GREATER BOZEMAN AREA TRANSPORTATION PLAN (2007 UPDATE)

prepared for
Bozeman Transportation Coordinating Committee, Bozeman, MT
in cooperation with
City of Bozeman, MT
Gallatin County, MT
Montana Department of Transportation

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EXECUTIVE SUMMARY

This Transportation Plan Update is intended to document changes and progress since the last *Greater Bozeman Area Transportation Plan (2001 Update)* was completed in the year 2001. This Plan Update strives to elevate non-motorized transportation planning in the community from both a mobility, and a liveability, perspective. The Plan attempts to address motorized and non-motorized transportation needs by placing both on equal playing fields. This has been accomplished through meaningful dialogue with the public and dozens of stakeholders, along with the analysis of the Consultant team and the transportation coordinating committee (TCC). The TCC is the advisory committee which oversaw the development of this update to the Transportation Plan.

The Greater Bozeman Area has seen and continues to experience substantial growth. The desire for growth in the community is sometimes met with mixed emotions: many long-time existing residents would like growth to subside and/or at least slow, while many new residents and business entities desire additonal services and economic benefits found in a growth oriented community. Almost all recognize, however, that the impacts of growth are being felt in the Gallatin Valley. A Transportation Plan is often in the position of responding to the existing impacts of this growth, while at the same time planning for the future needs to accommodate growth. This plan recognized this dichotomy and strives to achieve a balance in addressing existing deficiences while at the same time planning for the future. Growth within the Bozeman area was projected using a computer traffic model. The model used current socio-economic data and growth trends to project traffic volumes, as presented in **Chapter 3** of the Plan. These projected traffic volumes identified future traffic problems within the area. The projections indicate that many sections of the current street network will be insufficient to meet the traffic demands generated by future growth. The anticipated traffic demand in the year 2030 will produce unacceptable traffic congestion, and excessive vehicle delays at many major intersections. Several major corridors will need to be expanded to handle the additional traffic including South 19th Avenue, College Street, and Rouse Avenue.

Numerous new roads will also be required in the next 20 years to provide access to the new growth areas of the community. Without the recommended system upgrades, the anticipated increase in traffic volumes will overload these arterials. Even with the recommended road improvements contained in this Plan, traffic volumes on some arterials will grow to the point that some traffic congestion will still occur.

The analysis of the future traffic conditions indicated a need for numerous improvements in the area. These infrastructure improvements are contained in **Chapter 5** of this plan and are broken down into four categories:

- Transportation System Management (TSM) Improvements,
- Major Street Network (MSN) Improvements,
- Pedestrian Facility Improvements, and
- Bicycle Facility Improvements.

TSM projects focus mainly on intersection improvements, such as the addition of turning lanes and signalization. A total of thirty-seven (37) TSM projects are recommended. Major Street Network (MSN) Improvement projects focus on upgrading entire road corridors and the construction of new roadways. Thirty (30) MSN projects are recommended.

The Plan also strives to strengthen and/or reinforce policy and procedural actions for both non-motorized and motorized travel. **Chapter 6** of the plan presents concepts and guidelines for complete streets, context sensitive design (CSD) principles, transportation level of service, and a variety of pedestrian and bicycle programs and policies.

One of the most important pieces of information that is provided in this Plan is a projection of the major street network. A map showing this projection is presented in **Chapter 9**, and identifies where the arterial and collector routes of the community should be located as the area develops. This map, along with recommended street standards, is an important planning tool. This projection of the future road system is essential for the city and county planners. It provides a blueprint of how the arterial network should be developed. It enables the planners to locate future arterial corridors, and to request appropriate amounts of rights-of-way and new road sections throughout the development process. This will allow the community to create a logical and functional road network for the future. It is important to note that identifying the desired general alignment of future road corridors is significantly different from building roads to encourage development. The socio-economic trends indicate that substantial development will occur within the 20-year planning horizon of this transportation plan. This map of the future road system will insure that anticipated development also produces an appropriate road system.

The cost of the recommended improvement projects far exceeds the funds available through the federal-aid programs that are traditionally used to finance transportation improvements as defined in **Chapter 11**. Many projects will need to be financed by the private sector during the development process. The TSM projects should be completed as needed and as funding allows. Implementation of the TSM projects will keep most of the transportation system functioning at a satisfactory level during the 20-year planning period. However, a select group of Major Improvement projects must be implemented in order for the system to function effectively.

The "top ten” recommended Major Improvement projects are listed below:

<u>Top Ten Major Improvement Projects</u>

(Not listed in order of importance to the community)

1. **MSN-1: N. 19th Avenue (I-90 to Springhill Road)** – Upgrade to 5-lane urban arterial.

2. **MSN-2: Kagy Boulevard (S. 19th Avenue to Willson Avenue)** – Upgrade to 3-lane urban arterial.

3. **MSN-4: Rouse Avenue (Main Street to Story Mill Road)** – Upgrade to 3-lane urban arterial.

4. **MSN-5: College Street (Main Street to 19th Avenue)** – Upgrade to 5-lane urban arterial.

5. **MSN-14: W. Babcock Street (11th Avenue to 19th Avenue)** – Upgrade to 2-lane collector.

