CHAPTER 7

PUBLIC TRANSPORTATION

7.1 NEEDS ASSESSMENT AND PREVIOUS PLANS

This section discusses previous planning efforts that have taken place in the greater Bozeman area with regards to transit. Below is a list of past planning documents along with a brief description of each.

Greater Bozeman Area Transportation Plan – 2001 Update

Robert Peccia and Associates, June, 2001

This transportation plan is the overall transportation guide for the Bozeman area. This plan addresses all types of transportation, including transit. The transit chapter (Chapter 7) serves as a summary for the more detailed Greater Bozeman Area Transit Development Plan. The transit plan was prepared simultaneously with the transportation plan.

Gallatin County Transportation Needs – Phase 1 and Phase 2

LSC Transportation Consultants, Inc., February, 2005 and September, 2006

Phase 1 of this study serves as an implementation plan for the development of a transit system in the greater Bozeman area. The purpose of this phase is to "determine the feasibility of and appropriate boundaries for an Urban Transportation District (UTD), along with the types of service which are best suited to the different areas within those boundaries."

Phase 2 of this study "provides an assessment of the organizational options to implement public transportation services." This phase looks at three alternatives for providing long-term organizational structure to the transit service in the Bozeman Area. A recommendation is made to implement an Urban Transportation District (UTD) concept to the new transit service.

Bozeman Area Transportation Coordination Plan – FY 2009

Bozeman Area Transportation Advisory Committee, January, 2008

The transportation coordination plan was produced as a requirement by the federal 2005 SAFETEA-LU legislation and the Montana Department of Transportation (MDT). The plan serves as an analysis of the existing and future transportation coordination efforts in the greater Bozeman area. This coordination plan will be updated on a yearly basis.

Bus Stop Program – Guidance for Planners and Developers

Streamline Internal Working Draft – July 2008

This plan provides general guidance for the development of bus stops and street furniture for the Streamline bus system. As of this writing, this plan is currently in an "internal working draft" stage.

Additional Identified Needs

Below is a list of additional needs not identified in the *Bozeman Area Transportation Coordination Plan – FY 2009* (developed with assistance from Lisa Ballard, P.E., Current Transportation Solutions).

Information and Resource Needs

- There is currently no 5-year plan or 10-year plan that considers the expected growth of the community and where bus routes should be to meet these needs.
- Work with Bozeman Planning Department to determine where bus bays need to be included in new development areas.
- Establish a relationship with the county planning department or with Belgrade planning.
- The standard street design of 3 lanes plus bike lanes requires a bus bay to avoid bus-bike conflicts.
- Determine a standard design for street furniture.

Infrastructure Needs

- **College** – The westbound location at 23rd street has no sidewalk and has a ditch right next to the road.
- **Highland (**at Ellis) – This location is at the bottom of a hill and there is no pull out away from traffic.
- **S. 19th Street** – The sidewalk is separated from the road by a ditch, and there are no pedestrian connections to the road, even at driveways.
- **Main Street** (eastbound between 15th and downtown) – There are narrow shoulders.
- **Highland** – There is only a sidewalk on one side of the street and there is no connection between the sidewalk and the road.
- **Huffine** (out to Four Corners) – Inadequate pedestrian facilities
- **Jackrabbit** – Inadequate pedestrian facilities.
- **Oak Street** (eastbound just west of 7th) – There is no sidewalk
- **Oak Street** (at 15th right next to an accessible apartment complex) – Inadequate pedestrian facilities.
- **Durston and Babcock** – Have the bike lanes without a place to pull over. Durston lacks sidewalks in places.

7.2 Bus Stop Interaction with Development

The use of a transit system is in part driven by the types and size of the development areas that it serves. Density is the most significant demographic for determining transit demand. High density residential and commercial areas generally have high transit demands. Linking central business districts (CBD) and high density residential areas together with transit can greatly improve the overall use and function of the transit system. It is important to create a transit link between high trip generation areas.

Extra care should go into new high density development areas to account for future transit links. Investing in transit systems in new developing areas can also influence the type of development that will occur in the area. Transit investments can influence compact, mixed-use, and transit-supportive development types.

It must be noted that when planning for a transit system, the trip to transit, the trip from transit, and the transit trip itself must be properly planned for in order to achieve an operationally effective system.

7.3 Bus Stop Placement

Bus stop placement is an important factor to achieving the best performing transit system possible. Below is a list of factors that should be taken into consideration when deciding on where to locate bus stops.

- Spacing along the route
- Location of passenger traffic generators
- Operational effectiveness
- Safety
- Access to the stop including pathways leading to and from the stop
- Right-of-way
- Curb clearance

Table 7-1 gives a list of advantages and disadvantages for the location of the bus stop at intersections. **Figure 7-1** shows the minimum recommended distances required for a bus stop based on the location relative to the intersection. These minimum recommended distances assume that a 40-foot bus is being used.

