

Ozarks Transportation Organization
Fixed Route Operations Analysis

**Technical Memorandum #3:
Madison Model/Springfield Network**

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SRF Consulting Group Team

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Madison Model/Springfield Network

This memorandum analyzes a potentially new transit service concept for Springfield. The Madison Model/Springfield Network is based on the work of the City Utilities (CU) Board Member, Dan Scott. The network differs from the current system in that it reconfigures routes to serve more specific geographic areas and directly connects multiple transfer locations in an effort to shorten travel times for customers. This model is similar to the current route network in Madison, Wisconsin which has five outlying transfer centers and no downtown transfer center. Most of the routes that operate in downtown Madison are through routes that operate to two of the outlying transfer centers. Transfers can be made in downtown Madison between routes, but there is no central facility where buses meet.

The Madison Model as applied to Springfield would rely on three core routes that operate within the central area of Springfield and connect to three pulse points. At the pulse points, buses from the greater Springfield area would meet the core route buses to facilitate transfers to final destinations.

The suggested advantage of this concept compared to the current system is that some trips will be shorter in overall travel time because there will be no need to go to Park Central Transfer Station to make transfers between buses. As such, travel time would shorten for trips that have either a north side to north side origin/destination pairing, or a far south side to far south side origin/destination pairing. Travel time benefits would accrue only to those system users currently transferring between routes.

Network Description

The Madison Model/Springfield Network consists of three transfer centers located at:

- Near the CU Garage at Boonville/Division
- National/Grand
- Battlefield Mall

Three primarily north-south routes will connect the three pulse points. A series of mostly east-west routes will radiate out from each pulse point. Routes primarily north of Chestnut Expressway will serve the north transfer point; routes between Chestnut and Sunshine will serve the central transfer point; and routes south of Sunshine will serve the south transfer point. Figure 1 presents the overall concept.

North Side Transfer Location

Many north side passengers traveling exclusively on the north side will have a shorter trip with this network configuration. Instead of transferring at Park Central Transfer Station, passengers going to and from north side locations will transfer near the CU garage at Boonville/Locust. Most of the routing of the current service will be on the same streets as the present network, but will be modified to travel to the new north side transfer location. Eight routes would meet at this location.

Minimal passenger amenities including a shelter would need to be provided. Restroom facilities and enclosed waiting facilities are optional. Security personnel would be needed depending on usage and the possibility of the facility becoming a place for non-passengers to congregate. Care is needed to design pedestrian pathways that do not conflict with bus movements at this location. Additional planning work is needed to determine the cost of establishing a safe and convenient transfer location near the CU garage.

Central Transfer Location

The central transfer location could be located near the corner of National/Grand. At this location, two of the three core routes would meet as well as the central east-west collector routes. This could also be a minimal facility with passenger shelters similar to the current facility near Battlefield Mall on Glenstone or it could be an off-street facility.

Care is needed in designing safe pedestrian pathways for transferring passengers at this location as well. Buses may need to make a multi-turn movement similar to the current Route 11-Sunshine movements at Battlefield Mall to keep the passenger activity on one side of the street and eliminate the need to cross National or Grand to make transfers. Five routes would meet at this location. Additional planning is needed to determine the cost of establishing a safe and convenient central transfer location. If further study determines that an off-street facility provides maximum safety, land acquisition cost must be factored into the overall capital cost of the project.

Southern Transfer Location

The southern pulse point would be near Battlefield Mall where six routes would meet. Southern routes terminating at this location would be the east-west routes as well as routes that serve the commercial areas south of Battlefield and connect with the other two transfer locations.

The existing cutout could be expanded to provide adequate space for all routes to meet. Bus routing may require multiple turns to insure that passengers do not have to cross Glenstone to access their bus. Traffic engineering analysis is required to determine if safe distances are available for buses returning to traffic and if this level of pulsed bus movement will impact existing traffic flows.

Another option is an off-street facility, similar to Park Central Transfer Station, which could be constructed near Edgewood/Glenstone. Security would be needed if an off-street facility is constructed. The the capital cost of the land acquisition and the facility construction and upkeep costs would be included in the overall cost of the project.

