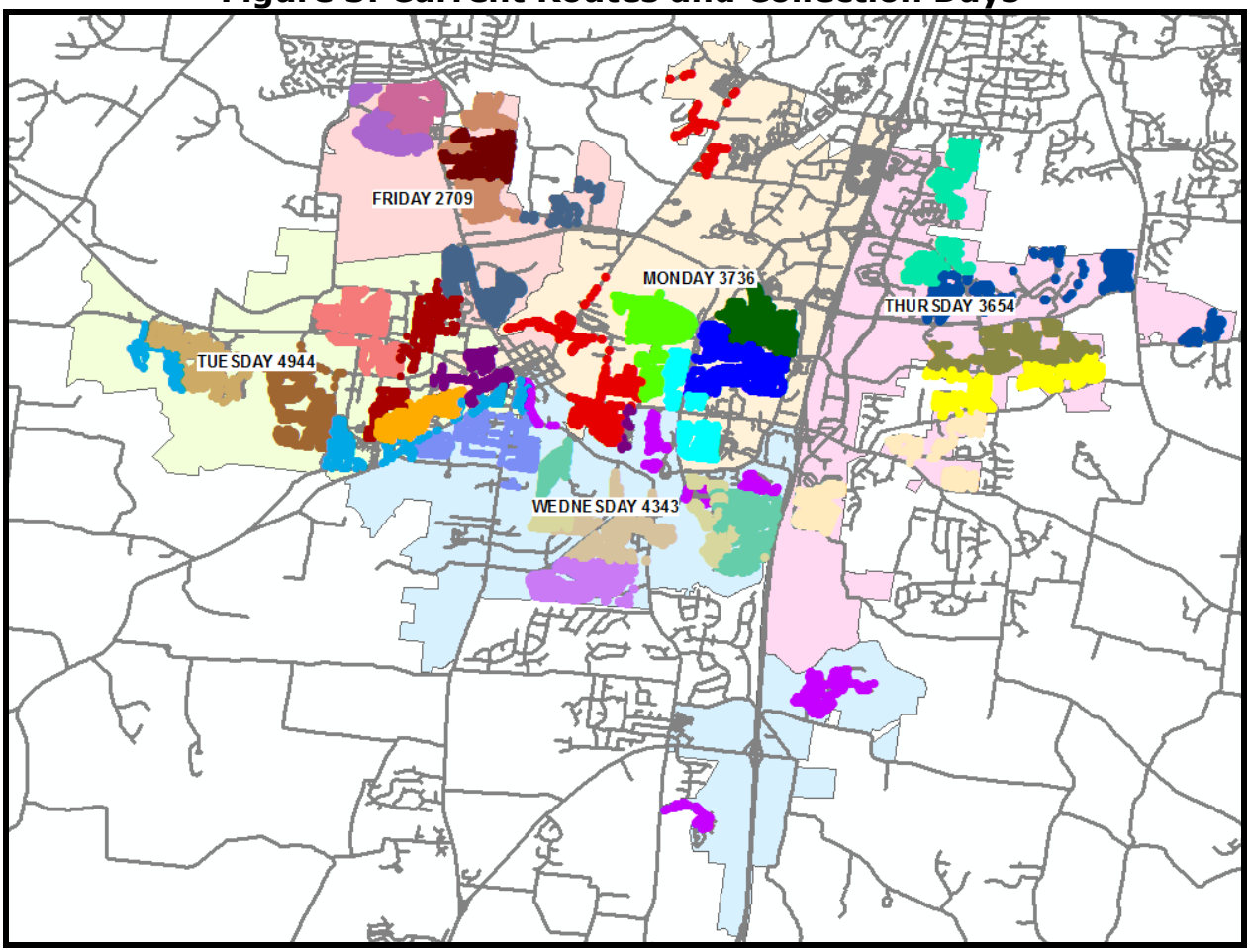


Figure 4 also compares the actual statistics from the June 2013 Performance Reports to those modeled in RouteSmart. The actual total mileage was 1,170 miles versus the modeled mileage of 987 miles, which indicates that the current routes may not be driven efficiently. The number of dump trips is 57 actual versus 52 modeled, which indicates that the drivers are not packing out the truck. However, when you look at Route 1106 with 331 stops, the truck would not have reached capacity for one dump, but it takes two dump trips.

It should be noted that the actual route times are from a peak month (June), but show less time than the modeled routes, because there is a need to have a "realistic buffer" in the model. On any given day, there may be anomalies in the collection system that increase the time to complete the routes. If the model is based on maximizing productivity during the peak times, there would not be enough slack in the system to handle anomalies, such as severe traffic, heavy set-outs, abnormal number of trucks being out of service, etc. Thus, the routes were modeled to be approximately 7% longer than the time that it would actually take during the peak season, as seen in the total actual time of 166.3 hours versus the modeled time of 178.4 hours for the week. As the new routes are developed with the model, there is a modest slack in the system to handle daily anomalies.