Table 7-1

Advantages and Disadvantages of Stop Placement Relative to the Nearest Intersection

Bus Stop Location	Advantages	Disadvantages	Recommended When the Following Location Conditions Exist
Nearside - Located immediately before an intersection	• Less potential conflict with traffic turning onto the bus route street from a side street. • The bus boarding door is close to the crosswalk. • Bus has intersection to merge into traffic. • Bus Driver can see oncoming buses with transfer passengers.	• Potential conflicts with right turning traffic due to cars cutting in front of the bus. • The stopped bus obscures the sight distance of drivers and pedestrians entering from the right. • The stopped bus may block visibility of the stop signs or traffic signals. • At signalized intersections, may result in schedule delays.	• When traffic is heavier on the farside than on the approaching side of the intersection. • When pedestrian access and existing landing area conditions on the nearside are better than on the farside. • When street crossings and other pedestrian movements are safer when the bus stops on the nearside than the farside. • When the bus route goes straight through the intersection. • When adequate sight distance can be achieved at the intersection.
Farside - Located immediately after an intersection	• Does not conflict with vehicles turning right. • Appropriate after the route has made a turn. • The stopped bus does not obscure sight distance to the left for vehicles entering or crossing from the side street. • At signalized intersections, buses can more easily re-enter traffic. • The stopped bus does not obscure traffic control devices or pedestrian movements at the intersection.	• The stopped bus obscures the sight distance to the right of drivers entering from the cross street to the right of the bus. • If the bus stopping area is of inadequate length, the rear of the stopped bus will block the cross street (especially an issue for stops where more than one bus may be stopped at a time). • If the bus stops in the travel lane, it may result in queued traffic behind it blocking the intersection.	• When traffic is heavier on the nearside than on the farside of the intersection. • At intersections where heavy left or right turns occur. • When pedestrian access and existing landing area conditions on the farside are better than on the nearside. • At intersections where traffic conditions and signal patterns may cause delays • At intersections with transit signal priority treatments.
Mid-Block - Located 300 feet or more beyond or before an intersection	• The stopped bus does not obstruct sight distances at an intersection. • May be closer to major activity centers than the nearest intersection. • Less conflicts between waiting and walking pedestrians.	• Requires most curb clearance of the three options (unless a mid-block sidewalk extension or bus bulb is built). • Encourages mid-block jaywalking. • May increase customer walking distances if the trip generator is close to an intersection. Length of mid-block stops can vary due to depth of a turn-out and a bus' ability to maneuver in/out of traffic lanes.	• When traffic or street/sidewalk conditions at the intersection are not conducive to a near-side or far-side stop. • When the passenger traffic generator is located in the middle of a long block. • When the interval between adjacent stops exceeds stop spacing standards for the area. • When a mid-block stop is compatible with a corridor or district plan.

Source: Omnitrans: Bus Stop Design Guidelines, October 2006

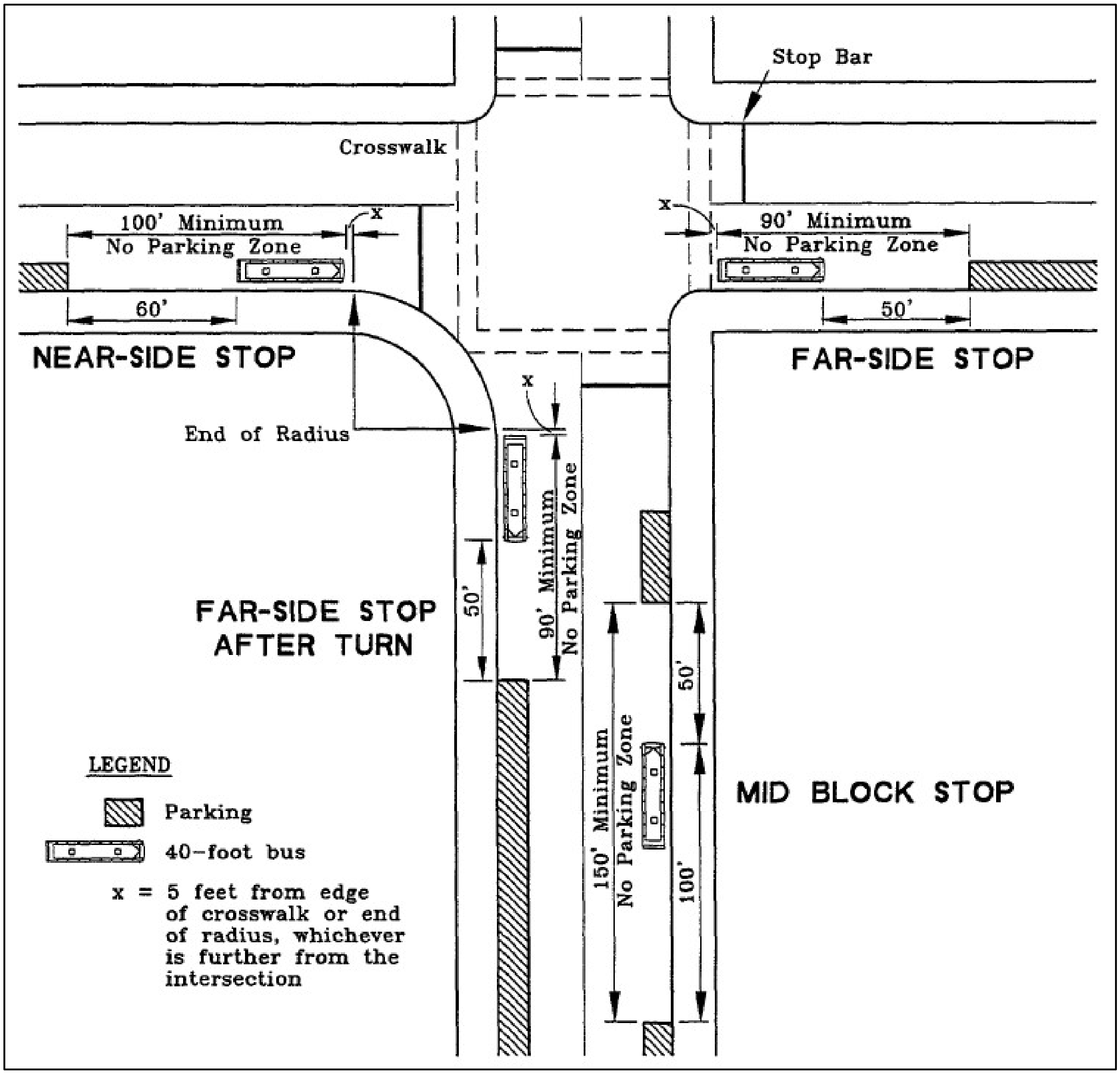

Figure 7-1
Suggested Bus Stop Distance

7.4 Bus Stop Elements

It is expected that each bus stop should incorporate a number of elements. A list of the minimum elements that each bus stop should have is listed below.