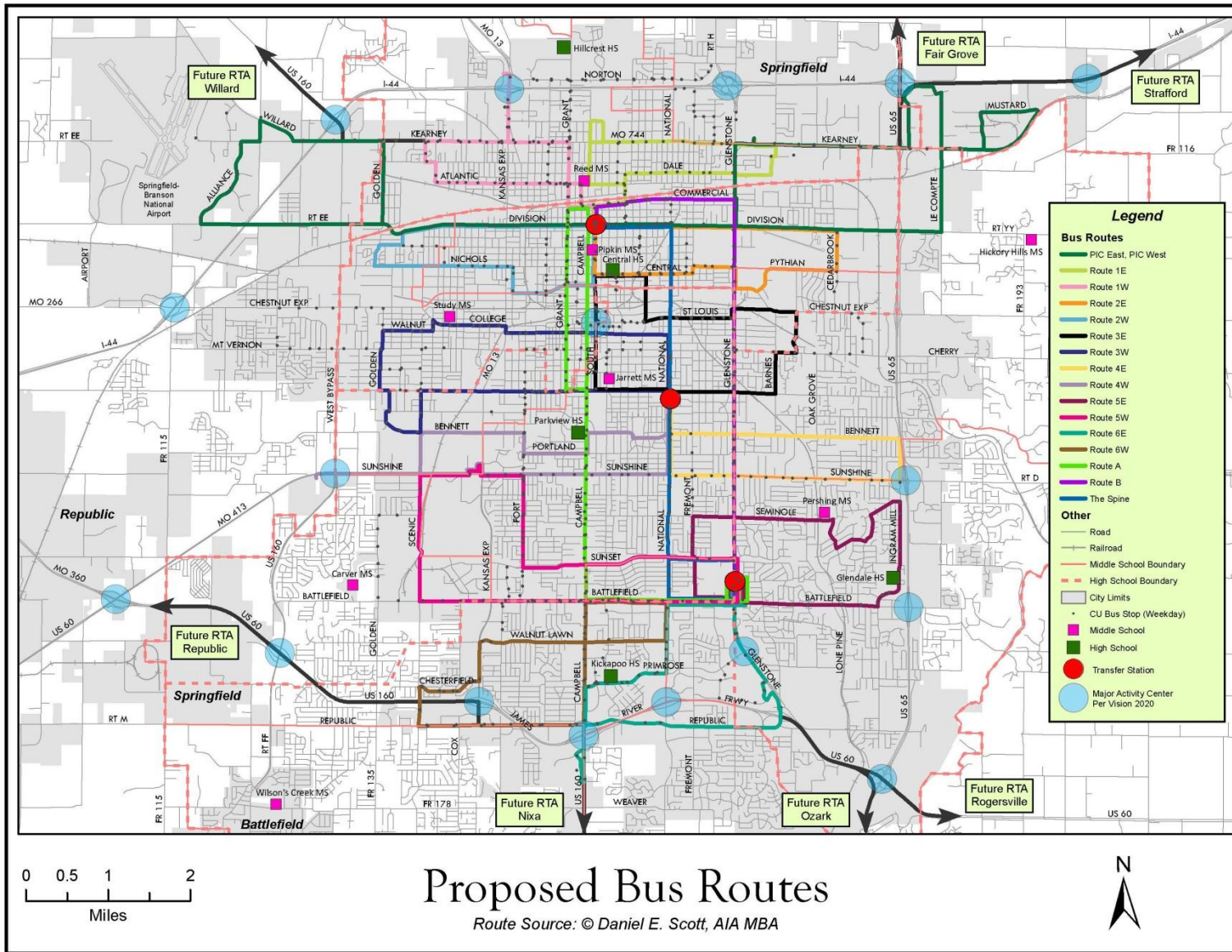
Travel Times under Madison Model/Springfield Network Concept

Under this new concept, travel times for north side to north side trips would be reduced by approximately 10 to 15 minutes, which is the time required to travel from Division Street to Park Central Transfer Station and back. Currently, some transfers are made at the CU garage between routes, but there is typically a 15 minute wait for those connections. Reduction in travel time is accomplished by more direct routing, not by faster travel speeds on existing streets.