Figure 4: Current Waste Collection Route Statistics

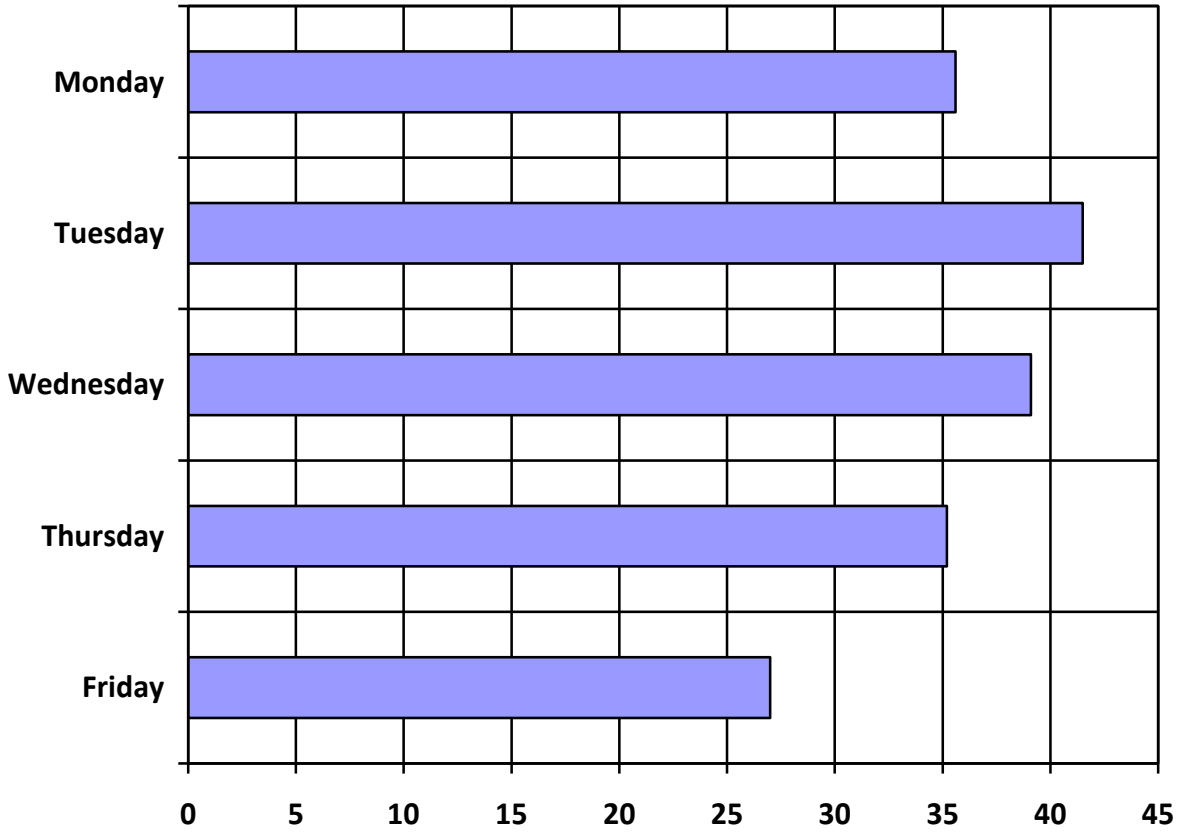
Day	Route	Actual Time (hours)	Time From Model (hours)	Tons	Vehicle Type	Actual Carts Collected*	Carts From Model	Actual Miles*	Miles From Model	Actual Dump Trips*	Dump Trips From Model
Monday	1101	6.8	6.6	10.1	Single	638	681	54	42	2	2
	1102	6.8	6.9	17.3	Tandem	744	799	41	39	2	2
	1103	5.0	6.2	11.4	Tandem	656	658	47	37	2	2
	1104	6.2	5.9	12.3	Tandem	639	608	36	33	2	2
	1105	6.5	6.3	13.6	Single	728	656	46	38	2	2
	1106	4.0	3.6	5.1	Tandem	331	334	29	17	2	1
	Average	**5.9**	**5.9**	**11.6**		**623**	**623**	**42**	**34**	**2.0**	**1.8**
	Total	**35.3**	**35.6**	**69.7**		**3,736**	**3,736**	**253**	**206**	**12**	**11**
Tuesday	2101	7.3	7.4	12.6	Single	857	891	31	31	2	2
	2102	6.0	6.3	16.6	Tandem	943	708	47	22	3	2
	2103	5.5	6.6	13.1	Tandem	702	735	36	32	2	2
	2104	7.2	7.1	11.1	Tandem	656	824	36	35	2	2
	2105	6.6	7.4	15.4	Single	850	1056	53	43	2	2
	2106	6.5	6.7	12.0	Tandem	583	730	40	38	2	2
	Average	**6.5**	**6.9**	**13.5**		**765**	**824**	**41**	**34**	**2.2**	**2.0**
	Total	**39.1**	**41.5**	**80.9**		**4,591**	**4,941**	**243**	**201**	**13**	**12**
Wednesday	3101	6.1	6.4	11.2	Single	585	717	33	26	2	2
	3102	6.6	6.6	16.8	Tandem	903	786	44	24	2	2
	3103	5.0	6.7	11.9	Tandem	695	770	37	29	2	2
	3104	6.3	6.0	10.5	Tandem	673	685	34	25	2	2
	3105	6.8	7.0	12.6	Single	720	813	48	38	2	2
	3106	5.5	6.4	6.8	Tandem	409	573	58	47	2	2
	Average	**6.1**	**6.5**	**11.6**		**664**	**723**	**42**	**32**	**2.0**	**2.0**
	Total	**36.3**	**39.1**	**69.9**		**3,985**	**4,340**	**254**	**190**	**12**	**12**
Thursday	4101	7.3	7.0	11.6	Single	707	736	38	48	2	2
	4102	5.8	6.6	12.1	Tandem	713	659	60	49	2	2
	4103	6.3	7.1	14.4	Tandem	601	705	66	59	2	2
	4104	6.3	7.0	8.7	Tandem	495	748	49	49	2	2
	4105	6.1	7.5	11.3	Single	682	806	48	50	2	2
	Average	**6.4**	**7.0**	**11.6**		**640**	**731**	**52**	**51**	**2.0**	**2.0**
	Total	**31.8**	**35.2**	**58.1**		**3,198**	**3,654**	**261**	**256**	**10**	**10**
Friday	5101	5.7	4.8	7.1	Single	580	448	36	25	2	1
	5102	5.3	6.5	12.8	Tandem	759	698	34	33	2	2
	5103	4.5	6.0	9.3	Tandem	518	610	22	32	2	2
	5104	4.3	4.7	6.8	Tandem	394	428	32	22	2	1
	5105	4.0	5.0	8.2	Single	457	525	35	21	2	1
	Average	**4.8**	**5.4**	**8.8**		**542**	**542**	**32**	**27**	**2.0**	**1.4**
	Total	**23.8**	**27.0**	**44.2**		**2,708**	**2,709**	**159**	**134**	**10**	**7**
All	**Total**	**166.3**	**178.4**	**322.9**		**18,218**	**19,387**	**1170**	**987**	**57**	**52**

Note: * Actual time, carts collected, miles, and dump trips are averages from the June, 2013, Production Reports. Actual times may not include the 60 minutes of break times and lunch times, as not all crews take this time during the servicing of the routes.

2.2 Current Collection Days

The current collection days operate five days per week and are not balanced. Additional growth will further exacerbate this unevenness of the workload. As seen in Figure 4 and Figure 5, the longest collection day is Tuesday requiring a total of 41.5 hours versus the lightest day being Friday only requiring 27 hours, a range of 14.5 hours. However, 6 trucks are run on Tuesday and of 5 trucks on Friday. The most carts are collected on Tuesday with 4,941. Interestingly, Tuesday has 83% more carts and 83% more tons collected than Friday. This significant range between the collection days severely limits the City's ability to optimize its residential collection operations to reduce costs and maximize efficiency. By balancing the collection days to have an equal number of trucks utilized each day (it currently ranges from 5-6 trucks per day), the City can optimize the efficiency of its automated waste collection.

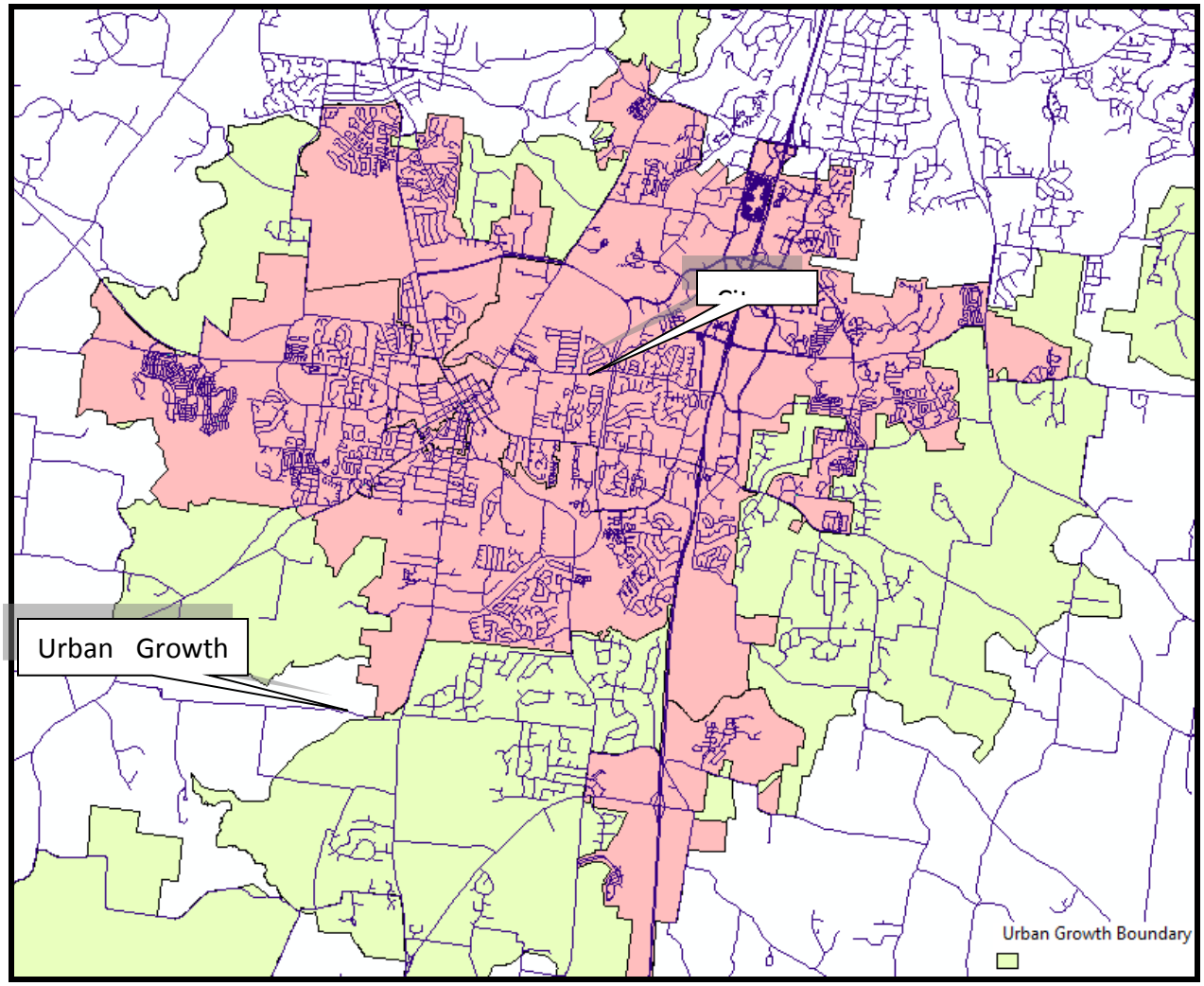
Figure 5: Total Hours (Modeled) by Current Collection Day