- **Landing Area** – The landing area must allow for lifts or ramps to be deployed on a suitable surface to permit a wheelchair to maneuver safely on and off the bus.
- **Pedestrian Connections** – A landing area of 5-feet wide by 8-feet long must be connected to a sidewalk of at least 4-feet wide.
- **Curb Ramps** – These shall be designed to conform to state and federal ADA standards.
- **Signage** – Appropriate signage must be used to mark the location of the bus stop. Route and schedule information should also be supplied at each bus stop.
- **Safety and Security** – Bus stops should not have hazardous conditions that could be potentially unsafe to users. The area should be well lit and free of obstacles.

Figure 7-2 and **Figure 7-3** show typical shelter characteristics at bus stops.

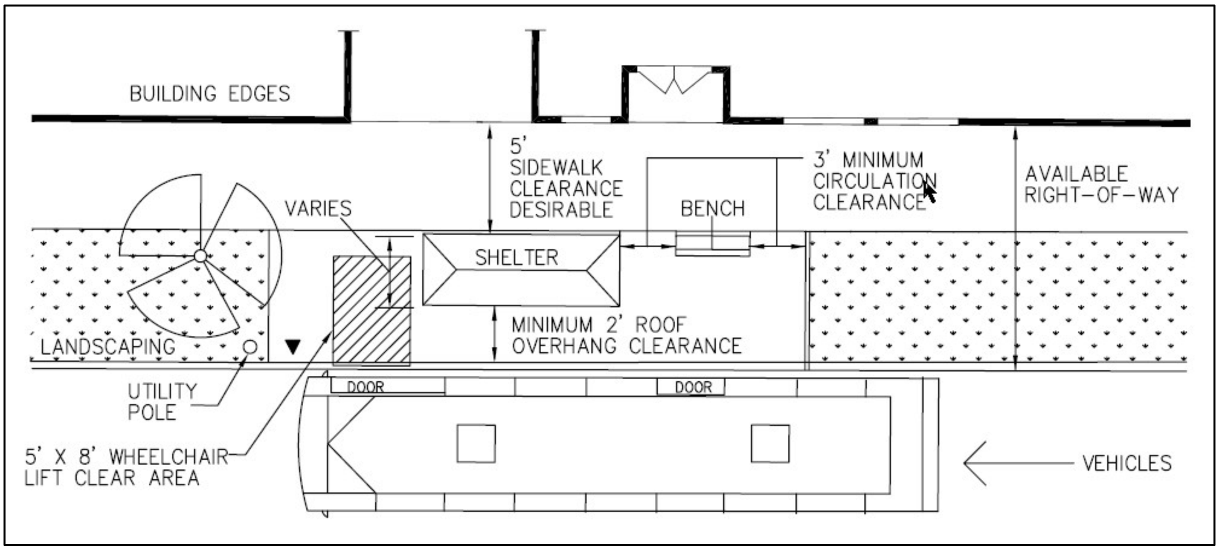

Figure 7-2
Typical Shelter Layout

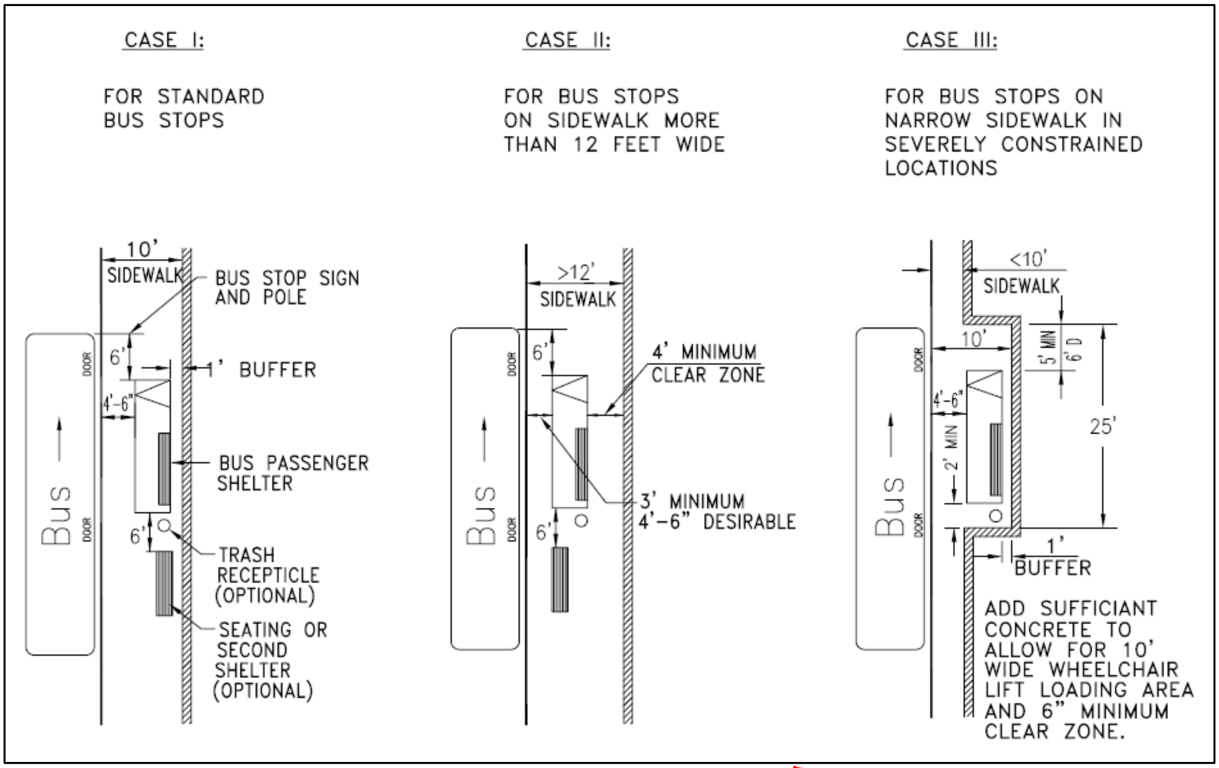

Figure 7-3
Shelter Placement

Figure modified due to TCC #20

UTD Section removed per City #8

7.5 Performance Analysis

This section serves as a summary of TRB's Transit Cooperative Research Program (TCRP) Report 100: *Transit Capacity and Quality of Service Manual, 2nd Edition*. The "Quality of Service" section in this report lists several performance factors for a transit system that can be analyzed to determine the performance level for that factor. Recommendations are made for how to grade each factor based on performance levels. These recommendations can be tailored to fit into the characteristics for the community being served by the transit system.

A performance analysis for a transit system should reflect a traveler's point-of-view. Completing a performance analysis can be useful in identifying problems in the system that need to be addressed. A transit system that has a poor performance level in the traveler's eye is less likely to be used than one that performs better. The following sections serve as suggested areas where a performance analysis can be completed to determine how the system performs. Fixed-route and demand responsive systems are analyzed separately due to the inherent differences in how these systems operate.

7.5.1 Fixed Route Systems

The performance of a fixed-route transit system can be defined by a number of elements that fall into two categories: (1) transit availability; (2) comfort and convenience. This section discusses how to use the elements contained in each category to determine the performance level of the transit system. A level of service (LOS) value can be applied to each element to represent the performance level for individual elements. The LOS values determined for these individual elements can be used to determine areas where the system performs well or areas where improvements are needed. Individual LOS value does not provide a complete picture of the performance of the transit system, and as such, they should be used together to identify the performance level of the system as a whole.

Transit Availability – Service Frequency

Service frequency represents how many times per hour a user has access to their desired transit service. This value can be expressed in terms of average headway, or as the number of vehicles per hour that a user has access to. Service frequency is a part of the convenience of the transit system and is a component in the determination of the overall trip time.

The service frequency must be determined by destination from a given transit stopping point. There may be several routes that serve a particular destination, but they may serve different transit stopping points. Special care must also be taken when analyzing transit stops that have multiple buses arriving close to each other. Buses arriving within 3 minutes of each other that serve the same destination should be counted as only one bus for the purposes of determining the service frequency. **Table 7-2** shows the service frequency LOS based on average headway and the number of transit vehicles per hour.