On the south side, travel time savings will be significant for trips with a far south to far south origin/destination pairing. For a near south side to far south side trip currently requiring a transfer at Park Central, the time savings is not significant. Depending on the origin and destination pairing, the Madison Model/Springfield Network may also require a transfer for near south to near south side trips. The transfer will occur at National/Grand instead of Park Central Transfer Station.

Currently, some trips originating and terminating south of Battlefield Road require two routes. Under the Madison Model/Springfield Network, the travel time savings for those trips would be significant at nearly 30 minutes per trip. The Madison Model/Springfield Network greatly improves the travel times on these types of trips and makes the system more attractive to potential passengers that have far south side origin and destination combinations.

Figure 1. Madison Model Proposed Routing



Travel Time Comparisons

Accurate travel time comparisons are difficult to make with currently available data. Travel times on the current CU system are known, but travel times on the Madison Model/Springfield Network require multiple assumptions. Normal planning procedures typically use 12 mph as a design speed for local bus service. The actual speed will vary by local traffic conditions. If any route in the proposed system cannot average 12 mph, then the only solution will be to shorten the route after implementation.

Comprehensive passenger origin/destination data does not currently exist to reassign trips from the current system to the proposed system. As a result, it is not possible at this time to accurately tally the exact travel time impacts of the proposed network. Before proceeding with implementation of such a significant change in service, a detailed evaluation of potential customer impacts should be completed. This will need to include a Title VI analysis to insure that there are not disparate impacts on low income or minority neighborhoods.

Transfers

Ease of transferring will be a key issue to the potential success of the proposed system. Ideally, all transfers will be made in a timely manner. With adequate time in the schedule and a reasonable average speed, it is anticipated that all transfers would be made unless there is an unusual temporary condition present.

Transfers by Direction

With the Madison Model/Springfield Network, some of the people who currently transfer will benefit from shorter travel time. The primary beneficiaries will be people whose trip origin and destination is either north side to north side or south side to south side. Passengers traveling between the north side and south side may or may not have to transfer in the new model. Table 1 and Table 2 provide an approximation of how many people might benefit. The data in these tables is from the transfer analysis completed during the last week of September 2011.

From the data provided the same route to same route transfers were not considered because these will most likely have the same travel times in any model. Similarly, the west side origins and destinations will probably still require a transfer and have similar travel times. North-south passengers will also have similar travel times and are not likely to see benefits from the new network. However, some of these customers may see longer travel times.

During the one-week sample period, 4,197 transfers were catalogued. The transfers collected are based on a cash fare and do not include transfers made by passengers with multiple ride passes. It is commonly assumed in transit planning circles that pass users exhibit the same pattern of transfer movements as cash fare users. This total includes 8 percent of passengers who made a same route transfer, 36 percent of the passengers made a north-south trip; and 21 percent of passengers who had a west side trip end. These represent current customers who are unlikely to see any benefits from the new network and together they represent 65 percent of all transferring passengers.

Table 1 summarizes the transfers between the routes of the CU system. The shading used on the totals shows the number of trips that are either north side to south side; north side to north side; south side to south side; and west side to either north or south. The directional totals of the transfers are shown in Table 2.

Table 1. Transfer Analysis - Weekly

From/ To	1	2	4	5	6	7	8	9	10	11	12	13	14	15	22	25	26	27	Total
1	21	34	13	21	44	32	28	9	6		11	23	39	5	1	1	1		289
2	50	77	15	55	68	99	31	49	26	4	69	14	44	19		4	4		628
4	10	2	1	8	13	28	1	27	1		20	3	5						119
5	41	67	22	65	71	84		45	45	48	41	20	112	2	9	10	8	4	694
6	72	22	18	59	26	60	1	24		8	47	18	79		17	39	4	11	505
7	55	61	32	68	81	36	1	36		15	38	16	87						526
8	14	33					21		2				13	9					92
9	11	37	17	31	30	30		10		4	17	16	34		6	31	7	3	284
10	9	41	6	6		1	9		8		1		1	1					83
11		1		37	1	40		8		5	27								119
12	22	51	15	36	41	43	5	29		65	23	18	60						408
13	8	7	1	14	15	10		1			7	2	8						73
14	7	8	5	13	23	16	11	4			17	1	12						117
15	1	42		1		1	2		2				1	1					51
22															5	15	11	11	42
25															17	8	25	17	67
26																			0
27															36	33	15	16	100
Total	321	483	145	414	413	480	110	242	90	149	318	131	495	37	91	141	75	62	4197