6. **MSN-17: Frontage Road (N. 7th Avenue to Belgrage)** – Upgrade to 3-lane rural arterial.

7. **MSN-20: East Belgrade Interchange** – Construct a new I-90 interchange to serve the airport and Belgrade areas.

8. **MSN-21: Gallatin Road (Gallatin Gateway to Four Corners**) – Upgrade to 3-lane rural arterial.

9. **MSN-22: Jackrabbit Lane (Four Corners to Frank Road)** – Upgrade to 5-lane arterial.

10. **MSN-26: Highland Boulevard (Main Street to Kagy Bouleverd)** – Upgrade to 5-lane urban arterial north of Ellis Street, upgrade to 3-lane urban arterial south of Ellis Street.

It needs to be expressed that this plan has a primary focus on non-motorized as well as vehicular projects. Although the "top ten" projects listed earlier are vehicular projects, every effort needs to be made to implement non-motorized projects whenever possible.

Lastly, although this Transportation Plan is a tool that can be used to guide development of the transportation system in the future, local and state planners must continually re-evaluate the findings and recommendations in this document as growth is realized and development occurs. If higher than anticipated growth is realized in the community, or if growth occurs in areas not originally planned for, transportation needs may be different from those analyzed in this plan. An update and re-evaluation of this document should occur every five years, at a minimum, for at least a cursory review to determine how implementation of the community's transportation system is progressing.

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DEFINITIONS

Access Management/Control – Controlling or limiting the types of access or the locations of access on major roadways to help improve the carrying capacity of a roadway, reduce potential conflicts, and facilitate proper land usage.

Average Daily Traffic (ADT) – The total amount of traffic observed, counted or estimated during a single, 24-hour period.

Annual Average Daily Traffic (AADT) – The average daily traffic averaged over a full year.

Americans with Disabilities Act (ADA) – The Federal regulations which govern minimum requirements for ensuring that transportation facilities and buildings are accessible to individuals with disabilities.

Bikeway – Any road, path, or way which in some manner is specifically designated as being open to bicycle travel, regardless of whether such facilities are designated for the exclusive use of bicycles or are to be shared with other transportation modes.

Bike Path – A bikeway physically separated from motorized vehicular traffic by an open space or barrier and either within the highway right of way or within an independent right of way.

Bike Lane – A portion of a roadway which has been designated by striping, signing and pavement markings for the preferential or exclusive use of bicyclists.

Bike Route – A segment of a system of bikeways designated by the jurisdiction having authority with appropriate directional and informational markers, with or without a specific bicycle route number.

Capacity – The maximum sustainable flow rate at which vehicles can be expected to traverse a roadway during a specific time period given roadway, geometric, traffic, environmental, and control conditions. Capacity is usually expressed in vehicles per day (vpd) or vehicles per hour (vph).

Collector Street – Provides for land access and traffic circulation within and between residential neighborhoods, and commercial and industrial areas. It provides for the equal priority of the movement of traffic, coupled with access to residential, business and industrial areas. A collector roadway may at times traverse residential neighborhoods. Posted speed limits on collectors typically range from 25 mph to 45 mph and can carry between 2,000 and 10,000 vehicles per day.

Congested Flow – A traffic flow condition caused by a downstream bottleneck.

Context Sensitive Design (CSD) – A fairly new concept in transportation planning and highway design that integrates transportation infrastructure improvements to the context of the adjacent land uses and functions, with a greater sensitivity to transportation impacts on the environment and communities being realized.

Delay – The additional travel time experienced by a driver, passenger, or pedestrian.

Facility – A length of highway composed of connected section, segments, and points.

Level of Service (LOS) – A qualitative measure of how well an intersection or road segment is operating based on traffic volume and geometric conditions. The level of service "scale" represents the full range of operating conditions. The scale is based on the ability of an intersection or street segment to accommodate the amount of traffic using it, and can be used for both existing and projected conditions. The scale ranges from "A" which indicates little, if any, vehicle delay, to "F" which indicates significant vehicle delay and traffic congestion.

Local Street – Comprises all facilities not included in a higher system. Its primary purpose is to permit direct access to abutting lands and connections to higher systems. Usually through-traffic movements are intentionally discouraged. Posted speed limits on local roads typically range from 25 mph to 35 mph and designed for less than 3000 vehicles per day.

Major Street Network (MSN) – The network of roadways defined for the Transportation Plan effort that include the interstate, principal arterials, minor arterials, collectors and some local streets.

Minor Arterial Street – Interconnects with and augments the Principal Arterial system. It also provides access to lower classifications of roads on the system and may allow for traffic to directly access destinations. They provide for movement within sub-areas of the city, whose boundaries are largely defined by the Principal Arterial road system. They serve through traffic, while at the same time providing direct access for commercial, industrial, office and multifamily development but, generally, not for single-family residential properties. The purpose of this classification of road is to increase traffic mobility by connecting to both the Principal Arterial system and also providing access to adjacent land uses. Posted speed limits on minor arterials typically range from 25 mph to 55 mph and can carry between 5,000 and 15,000 vehicles per day.