2.3 Future Growth

The city is growing. The City is planned to not only add more homes within its current boundary, but also expand the City limits, as seen in Figure 6. The current imbalance of workloads on each collection day will increase.

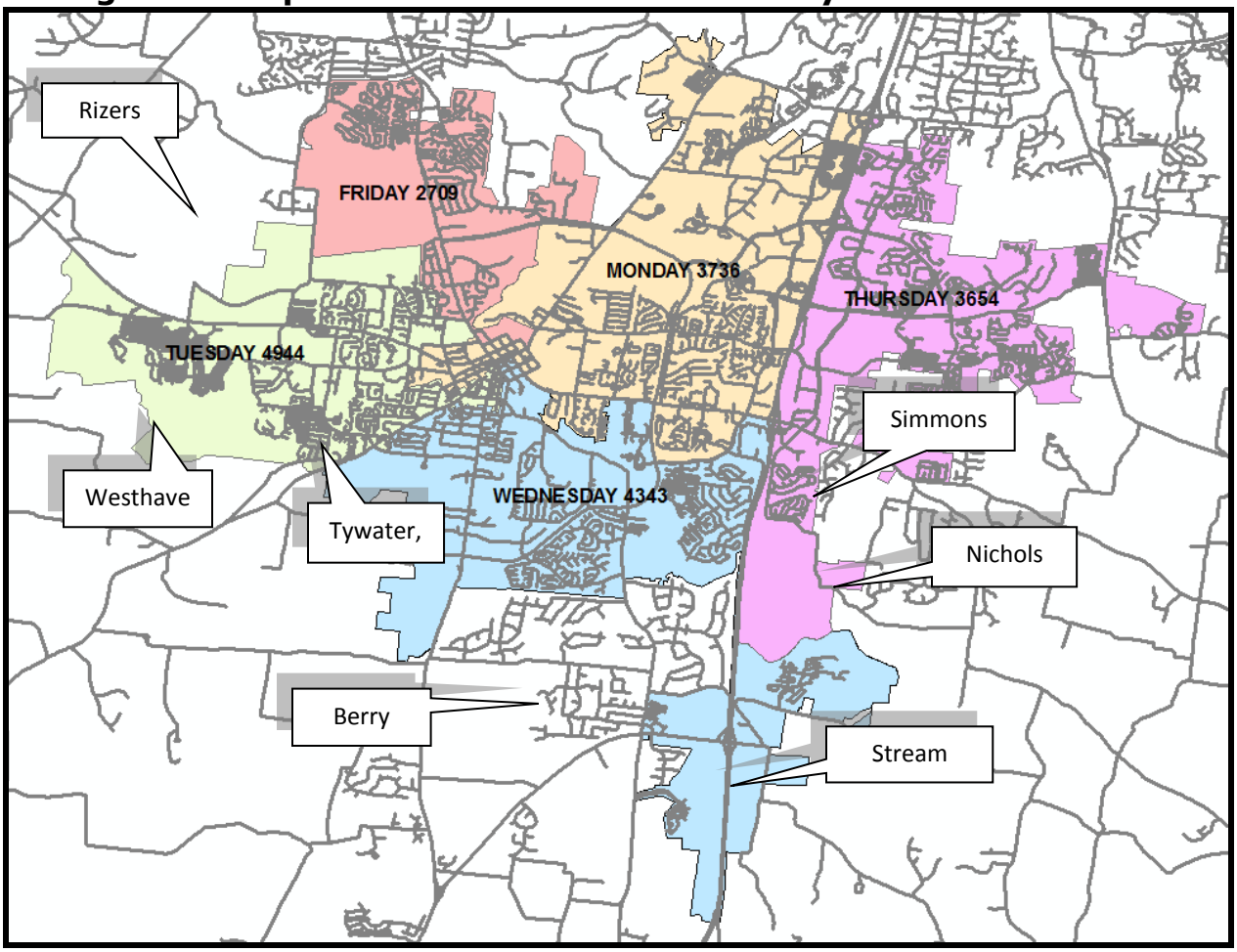
Figure 6: Current City Boundary and Potential Expansion of the City Limits



Source: Design Review Team, City of Franklin, and GIS, City of Franklin.

As shown in Figure 7, there are 1,495 new homes that are under development according to the City's Design Review Team and County permitting. The majority of the growth is occurring in the Tuesday, Wednesday and Thursday areas, which are already the heaviest collection days.

Figure 7: Map of Current Five Collection Days and New Growth



Source: Design Review Team, City of Franklin, and GIS, City of Franklin.