 Robert Peccia & Associates, Inc. / ALTA Planning + Design / Cambridge Systematics

Table 7-2
Service Frequency LOS

LOS	Average Headway (min)	veh/hr	Comments
A	<10	>6	Passengers do not need schedules
B	10-14	5-6	Frequent service, passengers consult schedules
C	15-20	3-4	Maximum desirable time to wait if bus/train missed
D	21-30	2	Service unattractive to choice riders
E	31-60	1	Service available during the hour
F	>60	<1	Service unattractive to all riders

Source: TRB's Transit Cooperative Research Program (TCRP) Report 100: Transit Capacity and Quality of Service Manual, 2nd Edition

Transit Availability – Hours of Service

Hours of service is defined as the number of hours when the transit service is provided. This value is determined by taking the number of hours when the transit service is offered at a minimum of one vehicle per hour frequency rate. Gaps in the system where at least one vehicle per hour is not offered are not included in the hours of service calculation.

The hours of service can be calculated in two different ways: (1) by route; (2) by trip. The "by route" method only takes into consideration the hours of service that a particular route is offered. The "by trip" method used the hours of service that a given trip can be achieved independently of the route use to make that trip. These two methods can result in different values in some situations.

To calculate the hours of service for either method, subtract the departure time of the last route in the day from the departure time of the first route of the day and add one to account for the last hour when service is provided. This calculation should be done for each portion of the day when at least one vehicle per hour is provided. **Table 7-3** shows the LOS associated with hours of service provided with the transit system.

Table 7-3
Hours of Service LOS

LOS	Hours of Service	Comments
A	19-24	Night or "owl" service provided
B	17-18	Late evening service provided
C	14-16	Early evening service provided
D	12-13	Daytime service provided
E	4-11	Peak hour service only or limited midday service
F	0-3	Very limited or no service

Source: TRB's Transit Cooperative Research Program (TCRP) Report 100: Transit Capacity and Quality of Service Manual, 2nd Edition

Transit Availability – Service Coverage Area

The service coverage area of a transit system is defined as the area that is within walking distance of an access point to the transit system. Walking distance is considered to be the straight-line distance (or air distance) within 0.25 miles from an access point. Areas where pedestrian access is not possible due to some type of barrier should not be included in the service coverage area. Calculating the service coverage area can be a relatively simple task through the implementation of GIS. If GIS software is not available, a more complex calculation method can be used instead.

The service coverage area should be calculated by determining how much of the dense areas that would typically produce the majority of users are being served. The *Transit Capacity and Quality of Service Manual* suggests that a density of approximately three units per gross acre be used as a minimum residential density for hourly transit service to be feasible, while a minimum employment density of approximately four jobs per acre should be used. The areas that meet these minimum density requirements are referred to as "transit-supportive areas" (TSA). **Table 7-4** shows the LOS value associated with percent of TSA coverage.