Multi-modal – A transportation facility for different types of users or vehicles, including passenger cars and trucks, transit vehicles, bicycles, and pedestrians.

Oversaturation – A traffic condition in which the arrival flow rate exceeds capacity on a roadway lane or segment.

Peak Hour – The hour of greatest traffic flow at an intersection or on a road segment. Typically broken down into AM and PM peak hours.

Road Failure – A condition by which a road has reached maximum capacity or has experienced structural failure.

Principal Arterial Street – Is the basic element of a city's road system. All other functional classifications supplement the Principal Arterial network. Direct access is minimal and controlled. The purpose of a principal arterial is to serve the major centers of activity, the highest traffic volume corridors, and the longest trip distances in an urbanized area. This classification of roads carries a high proportion of the total traffic within an urban area. The major purpose is to provide for the expedient movement of traffic. Posted speed limits on principal arterials typically range from 25 mph to 70 mph and typically carry between 10,000 vehicles per day and 35,000 vehicles per day.

Running speed – The actual vehicle speed while the vehicle is in motion (travel speed minus delay).

Service Life – The design life span of roadway based on capacity or physical characteristics.

Transportation Coordinating Committee (TCC) – The oversight committee that guided the development of this Transportation Plan Update. The committee is comprised of a multitude of individuals representing various departments of Gallatin County, the city of Bozeman, and the Montana Department of Transportation. The committee is a standing committee in the community that is generally responsible for overseeing transportation planning efforts.

Transportation Analysis Zone (TAZ) – Geographical zones identified throughout the study area based on land use characteristics and natural physical features for use in the traffic model developed for this project.

Transportation Demand Management (TDM) - Programs designed to maximize the people-moving capability of the transportation system by increasing the number of persons in a vehicle, or by influencing the time of, or need to, travel.

Travel speed – The speed at which a vehicle travels between two points including all intersection delay.

Volume to Capacity (V/C) Ratio – A qualitative measure comparing a roads theoretical maximum capacity to the existing (or future) volumes. Commonly described as the result of the flow rate of a roadway lane divided by the capacity of the roadway lane.

ACRONYMS

AASHTO	**A**merican **A**ssociation of **S**tate **H**ighway and **T**ransportation **O**fficials
CFR	**C**ode of **F**ederal **R**egulations
CIP	**C**apital **I**mprovement **P**rogram
FAA	**F**ederal **A**viation **A**dministration
FHWA	**F**ederal **H**ighway **A**dministration
HCM	**H**ighway **C**apacity **M**anual
HCS	**H**ighway **C**apacity **S**oftware
ISTEA	**I**ntermodal **S**urface **T**ransportation **E**fficiency **A**ct
ITE	**I**nstitute of **T**ransportation **E**ngineers
MDT	**M**ontana **D**epartment of **T**ransportation
MPO	**M**etropolitan **P**lanning **O**rganization
MUTCD	**M**anual on **U**niform **T**raffic **C**ontrol **D**evices
TEA-21	**T**ransportation **E**fficiency **A**ct for the **21**st Century
SAFETEA-LU	**S**afe, **A**ccountable, **F**lexible, **E**fficient **T**ransportation **E**quity **A**ct: A **L**egacy for **U**sers
TIP	**T**ransportation **I**mprovement **P**rogram

1.1 INTRODUCTION

The city of Bozeman and the surrounding area is experiencing tremendous growth that includes a mixture of commercial, residential, industrial, retail and office. This growth, coupled with the existing transportation system constraints, has necessitated the update of the community's current Transportation Plan. The existing Plan was completed in 2001, is commonly referred to as the "2001 Update" and provides a blueprint for guiding transportation infrastructure and associated decision making principles. Because of steadily increasing growth, and the community's increasing interest in transportation related matters, the governmental entities have decided to update their regional Transportation Plan. To that end, the consulting firm of Robert Peccia & Associates was retained to assist in developing the *Greater Bozeman Area Transportation Plan (2007 Update)* project.

This update is intended to offer guidance for the decision-makers in the greater Bozeman community. It contains a multi-modal analysis of the transportation system in the Bozeman area. This Plan includes an examination of the traffic operations, road network, transit services, non-motorized transportation system, trip reduction strategies, and growth management techniques. This document also identifies the problems with the various transportation systems and offers recommendations in the form of improvement projects and progressive programs that will help relieve existing problems and/or meet future needs.

A word of caution is appropriate. The previous focus of much of the transportation across the United States has been to move cars. This has necessitated more and larger roadways at extensive costs. The time is right in the Bozeman community, and the rest of western Montana, to begin to focus on moving people. Although the roadway needs will be well defined and will be the standard by which community transportation infrastructure is measured, the decision makers and community at large must recognize the need for alternatives. These alternatives include more and better bicycle and pedestrian facilities, a focus on transit service, a desire to explore alternative transportation, and the willingness to forge partnerships with adjacent jurisdictions. Growth in the Bozeman Area is well documented and explained later in **Chapter 3** of this document. Impacts to the transportation system resulting from this growth are a measurable and identifiable quantity, and the community must be prepared to deal with it accordingly.