Table 2. Transfer Direction Totals

Transfer Direction	Count	Percent
North-North	628	15%
South-South	841	20%
North-South	1,525	36%
West-North/South	866	21%
Same Route	337	8%
Total	4,197	100%

Current customers unlikely to see benefits from proposed network (65%)

During the sample period 15 percent of passengers made a north side-north side trip and 20 percent made a south side-south side trip. It is difficult to quantify how many south side-south side trips have a short trip length on one part of the trip. If all of these south side trips benefit from the Madison Model/Springfield Network, when combined with the north side transfers, then 35 percent of weekly passengers who transfer would benefit from a potentially shorter trip length with the Madison Model/Springfield Network. If we assume only 75 percent of potential transfers might benefit from the

new network as some of those trips are going to be very short, approximately 26 percent of weekly passengers who transfer might have a shorter travel time.

Of the 36 percent of transferring passengers making a north-south trip, it is unknown what percent of these transfers will see an increase in the number of transfers under the Madison Model/Springfield Network. This would be a significant disadvantage if a person now making a two seat trip is required to transfer twice and use three buses to complete their trip.

Bus Stops/Area Coverage

Consideration must be given to the current bus stop locations and the new locations. For many passengers, there will be a minimal change with only an additional one block walk to the new boarding location. Some locations will simply be across the street or around the corner.

Ozarks Transportation Organization (OTO) has provided information comparing the Madison Model/Springfield Network and the current network. 38.5 miles of the existing network will be abandoned. Of the 804 weekday bus stop locations, 253 will be closed. This is a significant reduction in area served from the current network. The route segments that will be abandoned are shown in Figure 2.

In some cases, passengers will be able to use the current sidewalk network to safely walk to the nearest new bus stop. However, in some cases, there is no safe or convenient pedestrian path to the nearest new bus stop location. Detailed pedestrian path analysis from the old stop to the new stop is required to accurately assess the risks involved in changing the bus stop locations.

Some of the areas where there would be a potentially dangerous walk to the new bus stop include:

- Route 8, on Norton and Glenstone
- Route 8, Grant north of Kearney
- Route 6, west of Golden
- Route 10, segments of Chestnut, Union, and Cherry
- Route 11, segments of Battlefield, Golden, and Seminole
- Route 9, Fort north of Battlefield

Additional areas of high risk pedestrian activity would need to be identified in future analysis.

The new network will provide bus service on streets that currently do not have bus service as 39.8 new route miles will be added. This will provide access to both residential and commercial land uses. Approximately 225 to 250 new bus stops will be added. Careful consideration is needed in the placement and design of new bus stop locations to provide maximum safety for pedestrians and minimize hazardous conditions. Impact on traffic flow should also be evaluated. The route segments that will be added to the system are shown in Figure 3.