While increasing the coverage area of a transit route may produce a better LOS for service coverage area, it may result in a decrease in the LOS of other factors such as travel time. Increasing the number of stops will ultimately increase the delay in the system which could have a negative effect on the transit service. A balance must be achieved between these factors to ultimately achieve the highest LOS for the entire system.

Table 7-4
Service Coverage Area LOS

LOS	% TSA Covered	Comments
A	90.0-100	Virtually all major origins & destinations served
B	80.0-89.9	Most major origins & destinations served
C	70.0-79.9	About ¾ of higher-density areas served
D	60.0-69.9	About two-thirds of higher-density areas served
E	50.0-59.9	At least ½ of the higher-density areas served
F	<50.0	Less than ½ of higher-density areas served

Transit-Supportive Area (TSA): The portion of the area being analyzed that has a household density of at least 3 units per gross acre (7.5 units per gross hectare) or an employment density of at least 4 jobs per gross acre (10 jobs per gross hectare).
Covered Area: The area within 0.25 mile (400 m) of local bus service or 0.5 mile (800 m) of a busway or rail station, where pedestrian connections to transit are available from the surrounding area.
Source: TRB's Transit Cooperative Research Program (TCRP) Report 100: Transit Capacity and Quality of Service Manual, 2nd Edition

Comfort and Convenience – Bus Load Factor

The bus load factor is defined as the level of crowding within the vehicles. This reflects the passenger's comfort level while on-board the vehicle. A poor LOS may indicate overcrowding on the bus which could be a result of poor system design or a need for larger or more buses.

The bus load factor described in this section assumes that the bus allows for standing and sitting room for passengers. Assumptions are also made for the space that a passenger would occupy while on the bus. If a high number of passengers wear backpacks, for example, the average space occupied by passengers would be higher than if they did not have backpacks. Discretion must be taken into account for variables that could affect passenger area.

Table 7-5
Bus Load Factor LOS

LOS	Load Factor (p/seat)	Standing Passenger Area (ft2/p)	Comments
A	0.00-0.50	>10.8**	No passenger need sit next to another
B	0.51-0.75	8.2-10.8**	Passengers can choose where to sit
C	0.76-1.00	5.5-8.1**	All passengers can sit
D	1.01-1.25*	3.9-5.4	Comfortable standee load for design
E	1.26-1.50*	2.2-3.8	Maximum schedule load
F	>1.50*	<2.2	Crush load

*Approximate value for comparison, for vehicles designed to have most passengers seated. LOS is based on area.
**Used for vehicles designed to have most passengers standing.
Source: TRB's Transit Cooperative Research Program (TCRP) Report 100: Transit Capacity and Quality of Service Manual, 2nd Edition

The passenger area inside the vehicle is measured based on two parameters: (1) number of seats; (2) standing room area. The number of seats in the vehicle is easy determined based on the bus standards. The standing room area is considered to be the area inside the vehicle that could be used for standing passengers; this area would not include any space taken up by the seats, wheel wells, or interior steps. A 14-inch buffer in front of longitudinal seating should also be discounted from the standing area to account for seated passenger leg room. **Table 7-5** shows the LOS values associated with the bus load factor.

Comfort and Convenience – On-Time Service

On-time service is defined as being 0 to 5 minutes late from the scheduled time. Early departures at locations where passengers board are not considered to be on-time. Early arrivals toward the end of the route, where no passengers are boarding, however, would still be considered on-time.

- Care should be taken when picking locations to measure on-time service. Locations where there are a high number of passengers either entering or exiting the bus are most important to users and should be picked as locations to perform this analysis.

On-time service can be measured either on a route-by-route basis or as a system-wide value. Both methods should measure on-time service over a series of days or months. **Table 7-6** shows LOS values based on the on-time service percentage.

Table 7-6
On-Time Service LOS

LOS	On-Time Percentage	Comments*
A	95.0-100.0%	1 late transit vehicle every 2 weeks (no transfer)
B	90.0-94.9%	1 late transit vehicle every week (no transfer)
C	85.0-89.9%	3 late transit vehicles every 2 weeks (no transfer)
D	80.0-84.9%	2 late transit vehicles every week (no transfer)
E	75.0-79.9%	1 late transit vehicle every day (with a transfer)
F	<75.0%	1 late transit vehicle at least daily (with a transfer)

Note: Applies to routes with a published timetable, particularly to those with headways longer than 10 minutes.
"On-time" is 0 to 5 minutes late, and can be applied to either arrivals or departures, as appropriate for the situation being measured. Early departures are considered on-time only in locations where no passengers would typically board (e.g., toward the end of a route).
*Individual's perspective, based on 5 round trips per week.
Source: TRB's Transit Cooperative Research Program (TCRP) Report 100: Transit Capacity and Quality of Service Manual, 2nd Edition

Comfort and Convenience – Travel Time

Travel time is an important factor for potential transit users. More specifically, the difference in travel time between the trip being taken by automobile and the trip being taken by the transit system is of importance to potential users. Trips that are significantly longer by transit than by automobile may have less appeal to a potential user. It can be argued, however, that the time aboard the transit system can be used for "additional free time" for the user. This may be beneficial to some users.

The difference in travel time between transit and auto is found by taking the "door-to-door" difference between these two modes. This takes into account any walking, waiting, parking, or transfer times involved in each mode. The total travel time for transit includes walk time to and from the transit station (assumed to be an average of 3 minutes each way), the travel time while on-board the transit vehicle, and the amount of time spent waiting for the transit vehicle (assumed to be 5 minutes). The travel time for an automobile includes the travel time inside the vehicle in addition to the parking and walking time required (assumed to be an average of 3 minutes).