1.2 STUDY AREA

All transportation plans begin by defining the study area. Sometimes this study area follows governmental boundaries such as city limits, but most often they include land outside city limits in which future growth is seen as likely to occur. As part of the 2007 update to the *Greater Bozeman Area Transportation Plan*, an evaluation of the past Transportation Plan's Study Area Boundary was undertaken in consultation with the City of Bozeman and Gallatin County, the Montana Department of Transportation, and the Bozeman Area Transportation Coordinating Committee (TCC). Subsequently, adjustments were deemed necessary and made to the Study Area Boundary in an effort to capture those areas likely to see future growth that may impact the community's transportation system.

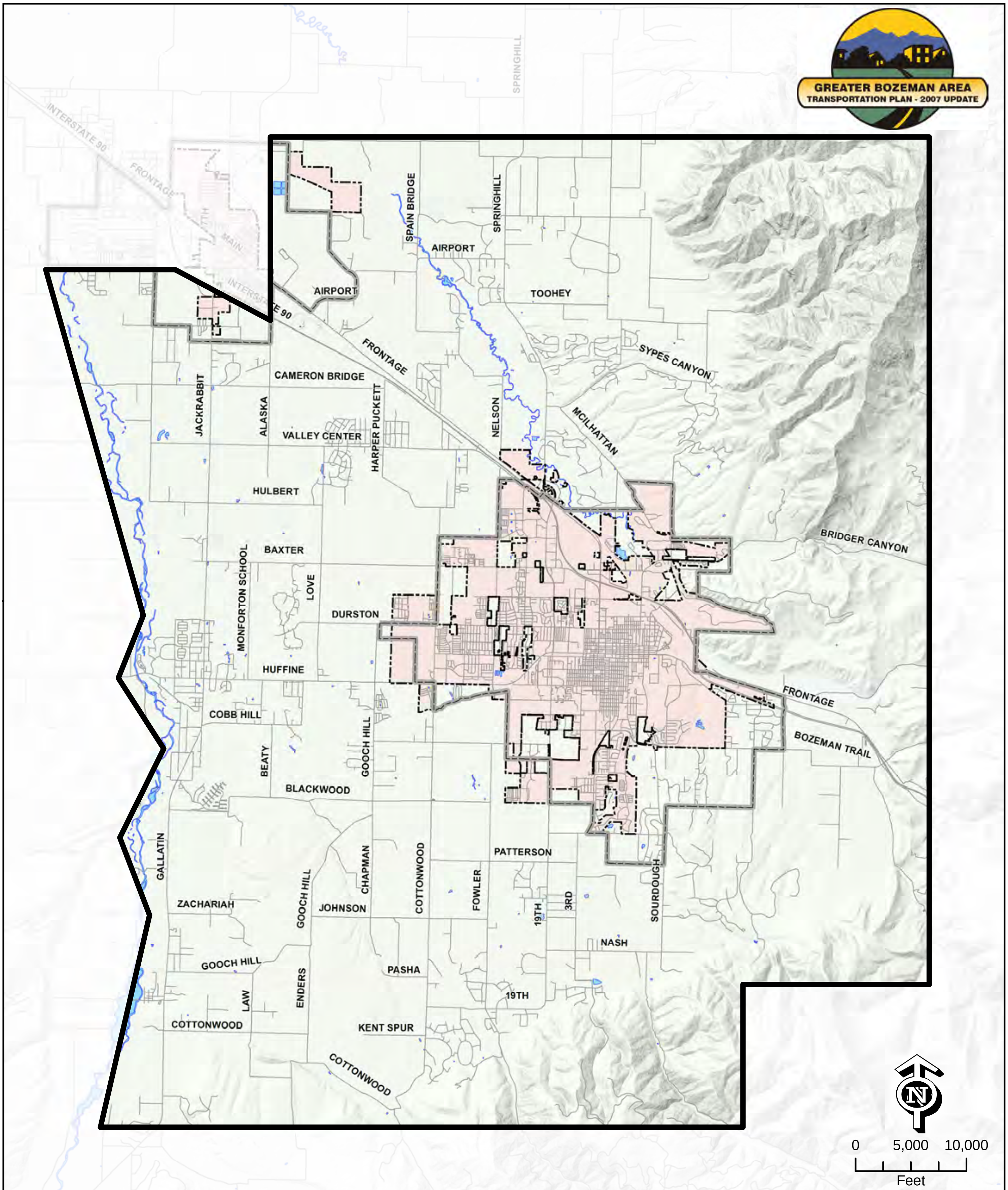
For the purposes of this Plan, the study area boundary includes the entire city limits of Bozeman, as well as a substantial portion of unincorporated lands surrounding the City. These lands are generally located to the north and south of the City proper, and extend from an eastern limit of the Bridger Mountains to a western limit of the Gallatin River.

The study area boundary was developed for two primary reasons. First, to include land where recent growth has occurred or is anticipated to occur in the foreseeable future and second, to include the *2001 Transportation Plan's* study area.