Figure 2. Madison Model Abandoned Route Segments

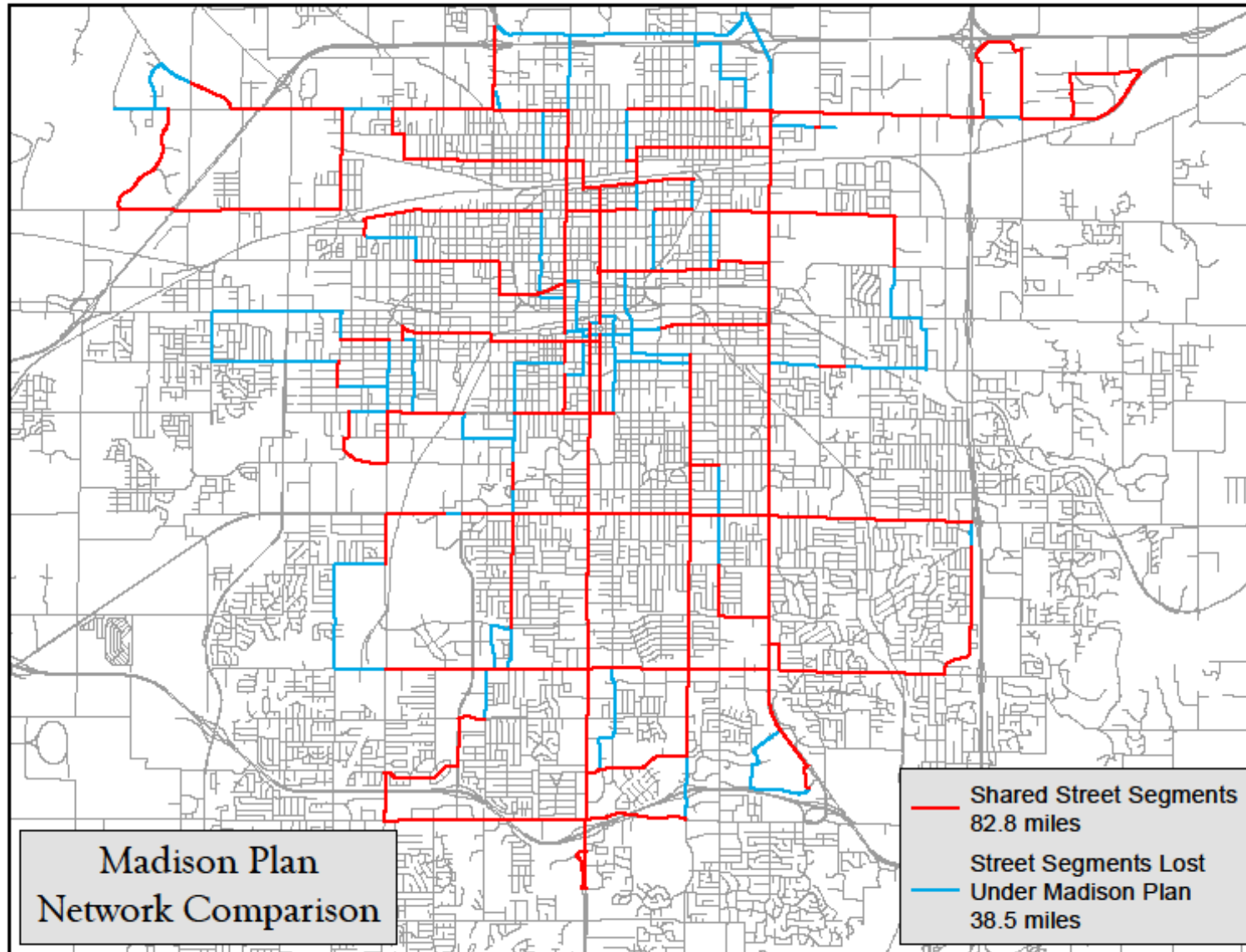
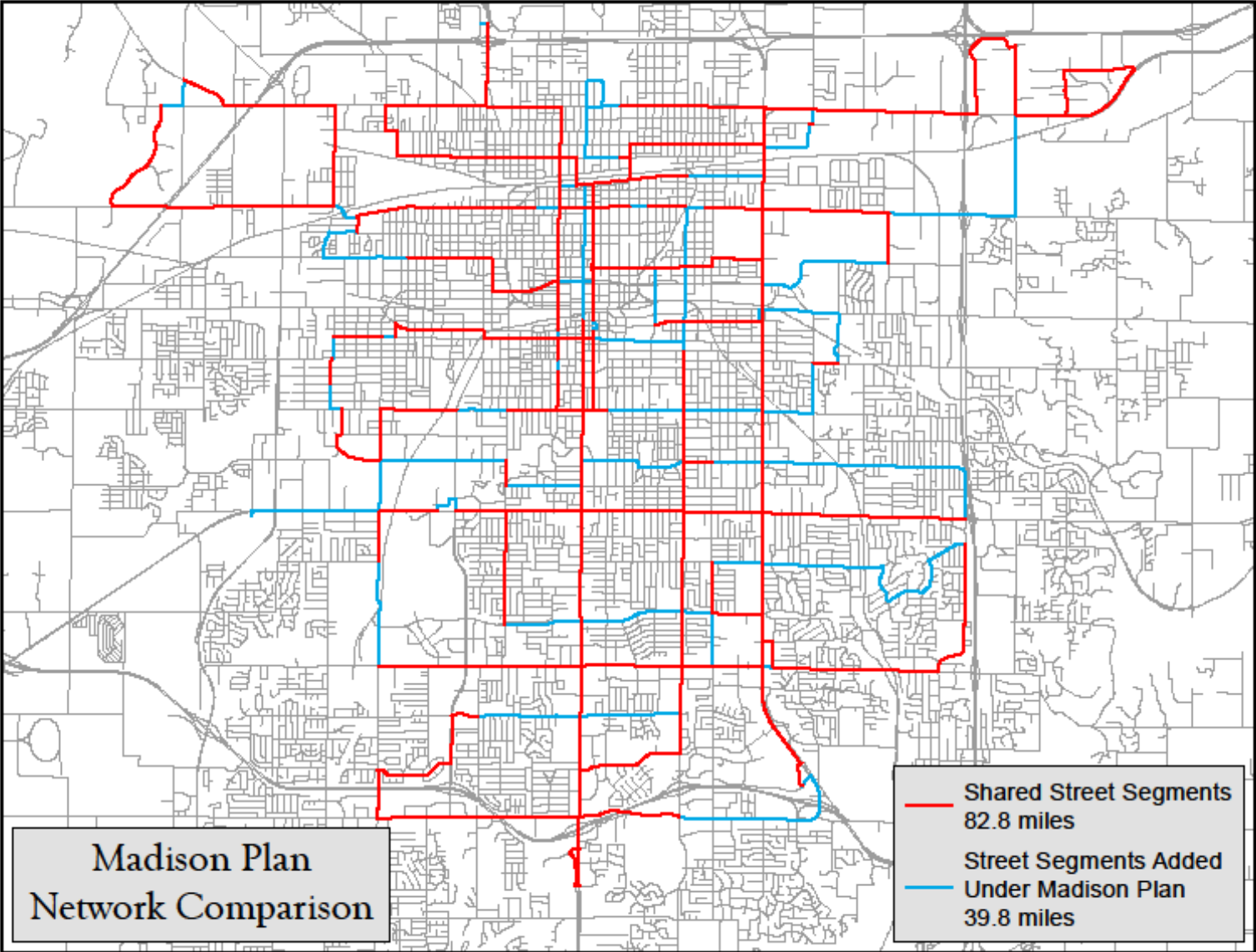