High levels of service based on travel time may be difficult to achieve in smaller cities. Generally in a small city, it is possible to drive most places within the city in about 10 to 15 minutes. The calculated travel time for transit is generally much higher than this, and as a result LOS values may suffer. **Table 7-7** shows the LOS associated with the travel time difference between transit and automobile methods.

Table 7-7
Travel Time LOS

LOS	Travel Time Difference (min)	Comments
A	≤0	Faster by transit than by automobile
B	1-15	About as fast by transit as by automobile
C	16-30	Tolerable for choice riders
D	31-45	Round-trip at least an hour longer by transit
E	46-60	Tedious for all riders; may be best possible in small cities
F	>60	Unacceptable to most riders

Source: TRB's Transit Cooperative Research Program (TCRP) Report 100: Transit Capacity and Quality of Service Manual, 2nd Edition

7.5.2 Demand Responsive Systems

A performance analysis for demand responsive systems can be done in much the same manner as a fixed-route system. A scale of "1" to "8" is used to define the quality of service is used for this type of system instead of using the level of service scale used for a fixed-route system. The quality of service method provides a broader range of performance levels than does a LOS ranking.

As was done with a fixed-route system, the performance of a demand responsive system is defined by a number of elements that fall into two categories: (1) transit availability; (2) comfort and convenience. Applying a quality of service ranking to each individual element in a demand responsive system provides an analysis of the system performance. This analysis can be used to determine problematic areas in the system. Each element analysis should be used together to determine the overall quality of service for the system.

Transit Availability – Response Time

Response time is defined as the minimum amount of time that a user needs to schedule a trip or the minimum amount of time that a reservation must be made in advance. **Table 7-8** shows the quality of service values associated with the response time of the transit system.

Table 7-8
Response Time QOS

QOS	Response Time	Comments
1	Up to ½ hour	Very prompt response; similar to exclusive-ride taxi service
2	More than ½ hour, and up to 2 hours	Prompt response; considered immediate response for DRT service
3	More than 2 hours, but still same day service	Requires planning, but one can still travel the day the trip is requested
4	24 hours in advance; next day service	Requires some advance planning
5	48 hours in advance	Requires more advance planning than next-day service
6	More than 48 hours in advance, and up to 1 week	Requires advance planning
7	More than 1 week in advance, and up to 2 weeks	Requires considerable advance planning, but may still work for important trips needed soon
8	More than 2 weeks, or not able to accommodate trip	Requires significant advance planning, or service is not available at all

Source: TRB's Transit Cooperative Research Program (TCRP) Report 100: Transit Capacity and Quality of Service Manual, 2nd Edition

Transit Availability – Service Span

The service span of a transit system refers to the number of hours per day and number of days per week that the demand responsive system is available. **Table 7-9** shows a quality of service matrix based on the days per week and hours per day the system is in operation. To use the matrix, determine the number of days per week that the service is available. From that column, use the number of hours per day that the service is provided to determine the quality of service value that represents these characteristics. A weighted average should be used in situations where the system operates during different hours depending on the day of week.

Table 7-9
Service Span QOS

Hours Per Day	Days Per Week						
	6-7	5	3 - 4	2	1	0.5*	< 0.5
≥16.0	1	2	4	5	6	7	8
12.0-15.9	2	3	4	5	6	7	8
9.0-11.9	3	4	4	6	6	7	8
4.0-8.9	5	5	5	6	7	7	8
< 4.0	6	6	6	7	8	8	8

*Service at least twice per month
Source: TRB's Transit Cooperative Research Program (TCRP) Report 100: Transit Capacity and Quality of Service Manual, 2nd Edition

Comfort and Convenience – On-Time Service

Demand responsive systems generally operate on a "window of time" system that gives the user a time frame of when the vehicle can be expected to arrive. The variable nature of demand response systems make it difficult to give users an exact time that the vehicle will arrive. As with fixed-route systems, early arrivals can also be a problem. Early arrivals may result in the user feeling compelled to hurry, or may result in an increase in no-shows. **Table 7-10** shows the resulting quality of service with regards to the on-time percentage of the demand responsive system.

Table 7-10
On-Time Service QOS

QOS	On-Time Percentage	Comments*
1	97.5-100.0%	1 late trip/month
2	95.0-97.4%	2 late trips/month
3	90.0-94.9%	3-4 late trips/month
4	85.0-89.9%	5-6 late trips/month
5	80.0-84.9%	7-8 late trips/month
6	75.0-79.9%	9-10 late trips/month
7	70.0-74.9%	11-12 late trips/month
8	<70.0%	More than 12 late trips/month

Note: Based on 30-minute on-time window.
*Assumes user travels by DRT round trip each weekday for one month, with 20 weekdays/month.
Source: TRB's Transit Cooperative Research Program (TCRP) Report 100: Transit Capacity and Quality of Service Manual, 2nd Edition

Comfort and Convenience – Trips not Served

The number of trips that are not served by a demand responsive system are a result of trips either being booked but the vehicle doesn't show up, or they are denied when requested for a variety of reasons. Trips turned down by the demand responsive system may be a sign that the system does not have enough capacity. Missed trips can be a result of a number of factors, including: poor scheduling; inadequate driver time allotted; inexperienced drivers; miscommunications; or a combination of factors. **Table 7-11** shows the resulting quality of service based on the percent of trips not served.