It should be recognized that there are many other areas that are not formally included in the study area boundary that will exhibit development patterns affecting the area transportation system. These areas include, but are not limited to, the City of Belgrade, the Gallatin Gateway area and east along Interstate 90. These are not included in the study area due to both funding and jurisdictional constraints, however, cursory attempts and land use forecasting will be made to evaluate overall transportation impacts through the travel demand modeling process. The new study boundary includes everything in the previous study area, along with additional areas that are developing and/or forecast to develop over the planning horizon of the study (i.e. the year 2030). Therefore, no land was removed from the study area.

The study boundary is shown on **Figure 1-1** and was used for all aspects of the *Greater Bozeman Area Transportation Plan (2007 Update)*. This study boundary includes all of the major employers in the area, and includes all of the land that may be used for employment centers in the next twenty years. It also includes developing residential land uses in the area, and those areas likely to increase the housing supply in the future and subsequently add traffic onto the transportation network.

It is important to recognize that areas outside of the formal study area boundary will still have an effect on the transportation system within the study area boundary. To that end, land use changes outside of the "formal" boundary are still accounted for and incorporated into the travel demand model; however, precise transportation system impacts are not identified for facilities outside of the "formal" study area boundary.



Legend

- Study Area Boundary
- City Boundary
- Urban Boundary

Greater Bozeman Area Transportation Plan (2007 Update)

Study Area Boundary
Figure 1-1

1.3 TRANSPORTATION PLANNING GOALS AND OBJECTIVES

The overall goal of this project is to update the existing 2001 community Transportation Plan. This existing plan was originally developed by Robert Peccia and Associates. The intent of this project is to take an entirely fresh look at the condition of transportation issues in the Greater Bozeman area.

This Transportation Plan Update is intended to facilitate community goals and improve the transportation infrastructure and services within the Greater Bozeman area to meet the needs of existing and future land use. The Plan will address regional transportation issues, overall travel convenience, traffic safety, property access, and potential special issues such as traffic calming and multi-modal connections. The Plan will include recommendations for short-term Transportation System Management (TSM) improvements as well as recommended modifications and capital improvements to the "Major Street Network (MSN)". The Plan will address all modes of transportation in a balanced attempt to meet the current and future transportation needs of the Greater Bozeman area while keeping in compliance with state and federal requirements.

With this background in mind, it is important to recognize that "Goals and Objectives" have been developed to guide this Transportation Plan Update. These are presented later in this section. It is also appropriate, however, to present the existing goals that are found in the various planning level documents found within the community.

Greater Bozeman Area Transportation Plan (2001) and the Bozeman 2020 Community Plan Goals

1. Maintain and enhance the functionality of the transportation system.
2. Ensure that a variety of travel options exist which allow safe, logical, and balanced transportation choices.
3. Encourage transportation options that reduce resource consumption, increase social interaction, support safe neighborhoods, and increase the ability of the existing transportation facilities to accommodate a growing city.
4. Establish and maintain an integrated system of transportation and recreational pathways, including bicycle and pedestrian trails, neighborhood parks, green belts, and open space.

In response to issues and concerns raised during the development of this transportation planning process, it is suggested that transportation related goals and objectives be refined to reflect the diversity of competing transportation interests and the inherent limitations of just focusing on automobile traffic. To that end, the "Goals and Objectives" found on the following page are presented for consideration by the community as transportation system development is considered over the planning horizon of this document.

"Goals and Objectives" for the Greater Bozeman Area Transportation Plan (2007 Update)

Goal #1: Provide a safe, efficient, accessible, and cost-effective transportation system that offers viable choices for moving people and goods throughout the community.

Objectives:

- Plan and implement a logical, efficient, long-range arterial and collector transportation system to ensure that public and private investments in transportation infrastructure support other land use decisions of the community.
- Plan a logical, efficient long-range arterial system that can be systematically implemented by right-of-way reservations and advance acquisition procedures.
- Meet the current and future needs of the greater Bozeman area that can be maintained with available resources.
- Provide adequate emergency service access to all residents inside and outside of the Study Area Boundary.
- Develop a "Major Street Network" classifying existing roadways by functional usage (as well as future corridors) within the Study Area Boundary.
- Address the needs of business and commerce both locally and regionally.
- Plan for adequate access to high volume traffic generation points.
- Conduct a comprehensive data collection effort that will include vehicular counts, truck counts, bicycle movements and pedestrian usage at the intersections identified for the study.
- Review the most recent three-year accident history and crash statistics to evaluate potential safety problems and possible mitigation efforts that can improve and/or resolve identified concerns on the existing transportation system.
- Examine population and employment growth trends to assess demographic changes and how those changes may affect transportation system users over the twenty year planning horizon.
- Develop a 20-year traffic model that can be used to predict future transportation system needs as growth occurs within the Study Area Boundary limits.
- Identify current and foreseeable traffic problems.

Goal #2: Make transit and non-motorized modes of transportation viable alternatives to the private automobile for travel in and around the community.

Objectives:

- Support alternatives to single occupancy vehicles.
- Establish safe pedestrian and bicycle access in designated areas by:
    - Considering pedestrian/bicycle needs when planning and designing new roads.
    - Considering improvement and dedication of bikeways and pedestrian paths though developing area.
    - Providing widened shoulders where possible to accommodate pedestrians/bicycles on existing roadways, with a preference for physical separation between motorized and non-motorized traffic.
- Encourage mixed-use development that integrates compatible residential, office, and commercial uses to reduce the need for automobile trips.