3. Collection Day Change Scenarios

To allow for optimizing the routes and to accommodate future growth, modifications to the collection day boundaries were analyzed. Two scenarios were developed:

1. Current – Baseline, no change, five days per week with eight hours per day.

2. Scenario One – Optimized routes for five days per week with eight hours per day (5 Days/8 Hours), and

3. Scenario Two - Optimized routes for four days per week with ten hours per day (4 Days/10 Hours).

In analyzing modifications to the collection days, the following guidelines were followed:

- Minimize changes - Minimize the number of customers that will have changes to their collection days to reduce inconveniences to citizens and reduce the cost and extent of public education that will be required,

- Balance for future growth – Housing that is under development will be taken into account in balancing the collection days, which will make the new collection days be imbalanced (until the new housing developments are occupied), and

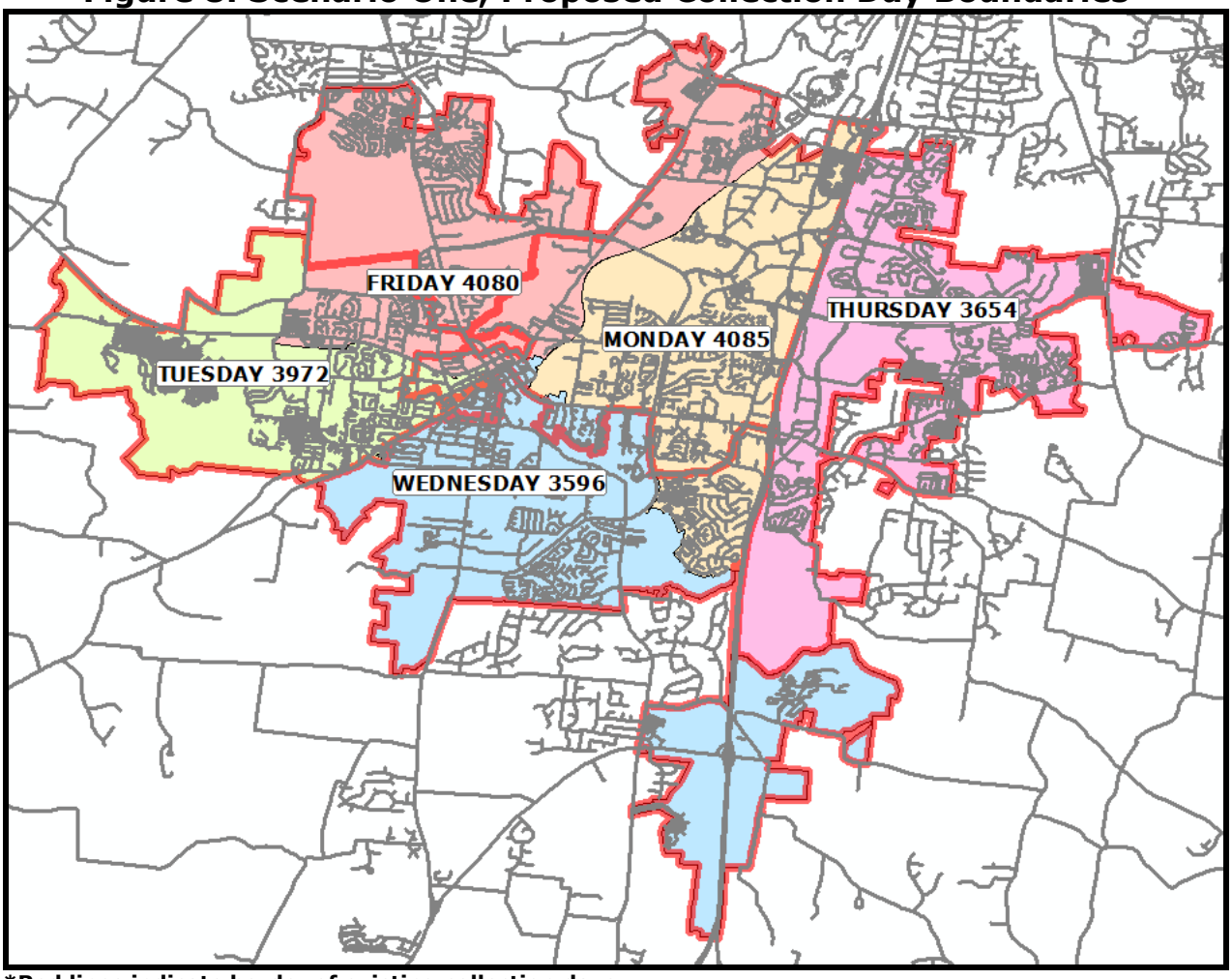
- Make new collection days as balanced as possible for the next five years – By planning the new collection days to be balanced after the new homes are developed in the next two years, it is intended that the collection days will not be imbalanced again until five years, if growth continues at its current pace.

- Create boundaries that are easy to understand – To improve customer service and make it easier for citizens to understand the collection day boundaries, the collection day boundaries should use major roads or other distinct geographical features as the boundaries of the collection days.

3.1 Scenario One, 5 Days/8 Hours

Scenario One maintains the current schedule of operating five days per week in eight hour shifts. Figure 8 shows the new collection days with the existing day boundaries being displayed as a red outline and the new days as a colored polygon.

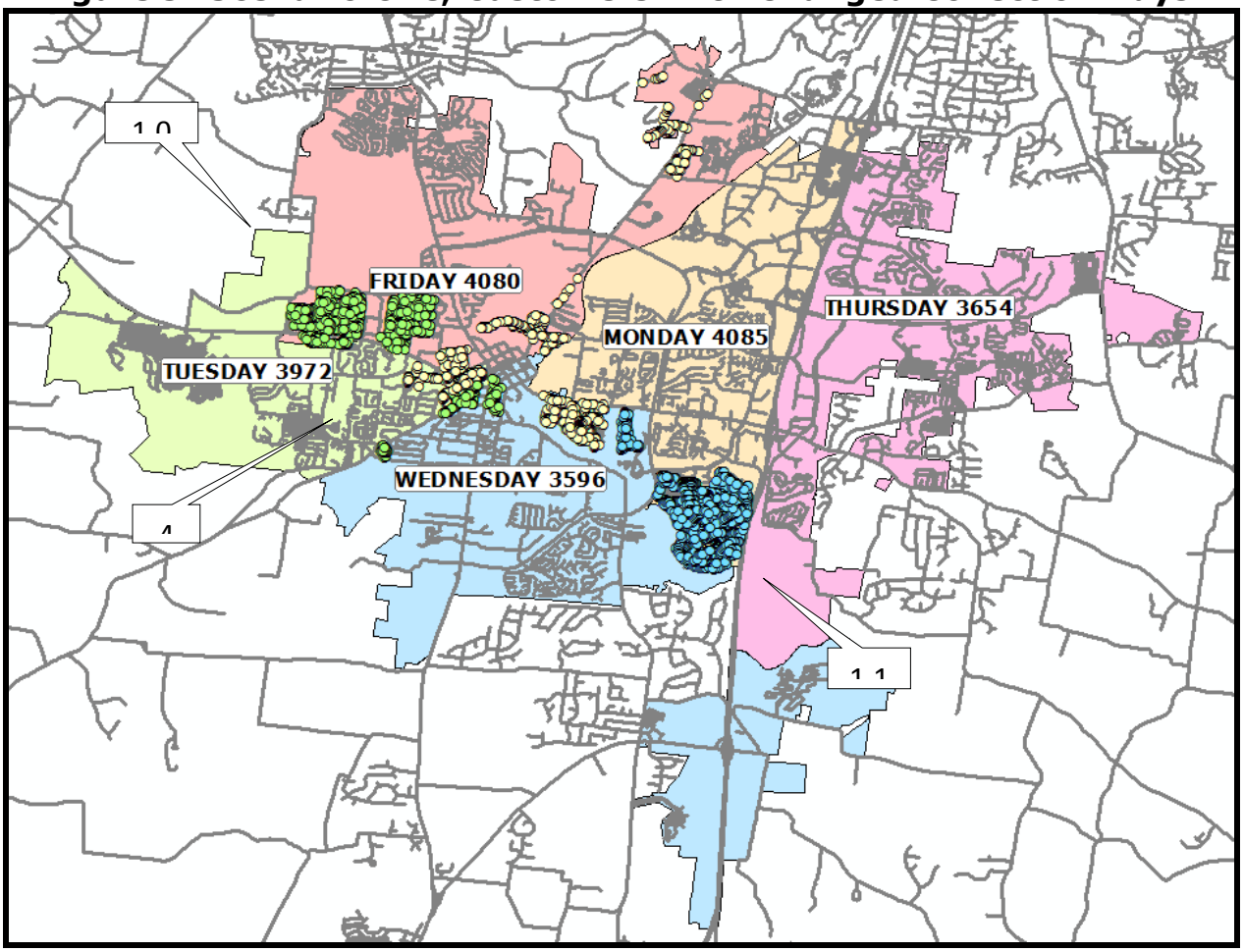
Figure 8: Scenario One, Proposed Collection Day Boundaries



***Red lines indicate border of existing collection days.**

Approximately 3,327 (17%) customers would have their collection days changed in Scenario One, as seen in Figure 9. Figure 9 displays the affected customers as circles colored as their previous collection days. For example, 1,193 customers are changed from Wednesday collection (in blue) to Monday collection (in tan). Figure 9 also displays the new number of carts per collection day to the right of the collection day name.