Table 7-11
Trips not Served QOS

QOS	Percent Trips Not Served	Comments*
1	0-1%	No trip denials or missed trips within month
2	>1%-2%	1 denial or missed trip within month
3	>2%-4%	1-2 denials or missed trips within month
4	>4%-6%	2 denials or missed trips within month
5	>6%-8%	3 denials or missed trips within month
6	>8%-10%	4 denials or missed trips within month
7	>10%-12%	5 denials or missed trips within month
8	>12%	More than 5 denials or missed trips within month

Note: Trips not served include trip requests denied due to insufficient capacity, and missed trips.

*Assumes user travels by DRT round trip each weekday for one month, with 20 weekdays/month.
Source: TRB's Transit Cooperative Research Program (TCRP) Report 100: Transit Capacity and Quality of Service Manual, 2nd Edition

Comfort and Convenience – Travel Time

Travel time for a demand responsive system is measured in much the same way as a fixed-route system. The "door-to-door" difference between the demand responsive system and automobile travel times is used for this calculation. The travel time for a demand responsive system does not include the time spent waiting for the vehicle to arrive. **Table 7-12** shows the quality of service value based on the travel time difference.

Table 7-12
Travel Time QOS

QOS	Travel Time Difference (min)	Comments
1	≤0	The same or slightly faster by DRT as by automobile
2	1-10	Just about the same or slightly longer by DRT
3	11-20	Somewhat longer by DRT
4	21-30	Satisfactory service
5	31-40	Up to 40 minutes longer by DRT than by automobile
6	41-50	May be tolerable for users who are transit-dependent
7	51-60	May indicate a lot of shared riding or long dwell times
8	>60	From most users' perspectives, this is "too lengthy"

Source: TRB's Transit Cooperative Research Program (TCRP) Report 100: Transit Capacity and Quality of Service Manual, 2nd Edition

7.6 ALTERNATIVE FUEL VEHICLES / FUEL CONSIDERATIONS

A list of alternative fuels designated by the Energy Policy Act of 1992 (1992 EPAct) or the Department of Energy after that date is found below:

- Alternative diesel (biodiesel, Fisher-Tropsch and diesel blends)
- Methanol, ethanol, and other alcohols
- Liquefied petroleum gas (propane)
- Blends of 85% or more of alcohol with gasoline
- Coal-derived liquid fuels
- Fuels (other than alcohol) derived from biological materials
- Natural gas and liquid fuels domestically produced from natural gas
- Hydrogen
- Electricity

7.6.1 Alternative Fuel Vehicles

Alternative Fuel Vehicles (AFV) are becoming increasingly popular due to rapidly rising gasoline prices and increased concern and awareness of environmental effects. An AFV runs on an alternative fuel source derived from means other than petroleum. There are several different types of AFV's which are described below.

Hybrid Electric Vehicle (HEV) – HEV's combine the features of an internal combustion engine with those of an electric motor. They are primarily powered by a gasoline powered engine similar to those of a conventional vehicle. The engine is assisted by an electric motor which uses energy stored in a battery. The assistance of the electric motor allows the engine to operate more efficiently and waste less energy. HEV's use energy dissipated during braking to charge the battery that runs the electric motor. The split use between the gasoline engine and electric motor combine to increase fuel economy and reduce emissions.

Biodiesel – Biodiesel is a form of eco-friendly diesel fuel manufactured from non-petro based oils. Vegetable oils, recycled restaurant grease, and animal fat can all be used to create biodiesel. Bio diesel can be created entirely from these non-petro based oils or can be blended with standard petroleum diesel. Pure biodiesel is given the name B100 (100% biodiesel). B5 (5% biodiesel) and B20 (20% biodiesel) are other common blends. Most diesel vehicles can safely run biodiesel with grades up to B5 or B20. However, this may void some vehicle warranties. It is not recommended that a vehicle run biodiesel unless it is intended to do so. Higher grades of biodiesel typically require modifications to the vehicle's engine.

Flexible Fuel Vehicle (FFV) – A flexible fuel vehicle is designed to run on standard gasoline or gasoline blended with up to 85% ethanol (E85). These vehicles are basically identical to standard gasoline ones, with a few changes being made to the fuel system and engine. FFV's typically get about 20-30% fewer miles per gallon off of E85 than off of standard gasoline. However, this decrease in fuel economy is typically offset by the lower price of E85 compared to gasoline. E85 also emits fewer toxins into the air and is manufactured from a renewable resource. There are currently dozens of vehicle models that are able to run off of E85.

Electric Vehicle (EV) – Unlike hybrid electric vehicles, electric vehicles are solely powered by an electric motor. The motor is powered by a battery pack that must be recharged. These battery packs need to be plugged in and can take anywhere from 4 to 8 hours to fully recharge and generally only allow for around 150 miles of travel. The battery packs are usually heavy, take up considerable space, and usually need to be replaced one or more times. Electric vehicles do have several distinct advantages over typical combustion motors, however: electric motors are up to 4 times more efficient than standard gasoline engines; they emit no vehicle pollutants; they reduce the dependence on foreign petroleum; and they are quiet, smooth, and generally powerful.

Fuel Cell Vehicle (FCV) – Fuel cell vehicles operate in much the same way as electric vehicles. They have an electric motor that is used to power the vehicle. The difference comes in how the electric motor is powered. While electric vehicles use bulky battery packs that need to be continually recharges, fuel cell vehicles use fuel cells onboard the vehicle to create electricity through the use of hydrogen fuel. A chemical process between hydrogen and oxygen inside the fuel cell produces the energy used to power the electric motor.