- Encourage walkable neighborhoods, both within existing developed areas and new residential and commercial subdivisions.
- Recommend policies and decisions to ensure bicyclists and pedestrians can access and conveniently cross all major roadways and highways.
- Identify and incorporate, as applicable, Transportation Demand Management (TDM) strategies to provide alternatives to private vehicle travel.
- Consider equestrian needs, where appropriate, when planning and designing new roads.

Goal #3: Provide an open public involvement process in the development of the transportation system and in the implementation of transportation improvements, and assure that community standards and values, such as aesthetics and neighborhood protection, are incorporated.

Objectives:

- Provide for citizen involvement in the planning and implementation of transportation plans and projects.
- Respect and ensure the areas natural and historic context and minimize adverse impacts to the environment and existing neighborhoods.
- Minimize negative transportation effects upon residential neighborhoods.
- Encourage transportation improvements that preserve the natural panorama of skylines and sightlines, and are compatible with historic resources.
- Evaluate and identify transportation system needs of area schools, and address existing and future transportation issues as appropriate.
- Provide for connecting streets among neighborhoods.
- Meet the unique transportation needs of the areas elderly, disabled and disadvantaged populations

Goal #4: Provide a financially sustainable Transportation Plan that is actively used to guide the transportation decision-making process throughout the course of the next 20 years.

Objectives:

- Review all existing and on-going planning reports and studies for compatibility.
- Conduct a financial analysis to ensure the Plan is financially feasible and sustainable.
- Identify funding mechanisms that may be viable alternatives to the traditional funding programs currently used to fund transportation system improvements.

Goal #5: Identify and protect future road corridors to serve future developments and public lands.

Objectives:

- Develop a Plan to address forecasted transportation growth needs.
- Identify future corridors and future connections to existing roadways in order to secure appropriate right of way and improvements.
- Identify road construction needs to serve developing areas, and encourage development in identified urban areas.

1.4 PREVIOUS TRANSPORTATION PLANNING EFFORTS

In the course of data collection, past plans and studies were obtained. From the review of these documents, applicable issues were incorporated into this Greater Bozeman Area Transportation Plan (2007 Update). The contributing documents are as follows:

- Gallatin County Growth Policy;
- Gallatin County Neighborhood Plans;
- Gallatin County Subdivision Regulations;
- Gallatin County Trails Plan;
- Gallatin County Transportation Infrastructure and Recommendations;
- Streamline Bus Routes;
- Gallatin County Transportation Needs (Phase I and Phase II);
- Gallatin County Road Impact Fee Study (currently underway);
- Bozeman 2020 Community Plan;
- Design and Connectivity Plan for North 7th Avenue Corridor;
- North 19th Avenue / Oak Street Corridor Master Plan;
- Gallatin County Regional Sewer Feasibility Study;
- Montana Department of Transportation Access Management Plans;
- City of Bozeman National Citizen Survey;
- Bozeman Creek Neighborhood Plan;
- Bozeman Parks, Recreation, Open Space and Trails Master Plan;
- Bozeman Unified Development Ordinance;
- Bozeman Impact Fee Update;
- Montana State University Long Range Plan (i.e. Campus Plan);
- Bicycle Facility Planning Map (developed by the Bike Board);
- Western Transportation Institute (WTI) Bozeman Bicycle Network Plan;
- Greater Bozeman Area Transportation Plan (2001 Update);
- Greater Bozeman Area 2001 Transportation (Transit) Development Plan Update;
- Downtown Bozeman Traffic Studies;
- Miscellaneous Traffic Impact Studies (Gallatin County & City of Bozeman);
- City of Bozeman Engineering Standards;
- Gallatin County Road Standards;
- Greater Bozeman Area Transportation Plan (1993 Update);
- School Bus Routes;
- Postal Routes;
- Fire District Maps;
- Bozeman Deaconess Hospital "Sub-area" Plan;
- Locally adopted master plans, public facility plans, and related development regulations;
- Official Code of the City of Bozeman;
- Montana Department of Transportation STIP and other Local Planning Documents;
- U.S. Bureau of Census data;
- City building permits, County location and conformance permits, and utility records; and
- Socioeconomic data and projections complied by the Planning Board, Montana Department of Commerce and/or University of Montana.

1.5 PUBLIC INVOLVEMENT

The primary goal of the communications program for the Greater Bozeman Area Transportation Plan (2007 Update) was to keep the public informed and involved in the project. A second goal of the process was to integrate the opinions and issues identified by the public, as a result of the program, into the project approach and methodology, wherever feasible. The methods that were used to achieve these goals included: guidance from the TCC; outreach to key constituencies (i.e. special interest groups and the general public); education of decision-makers (i.e. Gallatin County Commission and Bozeman City Commission); project newsletters; news releases; and public events.

An initial step in developing the project public outreach campaign was the development of a detailed *Public Participation Plan* to guide public opportunities and input as the project developed. The *Public Participation Plan* was structured around the developed scope of work for this Transportation Plan Update, and utilized several traditional and non-traditional public participation strategies. Furthermore, the *Public Participation Plan* defined the appropriate strategies to be used, defined the sequencing within which the various strategies to be implemented, and charted out a course of action to be followed as the project commenced.