Figure 9: Scenario One, Customers With Changed Collection Days



The modified collection days in Scenario One, 5 Days/8 Hours, allowed for reducing the number of routes from 28 routes per week to 22.5 routes per week by operating 4.5 routes per day. The half route operates and half of one day, which equals one load and dump. The routes utilize all tandem axle automated trucks to reflect the potential impact of converting to all tandem trucks. The statistics for Scenario One are shown below in Figure 10.

The average route time in Scenario One is 7.7 hours with Tuesday and Wednesday having room for growth of 2.2 hours and 2.9 hours, respectively. Tuesday and Wednesday could accommodate approximately 900 additional customers to make those days even with the times of the other collection days.

Figure 10: Statistics for Scenario One, 5 Days/8 Hours

Day	Total Time (hours)	Total Carts	Miles	Total Tons	Dump Trips	Number of Trucks	Average Route Time (hours)
Monday	35.8	4,085	191	73.7	9	4.5	7.9
Tuesday	33.6	3,972	161	71.7	9	4.5	7.5
Wednesday	32.9	3,596	159	64.9	9	4.5	7.3
Thursday	35.4	3,654	261	65.9	9	4.5	7.8
Friday	35.8	4,080	199	73.6	9	4.5	7.9
Total	173.5	19,387	971	349.8	45	22.5	38.4
Average	34.6	3,877	194	69.96	9	4.5	7.7

Note: Time does not included lunches and breaks

As seen in Figure 11, the City could potentially decrease total weekly work time from 178.4 hours to 173.5 hours and reduce from 28 routes to 22.5 routes per week. Dump trips would be reduced from 57 actual dumps per week to 45 dumps or 12 less dump trips per week.

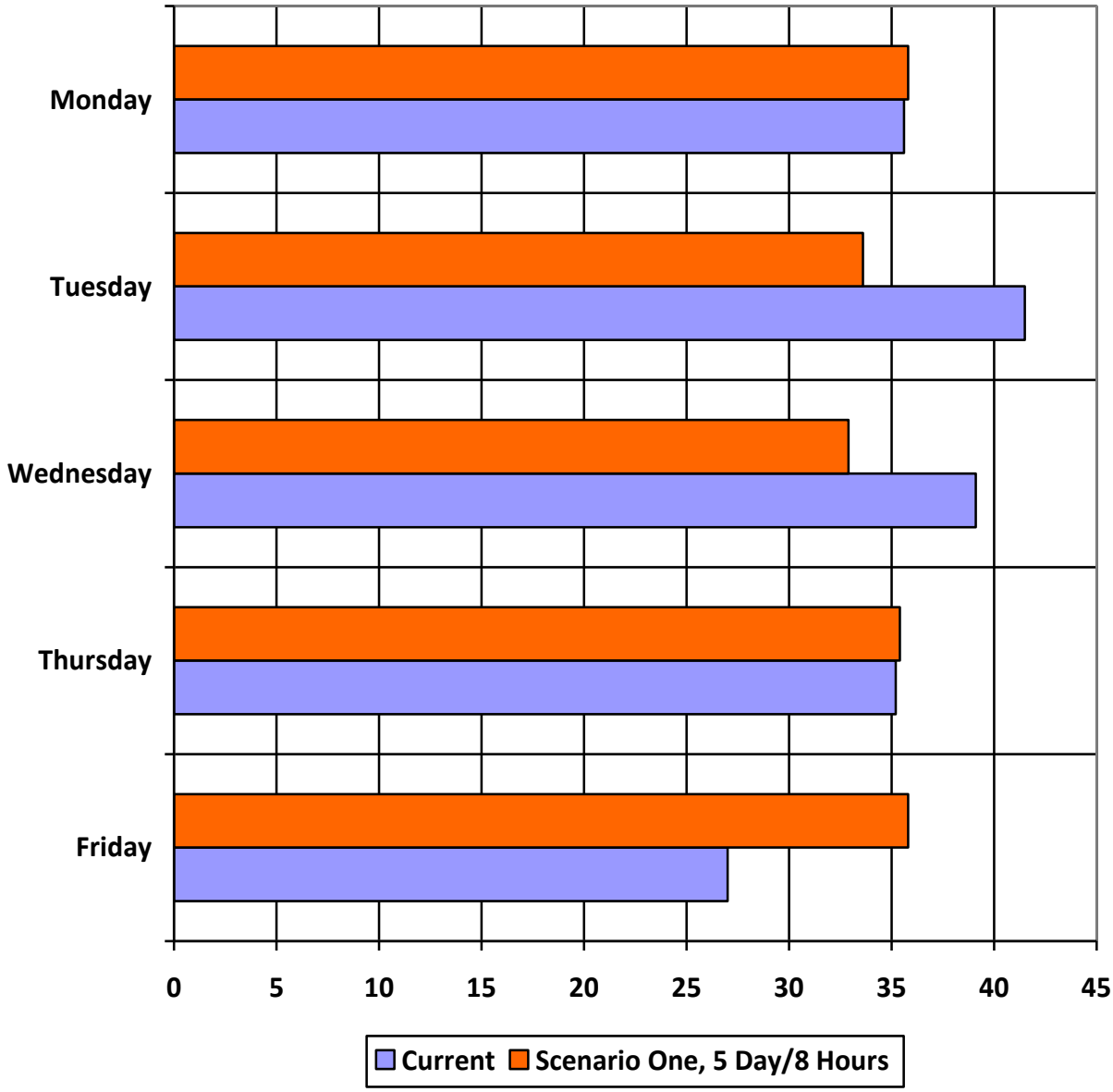
Figure 11: Comparison of Current Days Versus Scenario One

	Current, 5 Day/8 Hour, 28 Routes*				Scenario One, 5 Day/8 Hour, 22.5 Routes			
Day	**Total Time (hours)**	**Average Route Time (hours)**	**Average Carts per Route**	**Average Tons per Route**	**Total Time (hours)**	**Average Route Time (hours)**	**Average Carts per Route**	**Average Tons per Route**
Monday	35.6	5.9	623	11.6	35.8	7.9	908	16.4
Change					*+0.2*	*+2.0*	*+285*	*+4.8*
Tuesday	41.5	6.9	765	13.5	33.6	7.5	882	15.9
Change					*-7.9*	*+0.6*	*+117*	*+2.4*
Wednesday	39.1	6.5	664	13.5	32.9	7.3	799	14.4
Change					*-6.2*	*+0.8*	*+135*	*+0.9*
Thursday	35.2	7.0	640	11.6	35.4	7.8	812	14.6
Change					*+3.7*	*+0.8*	*+172*	*+3.0*
Friday	27.0	5.4	542	8.8	35.8	7.9	907	16.4
Change					*+8.8*	*+2.5*	*+365*	*+7.6*
Total	178.4				173.5			
Average	35.7	6.4	647	11.8	34.6	7.7	957	15.5

Note: *data is from the modeled routes.