Figure 3. Madison Model New Route Segments



Potential Ridership

The primary beneficiaries of the Madison Model/Springfield Network will be people who currently transfer in the system and whose trip origin and destination is either north side to north side or far south side to far south side. Currently, about 60 percent of passengers transfer and between 26 and 35 percent of transfers analyzed have an origin and destination pairing of either north side to north side, or south side to south side. Some current customers with different origin and destination pairings could actually see longer travel times if the network is implemented.

The average daily ridership on the CU system is about 5,400. In September 2011, CU conducted an on-board survey. Of those passengers surveyed, about 60 percent stated that they transferred or would transfer to reach their destination. This equates to approximately 3,240 daily passengers transferring. At most the number of passengers benefitting from the Madison Model/Springfield Network would be 35 percent of the 60 percent of customers who currently transfer. This results in at most 21 percent¹ of current customers expected to benefit from implementation of the new network. To account for the very short trips that will probably not realize time savings under the new network we estimate that as many as 25 percent of the potential north to north or south to south transfers may not accrue any time saving benefits under this system. A more conservative estimate of the level of users who may benefit from the new network would be 16 percent². Based on this analysis, about one in six to perhaps one in five current passengers may benefit from implementation of the Madison Model/Springfield Network.

Table 3. Daily Riders Who May Benefit from New Network

Daily Ridership	5,400
Transfers (60%)	3,240
High Estimate of Riders Benefitting (21%)	1,134
Low Estimate of Riders Benefitting (16%)	518

Service Plan

Peak buses required are 23 as shown in Table 4. This compares to a current peak bus requirement of 20.