The purpose of the *Public Participation Plan* was to insure a proactive public involvement process that assured the opportunity for the public to be involved in all phases of the planning process. This was accomplished by providing complete information, timely public notice, and opportunities for making comments and full access to key decisions.

The goal of the TCC and the Consultant team was to have significant and ongoing public involvement for this transportation planning process. Education and public outreach were an essential part of fulfilling the local entities responsibility to successfully inform the public about the transportation planning process. All three contracting entities (i.e. Gallatin County, the city of Bozeman and MDT) strove to empower the public to voice their ideas and values regarding transportation issues. The entities also strove to ensure early and continuous public involvement in all major actions and decisions.

The Consultant team understood that the interest of the public in transportation issues has increased with the community’s rate of growth, and that updating the Plan provided public outreach opportunities that served to:

- Educate the public on the critical elements of planning and engineering the community’s transportation system;
- Respond to the increasing interest of the general public to participate in planning of the community; and
- Increase the public’s investment in our Transportation Plan.

A brief summary of some of the project outreach activities utilized during the projects development is contained in the following pages.

Transportation Coordinating Committee (TCC)

The Bozeman Transportation Coordinating Committee (TCC) provided project oversight for this project to serve in an advisory capacity and to review and comment on materials over the projects duration. Meetings were generally held every month (on the fourth Wednesday of the month). Membership was composed of individuals as noted on the acknowledgements page of this document, and generally included representatives from the Montana Department of Transportation, Gallatin County, the City of Bozeman, and local business and citizen interests. The TCC was the principal guiding force behind this Transportation Plan. In addition, a full-day workshop was held on October 1st, 2008 to discuss the information contained in the "Administrative Draft" of the Transportation Plan Update. From that exercise, several projects were modified and/or removed from consideration.

Public Meetings

Three formal public meetings were held during the study process. The first meeting was held at a time when the data collection process was nearing completion. This meeting focused on informing the public about the current transportation problems that had been identified to date, and receiving public comment on which issues should be addressed in the Plan. A variety of key issues were identified. The issues generally fell within four categories: 1) the need to plan for future growth; 2) to relieve traffic congestion; 3) to improve traffic safety; and 4) to provide alternatives to the automobile. Specific problem intersections and roadway corridors were identified and presented at this first meeting.

The second public meeting was held after the analysis of the existing transportation system was completed. Additionally, the effects of population growth on traffic volumes and transportation infrastructure were discussed. Where and potentially when future land use changes (i.e. growth) were also defined and discussed. Again, the public had the opportunity to give their opinions on transportation system issues in the study area, as well as any other concerns they might have.

The third public meeting was held after the preliminary project recommendations were completed and prior to release of an "official" Public draft document. This meeting gave the public the opportunity to review the preliminary project recommendations in their entirety, including a thorough review of recommended projects that not only offered mitigation measures to solve existing transportation issues, but also measures to accommodate future growth issues.

All three public opportunities described above were held at the Bozeman High School cafeteria.

Other Public Outreach Activities

Formal and informal meeting and presentations occurred many times over the course of the project. These are specifically listed in **Table 1-3** later in this chapter.

Public Hearing

One public hearing was conducted near the completion of this planning process to obtain formal public comment on the public draft document before the Gallatin County Commission and separately before the Bozeman City Commission. The public hearing covered all elements of the draft and significant additional time for public comment was provided after the public hearing closed. After reviewing the comments received at the public hearing, the TCC met with the consultant to provide comments and direction in revising the draft document, and developing the final version of the Plan.

News Releases

Television and newspaper articles were used several times during the planning process to help keep the public informed. These news releases generally were issued prior to public meetings (and the public hearing), to generate interest in the process, and to encourage participation by the public.

Internet Access

The results of the traffic studies and analyses conducted during the study process were made available to the public on the Internet website. As sections of the report and graphic displays became available, they were posted on the web site for public review and comment. This enabled the public to stay abreast of the developments occurring during the planning process. It also provided an opportunity for the public to submit comments.

Project Newsletters

Several project newsletters were created and distributed via email to a project email list. Towards the end of the project, there were approximately 915 people on the project e-mailing list.

1.6 Coordination Summary

The following tables (**Table 1-1** thru **Table 1-3**) summarize all of the coordination that occurred over the course of this planning project. They encompass all formal and informal meetings, including but not limited to Transportation Coordinating Committee (TCC) meetings and workshops, formal public meetings, and others.