Based on these statistics, the current 28 routes per week average 6.4 hours per route versus the 22.5 Scenario One routes average 7.7 hours and 957 stops. Figure 12 displays a graphical comparison the existing and Scenario One weekly collection hours.

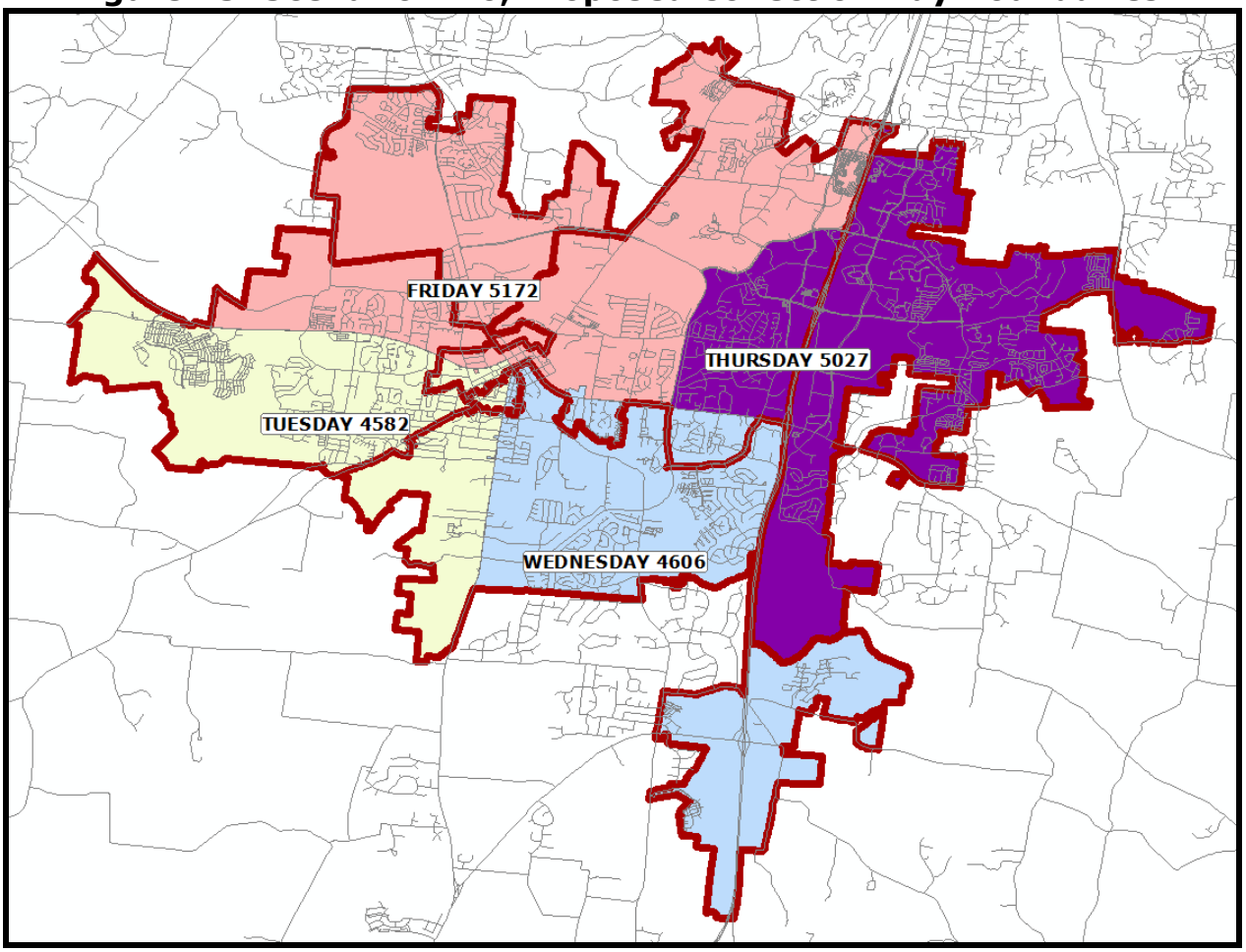
Figure 12: Comparison of Weekly Route Times, Current Versus Scenario One



3.2 Scenario Two, 4 Days/10 Hours

Scenario Two adjusts the collection days to be four days per week with ten hour workdays. The ten hour workday allows for the routes to be larger and reduces the weekly time for breaks, pre-trip and post-trip. Figure 13 shows the new collection days with the existing day boundaries being displayed as a red outline. Approximately 5,062 (25%) customers would have their collection days changed in Scenario Two, as seen in Figure 14.