Table 4. Madison Model Service Plan

Route	Headway	Bus Req.	Rt. Mi.	Trips/Day	Daytime Mileage
PIC E	60	1	13.6	12	163.2
PIC W	60	1	14.0	12	168.0
Route 1E	30	1	7.4	25	185.0
Route 1W	30	1	7.5	25	187.5
Route 2E	60	0.5	7.9	12	94.8
Route 2W	60	0.5	7.3	12	87.6
Route 3E	30	1.5	8.2	25	205.0
Route 3W	30	1.5	10.0	25	250.0

¹ 60% x 35% = 21%

² 60% x 35% x 75% = 16%

Route	Headway	Bus Req.	Rt. Mi.	Trips/Day	Daytime Mileage
Route 4E	30	1.5	10.5	25	262.5
Route 4W	30	1.5	11.0	25	275.0
Route 5E	30	1.5	8.4	25	210.0
Route 5W	30	1.5	11.5	25	287.5
Route 6E	30	1.5	9.7	25	242.5
Route 6W	30	1.5	11.3	25	282.5
Route A	30	2	14.1	25	352.5
Route B	30	2	12.4	25	310.0
Route C	30	2	13.6	25	340.0
Total		23			3,904

Assumes evening network would be same as current

Capital Costs

The peak bus requirement to implement the Madison Model/Springfield network is 23 vehicles. This compares to the current peak vehicle requirement of 20 buses. The unit cost per vehicle is assumed to be \$400,000, bringing the total extra capital cost for the concept to \$1.2 million.

Operating and Maintenance Costs

To estimate the change in operating cost, the annual service miles of the Madison Model/Springfield Network plan was compared to the existing annual service miles. The current annual service miles were estimated by multiplying the daily cost of weekday, weeknight, Saturday, and Sunday service by the number of days in a year. It was assumed that there are 255 weekdays and nights per year and 52 Saturdays and Sundays per years. These estimates ignore holidays. As shown in Table 5, the estimated annual service miles of existing service is 1,118,777. This value is within roughly 1.4 percent of the reported National Transit Database value of 1,102,927 for motor bus service.

Table 5, Current Service Miles

	Days per Year	Daily Miles	Annual Miles
Weekday	255	3,369	859,095
Weeknight	255	334	85,170
Saturday	52	2,113	109,876
Sunday	52	1,243	64,636
TOTAL			1,118,777

A similar process was followed to estimate the annual miles for the Madison Model/Springfield Network. Since no changes are proposed for weeknight, Saturday, or Sunday service, the only number to change is the weekday daily service miles. As shown in Table 6, this results in an annual service mile value of 1,255,100, an increase of approximately 12 percent over the current service miles. Therefore, it is estimated that the annual operating cost will likewise increase from roughly \$6.5 million per year to \$7.3 million per year, an increase of \$0.8 million per year.

Table 6, Madison Model Service Miles

	Days per Year	Daily Miles	Annual Miles
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Weekday	255	3,904	995,418
Weeknight	255	334	85,170
Saturday	52	2,113	109,876
Sunday	52	1,243	64,636
TOTAL			1,255,100

Security Considerations

Currently, only the Park Central Transfer Station has security personnel. The Kearney/Glenstone Walmart and Battlefield Mall transfer locations do not have security personnel present. Each of these secondary facilities has three buses present at one time transferring passengers.

In the Madison Model/Springfield Network, there may be more buses at one time and more people using each facility. An increase in passenger traffic may require closer supervision. Similarly, people who are not bus passengers tend to congregate around public spaces such as a transfer facility. Construction of the central and south facility may require a security presence depending on the size and complexity of the facility and the daily passenger usage.

Anti-loitering ordinances would need to be reviewed and CU may need to adopt policies that discourage or prohibit loitering by people who are not using CU Transit at these facilities. The operating cost of security personnel will need to be part of the final operating cost estimate of implementing this model.

Shelters and Turnouts

Under the new network, 20 existing shelters will not be used and 6 turnouts will not be needed. The shelters can be moved while the turnouts will need to be abandoned. The turnouts were constructed with Federal Transit Administration (FTA) funds. The cost of moving shelters and the repayment to FTA will be part of the capital cost of the Madison Model/Springfield Network.

Summary

The Madison Model/Springfield Network cannot be designed to operate within the current operating budget and provide equivalent service to the current transit service area. Of the 804 weekday bus stops in the current network, 253 will not be served if the Madison Model is implemented as depicted in this analysis. This would be somewhat balanced against service being added to about the same number of new stops in areas of the community that do not currently have service available.