7.6.2 Alternative Fuels in Transit Vehicles

The use of alternative fuels in transit vehicles is becoming more popular with increasing emission regulations and awareness of the affects that pollution has on the environment. Transit systems are well suited to alternative fuel use. They generally use high amounts of fuel and operate using a centralized fueling station. These characteristics help transit systems to sustain an alternative fueling infrastructure that supports private fueling. Transit systems also are generally serviced by technicians who work on the entire fleet and are required to be regularly trained. Transit systems generally operate in urban areas where air quality is of greater concern. The use of alternative fuels in transit systems becomes more and more important with the increase in miles traveled by the system.

The new yellow busses operated by Streamline Transit run off of B20 biodiesel. B20 biodiesel is a blend of 80% petroleum diesel and 20% biodiesel. This type of fuel is a good balance of emission benefits, cost, maintenance, and field problems. B20 is commonly used in diesel engines with no modifications. A B20 fueling station is currently located at Story Distributing Co. in Belgrade.

7.7 Public Transportation Conclusion

It is evident that with the continued success of Streamline, transit as a travel choice will be heightened in the coming years. To that end, the community should strive to hold transit on par with vehicular and non-motorized travel modes. Several factors contained in this chapter will by necessity be brought to the forefront as the transit system develops.

The most pressing types of discussions that should be addressed going forward are as follows:

- Should the system be governed by an Urban Transportation District (UTD)?
- What "level of service' standard should be the goal for operations, given limited funding?
- How can the future infrastructure needs for transit be better coordinated with private development and the development process?
- How can transit become ingrained in everyday life and be a part of overall community planning efforts.

Along with these questions that must be addressed going forward, some basic recommendations for transit have been made in **Chapter 5** of this document. These are reiterated herein as shown below:

TSM-36: **Development Review/Coordination Efforts**
It is desirable to have a formal mechanism by which Streamline board and staff can participate in the development revise process. This will allow for continued coordination of proper bus stop location and identification of appropriate bus bay design and locations. The goal is to be able to participate in the formal review such that knowledge is disseminated to all affected parties pertinent to transit growth opportunities (routes, destinations, etc) and how those opportunities interface with private development infrastructure.

TSM-37: **Formalize Transit Representation on TCC**
It is recommended that a member of Streamline (board or staff) have a formal, allocated seat on the Bozeman Transportation Coordinating Committee (TCC).

7.8 Land Use Planning & In-Fill Development Strategies

Land use planning and development strategies are crucial in order to maximize the efficiency of any transportation system. Proper planning can create a user friendly environment that is eco-friendly and promotes multimodal use. It is important to develop a vision, or goal, for the community and put development strategies in place to help achieve that goal.

Current development patterns are showing a tendency to develop outwardly to undeveloped land areas. This development pattern is sometimes called "sprawl". Characteristics of this type of development generally include single-family homes on the outskirts of the city, low population densities, areas concentrated with specific development types, and a majority of residents commuting by automobile.

Sprawl is a controversial topic that generally has a negative connotation to it. Opponents of sprawl argue that this type of development strategy tends to negatively impact the environment and that it creates higher pollution rates per person, increases traffic levels, and decreases the walkability of the community. This general way of thinking comes from the fact that sprawl consumes larger areas of land due to its low density nature. Lots are spaced farther apart, and additional roadways are needed to connect outward developments together. This type of development generally lumps land use types together which makes it difficult to use non motorized modes of transportation. Sprawl has become popular due to the generally lower priced land available outside of the city and the fact that there is a desire for single-family homes in low density neighborhoods.

It may be desirable to for some cities to create in-fill development strategies that discourages sprawl and encourages mixed use high density development types located inside the city. This type of development strategy is often called "smart growth" and promotes compact mixed-use development types complete with multimodal transportation facilities. Smart growth's ideals are based on town-centered developments that encourage multimodal travel to create a compact environmentally friendly community. Open space is preserved and city centers are restored under this development strategy.

The following is a list of smart growth principals as defined by the *Smart Growth Network*:

- **Create Range of Housing Opportunities and Choices** – Providing quality housing for people of all income levels is an integral component in any smart growth strategy.
- **Create Walkable Neighborhoods** – Walkable communities are desirable places to live, work, learn, worship and play, and therefore a key component of smart growth.
- **Encourage Community and Stakeholder Collaboration** – Growth can create great places to live, work and play -- if it responds to a community's own sense of how and where it wants to grow.
- **Foster Distinctive, Attractive Communities with a Strong Sense of Place** – Smart growth encourages communities to craft a vision and set standards for development and construction which respond to community values of architectural beauty and distinctiveness, as well as expanded choices in housing and transportation.
- **Make Development Decisions Predictable, Fair and Cost Effective** – For a community to be successful in implementing smart growth, it must be embraced by the private sector.

- **Mix Land Uses** – Smart growth supports the integration of mixed land uses into communities as a critical component of achieving better places to live.
- **Preserve Open Space, Farmland, Natural Beauty and Critical Environmental Areas** – Open space preservation supports smart growth goals by bolstering local economies, preserving critical environmental areas, improving our communities quality of life, and guiding new growth into existing communities.
- **Provide a Variety of Transportation Choices** – Providing people with more choices in housing, shopping, communities, and transportation is a key aim of smart growth.
- **Strengthen and Direct Development Towards Existing Communities** – Smart growth directs development towards existing communities already served by infrastructure, seeking to utilize the resources that existing neighborhoods offer, and conserve open space and irreplaceable natural resources on the urban fringe.
- **Take Advantage of Compact Building Design** – Smart growth provides a means for communities to incorporate more compact building design as an alternative to conventional, land consumptive development.

- Source: Smart Growth Network

It is important to take into consideration all of the positives and negatives of all development strategies. There is no "one-size-fits-all" solution that works for every community. A vision should be created to define what is important to the community and where they want to go in the future. The development strategy for a community should reflect their desired vision.