Figure 13: Scenario Two, Proposed Collection Day Boundaries



***Red lines indicate border of existing collection days.**

Figure 14: Scenario Two, Customers with Changed Collection Days

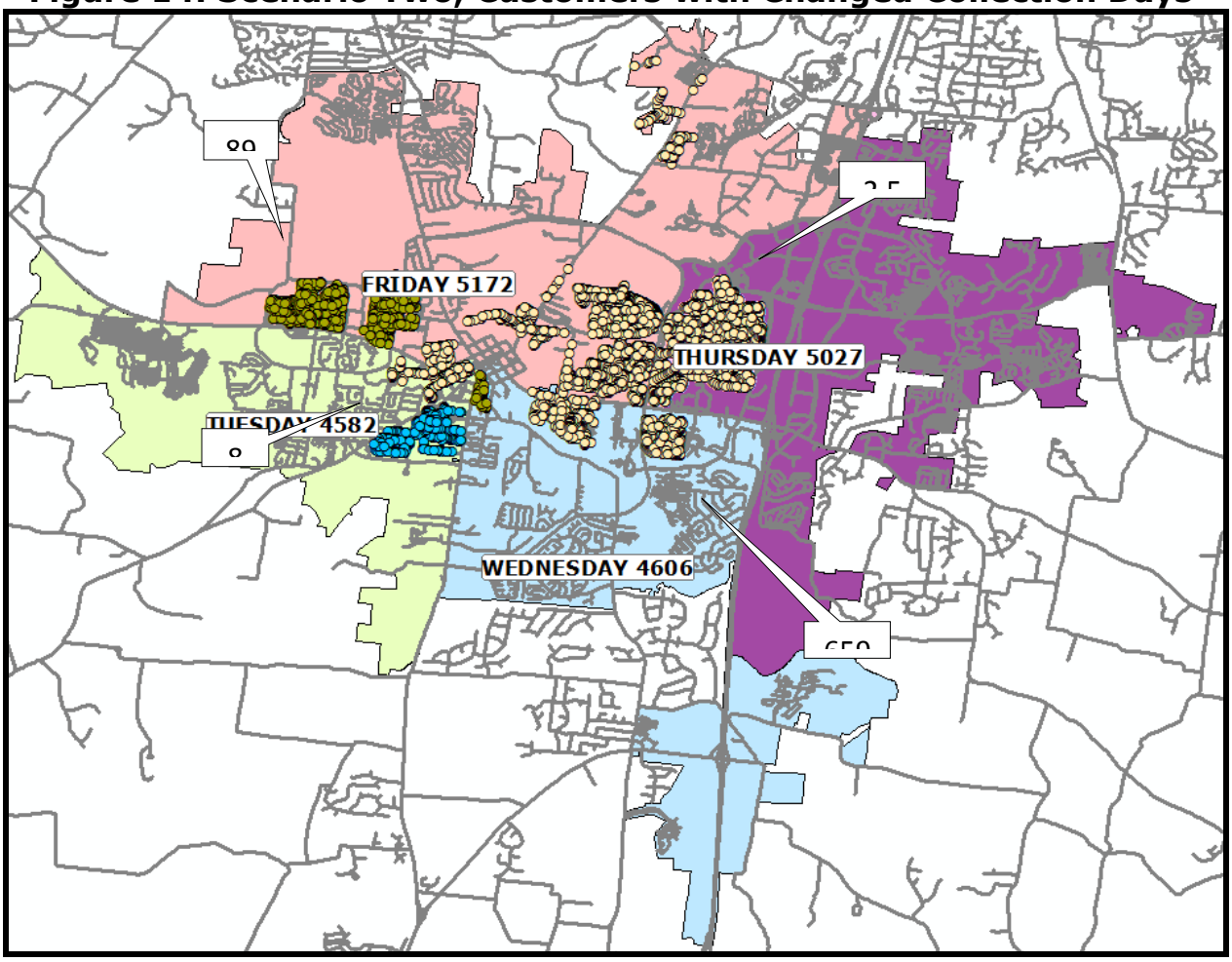


Figure 15 displays the statistics for Scenario Two, 4 Days/10 Hours. If all of the current trash collection routes were to utilize tandem axle automated trucks, as was modeled in this second scenario, there would be a significant improvement in efficiency.

Figure 15: Statistics for Scenario Two, 4 Days/10 Hours

Day	Time (hours)*	Containers	Mileage	Tonnage	Dump Trips	Number of Trucks	Average Time per Route (hours)
Tuesday	36.8	4,582	171	82.7	9	4.5	8.2
Wednesday	37.7	4,606	183	83.1	9	4.5	8.4
Thursday	42.1	5,027	281	90.7	9	4.5	9.4
Friday	41.2	5,172	229	93.3	9	4.5	9.2
Total	**157.8**	**19,387**	**864**	**349.8**	**36**	**18**	**35.2**
Average	**39.5**	**4,846**	**216**	**87.5**	**9**	**4.5**	**8.8**

Note: Time does not included 30 minute lunch or 15 min breaks.

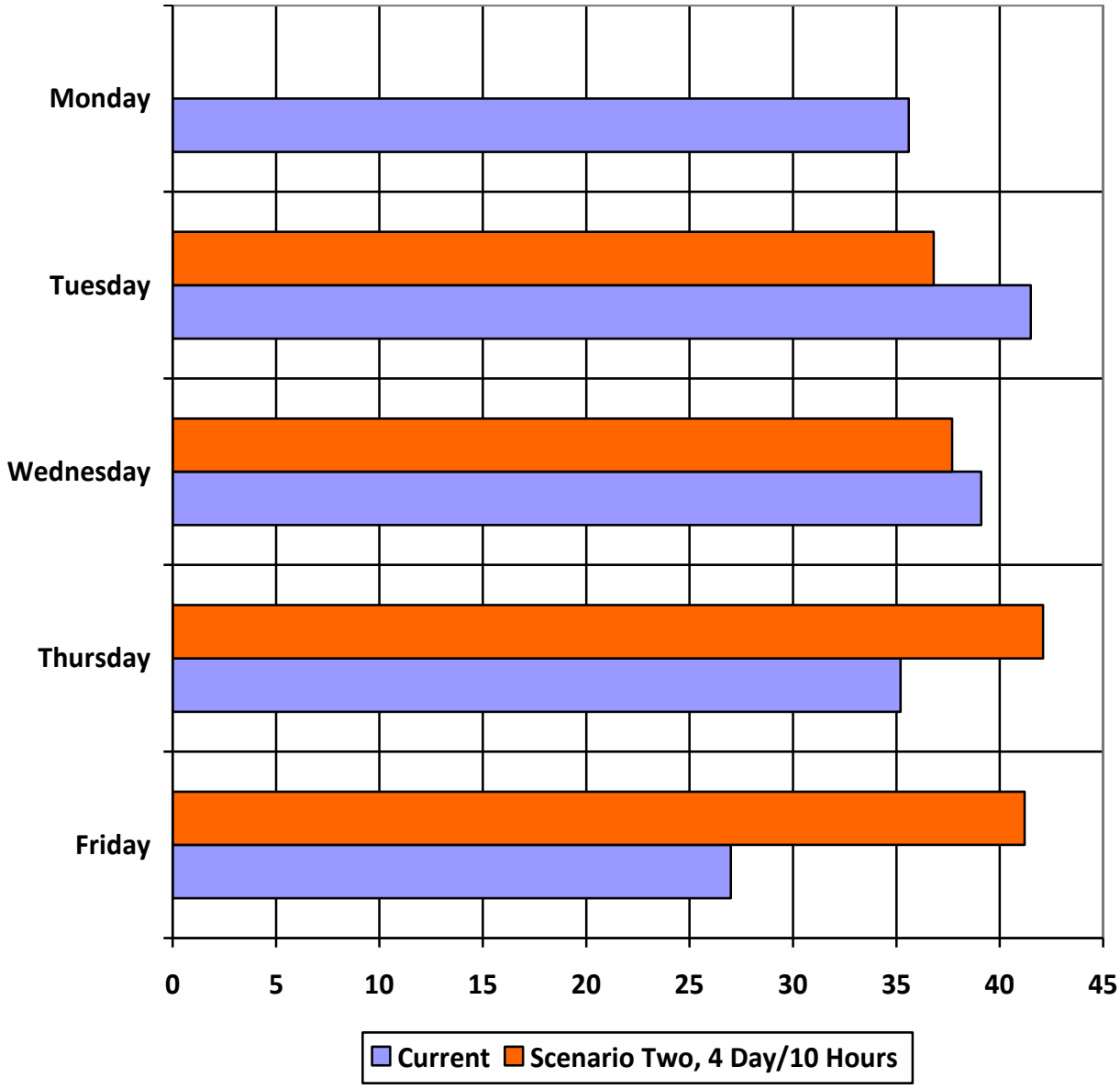
In Scenario Two, the City would decrease its weekly number of routes from 28 to 18 routes. As seen in Figure 16, the City could potentially reduce total weekly route time from 178.4 to 157.8 hours or 12%. This greatly increases productivity of the workforce. Scenario Two allows for more growth than Scenario One, because there are still 15.5 hours of time available before overtime on a combined Tuesday and Wednesday. Scenario One only has 5.5 hours of slack available before it approaches overtime on its heaviest housing growth days of Tuesday and Wednesday.

Figure 16: Comparison of Current Days Versus Scenario Two

	Current Days, 28 Routes				Scenario One, 22.5 Routes			
Day	**Total Time (hours)**	**Average Route Time (hours)**	**Average Carts per Route**	**Average Tons per Route**	**Total Time (hours)**	**Average Route Time (hours)**	**Average Carts per Route**	**Average Tons per Route**
Monday	35.6	5.9	623	11.6				
Change								
Tuesday	41.5	6.9	765	13.5	36.8	8.2	1,018	18.4
Change					*-4.5*	*+1.3*	*+253*	*+4.9*
Wednesday	39.1	6.5	664	13.5	37.7	8.4	1,023	18.5
Change					*-1.4*	*+1.9*	*+359*	*+5.0*
Thursday	35.2	7.0	640	11.6	42.1	9.4	1,117	20.2
Change					*+6.9*	*+2.4*	*+477*	*+8.6*
Friday	27.0	5.4	542	8.8	41.2	9.2	1,149	20.7
Change					*+14.2*	*+3.8*	*+607*	*+11.9*
Total	178.4				157.8			
Average	35.7	6.4	647	11.8	39.5	8.8	1,076	19.5

Figure 17 shows the total hours of all trucks per day. This Figure displays Scenario Two's available capacity for additional growth on Tuesday and Wednesday.