The implementation requirements for the Madison Model/Springfield Network include:

- 3 additional buses costing \$1.2 million
- \$0.8 million annual increase in operating costs
- Special startup planning assistance
- On-going supervisor monitoring costs
- On-going security costs
- Repayment of federal funds for unused pullouts

- Costs to move shelters.

For individual passengers, many will have the same overall connectivity between their residential locations and their current destinations, but the new network may require a different boarding location within one block of their current location and could require travel by a different route or combination of routes to reach their destination. An undetermined number of passengers will have to walk more than one block to their new boarding location.

For people traveling from the north side to the south side, there will be no significant change in travel times and in some cases an extra transfer may be introduced. The average speeds of the routes will remain similar to the recommendations for the current network improvements so overall travel times would not be changed. Trips from the west side to either the north or the south side will have travel times similar to current levels.

One possible advantage of this network is that it may be more attractive to new transit passengers traveling exclusively within the north side or the south side. These trips currently have long travel times when they require a transfer at Park Central.

The potential impact on service reliability due to the different route structure is extremely difficult to predict. The current network has specific repetitive events that CU staff understands. The new system, with different routings, may have unknown or unexpected traffic delays. For this analysis, average bus speeds are assumed similar to the current system. If the Madison Model/Springfield Network is selected for implementation, the service will need to be carefully evaluated before implementation and then carefully monitored as service is deployed to assess the on-time performance compared to the current system levels.

Overall, the Madison Model/Springfield Network is a bold approach that could make transit in Springfield more attractive to potential passengers. With the current 30 and 60 minute intervals, it is unlikely that there will be a significant short term increase in ridership in either model. The Madison Model/Springfield Network may provide some benefits, but it will also create a high risk of failure. There will probably be an initial strong negative reaction by the public until they adjust to the new system with most customers seeing no changes and some customers seeing increased travel penalties due to an additional transfer.

The Madison Model/Springfield Network would position CU for faster growth of new services in some parts of Springfield. It would primarily benefit current passengers in the far north part of Springfield traveling to other northern destinations. Similarly, it would benefit far south side to far south side origin/destination pairs. For the central core portion of Springfield, it is likely there would be no noticeable travel time savings.

The most significant advantages and disadvantages of the Madison Model/Springfield Network are:

Advantages

- Reduced need to travel to downtown to transfer (north side to north side, or far south side to far south side)
- Increases residential penetration on south side; reducing walk distance to/from bus stops (3 percent more population served)

- Improves east-west travel times on far south side
- Improves east-west travel times on north side

Disadvantages

- Initially difficult to understand
- May require a three seat ride instead of a two seat ride for long trips (north of Division to south of Battlefield)
- Some one seat rides will now require a transfer and become two seat rides
- Some passengers will incur longer ride times
- More precise scheduling needed to avoid cascading effect of late buses
- \$1.2 million in capital costs
- \$0.8 million in additional annual operating costs
- Repayment to FTA for abandoned cutouts
- Additional security cost
- 253 bus stops eliminated (31 percent)
- Unknown pedestrian impacts to current passengers

Additional Planning Steps

If the CU Board wants to pursue the Madison Model/Springfield network, additional planning work and a more in-depth analysis with detailed data is required. Data on origins and destinations of passengers is needed to estimate with confidence the impact on current customers.

With the additional data, several analytical tasks are needed to accurately assess the impact of the new route model. These include:

- Determine travel time differences for O/D sample
- Test running of proposed routes to determine accurate running time
- Modify proposed routes if running time tests indicate a shorter route is needed on any of the new routes
- Pedestrian access analysis to different bus stop locations
- Social impact analysis of closed bus stops
- Residential reaction to new routes on residential/collector streets
- Placement and design of up to 250 safe new bus stop locations on new route segments
- Title VI analysis of final route network
- Traffic flow impact analysis
- Prediction of new trips generated by new network
- Calculation of repayment to FTA for abandoned turnouts
- Calculation of capital costs for three new transfer locations
- Calculation of operating cost for security at each transfer location
- Public hearings on proposed route changes