Figure 17: Comparison of Weekly Route Times, Current Versus Scenario Two



4. Costs by Scenario

Figure 18 provides costs for both the Regular automated Sideloader curbside waste collection and the additional Ground Trash collection of un-containerized materials. The current operations for both collection services are estimated at $1.08M. Scenario One is estimated to lower Regular and Ground Trash collection costs to $830k for a savings of 23% or $2.5k. Scenario Two will further reduce waste collection costs to $677k for a savings of 37% or $405k.

Figure 18: Comparison of Annual Costs for Scenarios

	Scenario	Routes Per Week	Time (hours)[1]	Labor Cost[2]	Miles	Mileage Cost[3]	Truck Usage Cost[4]	Total Cost
Current	Regular, 5 Days/8 Hours	28	11,648	$307,391	51,324	$69,845	$234,474	**$611,710**
	Ground Trash, 5 Days/8 Hours	15	12,480	$311,002	26,078[5]	$35,489	$125,611	**$472,102**
	Total	**43**	**24,128**	**$618,392**	**77,402**	**$105,334**	**$360,085**	**$1,083,812**
Scenario 1	Regular, 5 Days/8 Hours	22.5	9,360	$247,010	50,492	$68,713	$188,417	**$504,140**
	Ground Trash, 5 Days/8 Hours	10	8,320	$207,334	26,078[5]	$35,489	$83,741	**$326,564**
	Total	**32.5**	**17,680**	**$454,345**	**76,570**	**$104,202**	**$272,158**	**$830,704**
Scenario 2	Regular, 4 Days/10 Hours	18	7,488	$197,608	44,928	$61,141	$150,733	**$409,483**
	Ground Trash, 4 Days/10 Hours	8	6,656	$165,868	26,078[5]	$35,489	$66,993	**$268,349**
	Total	**26**	**14,144**	**$363,476**	**71,006**	**$96,630**	**$217,726**	**$677,832**
	Scenario 1 Total Savings	**10.5**	**6,448**	**$164,048**	**832**	**$1,132**	**$87,928**	**$253,108**
	Change	***-24%***	***-27%***	***-27%***	***-1%***	***-1%***	**-24%**	**-23%**
	Scenario 2 Total Savings	**17**	**9,984**	**$254,916**	**6,396**	**$8,704**	**$142,359**	**$405,980**
	Change	***-40%***	***-41%***	***-41%***	***-8%***	***-8%***	**-40%**	**-37%**

Notes: [1] full day hours not just route time

[2]Labor Cost is based on average hourly rate for Workers of $17.59 and for Operators of $15.63, plus 50% for benefits to equal $23.45 and $26.39, respectively.

[3] Mileage Cost is based on 2.3 mpg and fuel cost $3.13 per gallon, provided by Fleet Maintenance.

[4] Truck Usage rates are $20.13 an hour, provided by Fleet Maintenance.

[5] Mileage is the actual miles run for Ground Trash service in 2013, without adjustment for less routes per day.

5. Conclusions

There are substantial savings to be incurred by moving to either Scenario One ($0.25M savings) or Scenario Two ($0.4M savings). Either scenario requires collection day changes for a limited number of citizens. Scenario One results in 3,327 changed customers, while Scenario Two results in 5,062 customers being affected. With a savings of 37% or $.4M, Scenario Two is clearly the most advantageous plan from a cost perspective.

The cost of Ground Trash collection, not analyzed in-depth in this analysis, requires further assessment for optimization across services. Given that Ground Trash service currently accounts for 40% of the total cost for curbside waste collection services (Regular and Ground Trash), the value of that service and alternative options requires further investigation.

Provided below are the answers to the questions from Section 1:

1. **Are the waste routes currently optimized for Regular and Ground Trash?**

   No.

2. **Are any collection day changes required to optimize the routes?**

   Yes, to allow for future growth.

4. **How many routes do we need per week?**

   With accounting estimated for the accommodation of growth, the Regular collection is estimated to be 26 to 32.5 routes per week and the Ground Trash, between 8-10 routes.

4. **What are the lowest cost routes to operate that accommodate future growth?**

   Scenario Two, four days per week with ten hours per day (4 Days/10 Hours), is estimated to have the highest savings of $0.8M annually and the most capacity for future growth before requiring future changes to collection days.

Appendix
Route Design Specifications

Routing Project Title:	Side Loader Optimization
Date Form Was Completed:	12/18/2013
Client Organization:	Franklin TN
Client Contact Person/Title:	Patrick Mustell
Client Contact Telephone Number:	615-794-1516
Client Contact Email Address:	Patrick.mustell@franklintn.gov
Material Type(s) (e.g., waste, recyclables, yard waste):	Waste
Number of Existing Routes (route is one crew shift for one vehicle):	28 routes/day
Desired Number of New Routes:	16-20
New Route Numbering:	4 digits: 1st Day, 2nd -4th is Route. E.g., 2103 is Tuesday route 103. Monday is 1 and Friday is 5.
Collection frequency:	1x/week
Collection days per week, hours per day, operating hours, days of week:	5dpw, 8 hrs/day, Mon-Fri
Potential new days per week, hours per day, operating hours, days of week:	5 dpw, 8 hrs/day, Mon-Fri or 4 dpw, 10 hrs/day, Tue-Fri
Time Workday Begins, i.e. punch in:	6:30am
Earliest Time for First Pickup in Morning:	7am
Punch Out	3pm
Total Daily Break (minutes):	30 min, 2 x 15 minute breaks
Lunch Time (minutes): Paid or not?	30 min
Breakdown Time (minutes):	19 minute breakdown
Customer (or Stop) *Count:*	19,387 carts (excluding backdoor, rear loader)
Collection Unit Count:	19,387 carts (excluding backdoor, rear loader)
Container Type(s) and Size(s):	96g

Average Stop Time Per Cart/Container (seconds) (includes acceleration deceleration):	16 seconds 26 seconds for cul de sacs/deadends and dense/problematic collection areas 1 minute for backdoors
*Average Weight Per Container (pounds) *KEY VARIABLE*:*	36.1 lbs per stop USING 1 per stop as demand field
*Average Set-out Rate (*KEY VARIABLE*, if applicable):*	100%
Route Design Specifications / Change Limits	
Current Routes Are Divided Into Districts:	___ Yes __X__ No
Use of Current Day of Week or Districts:	___ Use Current __X__ Modify Current
Type(s) of Vehicles (Automated, semi-automated rear load or side load carts, manual rear load, Curotto cart front load; container front load, container rear load, etc.):	Auto
*Truck Crew (Number of crewmembers on each truck) **	_____ Drivers _____ Helpers ___ Yes ___ No Do Helpers have CDL?
*Maximum Quantity per Vehicle (tons) *KEY VARIABLE*:*	Dual Tandems: 550 units
Disposal/Transfer Facility and Location:	
Depot Name(s) and Location(s)	
Pre-trip Morning Preparation Time at Depot (minutes):	15
Post-trip Time at the End of the Day, If Any (minutes):	*15*