Table 1-1
Summary of Transportation Coordinating (TCC) Activities

Date	Agency or Individual
03/28/2007	Transportation Coordinating Committee (TCC) Meeting No. 1
04/25/2007	Transportation Coordinating Committee (TCC) Meeting No. 2
05/23/2007	Transportation Coordinating Committee (TCC) Meeting No. 3
06/27/2007	Transportation Coordinating Committee (TCC) Meeting No. 4
07/25/2007	Transportation Coordinating Committee (TCC) Meeting No. 5
08/22/2007	Transportation Coordinating Committee (TCC) Meeting No. 6
09/26/2007	Transportation Coordinating Committee (TCC) Meeting No. 7
10/24/2007	Transportation Coordinating Committee (TCC) Meeting No. 8
11/28/2007	Transportation Coordinating Committee (TCC) Meeting No. 9
12/19/2007	Transportation Coordinating Committee (TCC) Meeting No. 10
02/27/2008	Transportation Coordinating Committee (TCC) Meeting No. 11
03/26/2008	Transportation Coordinating Committee (TCC) Meeting No. 12
04/23/2008	Transportation Coordinating Committee (TCC) Meeting No. 13
05/21/2008	Transportation Coordinating Committee (TCC) Meeting No. 14
07/23/2008	Transportation Coordinating Committee (TCC) Meeting No. 15
08/27/2008	Transportation Coordinating Committee (TCC) Meeting No. 16
10/01/2008	Transportation Coordinating Committee (TCC) Meeting Workshop
10/29/2008	Transportation Coordinating Committee (TCC) Meeting No. 17
12/17/2008	Transportation Coordinating Committee (TCC) Meeting No. 18

Table 1-2
Summary of "Formal" Local Government Outreach Activities

Date	Agency or Individual
08/20/2007	Bozeman City Commission Meeting No. 1
08/21/2007	Gallatin County Commission Meeting No. 1
02/06/2008	Gallatin County Commission Meeting No. 2
02/11/2008	Bozeman City Commission Meeting No. 2
12/17/2008	Gallatin County Commission Meeting No. 3
01/20/2009	Bozeman City Commission – Public Hearing
02/10/2009	Gallatin County Commission – Public Hearing

Table 1-3
Summary of "Other" Outreach Activities

Date	Agency or Individual
04/12/2007	Gallatin County Staff Meeting – Planning & Public Works
04/12/2007	Bozeman City Commission – Roadway Design Best Practices Meeting
04/27/2007	City of Bozeman Staff Meeting - Planning & Public Works
05/08/2007	Inter-Neighborhood Council (INC) Project Outreach
06/14/2007	Gallatin County Staff Meeting – Planning & Public Works
06/14/2007	City of Bozeman Staff Meeting - Planning & Public Works
06/15/2007	Bozeman Chamber of Commerce – Eggs & Issues Meeting
06/26/2007	Streamline Transportation Advisory Committee (TAC) Presentation
06/27/2007	Transit Outreach Meeting – Lisa Ballard (Current Transportation Solutions)
06/27/2007	Public Information Meeting #1 (held at Bozeman High School)
07/25/2007	Four Corners Neighborhood Group Meeting
07/25/2007	MDT Director Jim Lynch & Gallatin Gateway Neighborhood Group Meeting
08/09/2007	City of Bozeman/Engineering Inc./PC Development Meeting - Highland
08/21/2007	City of Bozeman Planning Board Presentation
10/17/2007	South Central Association of Neighbors (SCAN) Project Outreach
11/28/2007	Public Information Meeting #2 (held at Bozeman High School)
04/07/2008	Montana State University – Engineering Students/Faculty Presentation
08/12/2008	Gallatin County Planning Board
08/20/2008	Public Information Meeting #3 (held at Bozeman High School)
08/26/2008	Streamline Transportation Advisory Committee (TAC) Presentation
10/07/2008	Northeast Neighborhood (NENA) - Neighborhood Fall Meeting
11/12/2008	Inter-Neighborhood Council (INC) Project Outreach

2.1 INTRODUCTION

In an effort to clearly understand the existing traffic conditions, it was necessary to gather current information about different aspects of the transportation system. Existing traffic volume data from 2005 was used to determine weighted annual average daily traffic (AADT) volumes on major road segments within the community. Additional traffic data was collected during the summer/fall of 2007. The data was used to determine current operational characteristics, and to identify any traffic problems that may exist or are likely to occur within the foreseeable future. A variety of information was gathered to help evaluate the system including:

- Existing functional classifications & study roadways;
- Existing machine traffic volume counts (2005);
- Existing roadway corridor size;
- Intersection turning movement counts;
- Current traffic signal operation information;
- Intersection data required to conduct level of service analyses;
- Traffic crash records.

2.2 MOTORIZED

2.2.1 Existing Functional Classifications & Study Roadways

One of the initial steps in trying to understand a community's existing transportation system is to first identify what roadways will be evaluated as part of the larger planning process. A community's transportation system is made up of a hierarchy of roadways, with each roadway being classified according to certain parameters. Some of these parameters are geometric configuration, traffic volumes, spacing in the community transportation grid, speeds, etc. It is standard practice to examine roadways that are functionally classified as a collector, minor arterial, or principal arterial in a regional transportation plan project. These functional classifications can be encountered in both the "urban" and "rural" setting. The reasoning for examining the collector, minor arterial and principal arterial roadways, and not local roadways, is that when the major roadway system (i.e. collectors or above) is functioning to an acceptable level, then the local roadways are not used beyond their intended function. When problems begin to occur on the major roadway system, then vehicles and resulting issues begin to infiltrate neighborhood routes (i.e. local routes). As such, the overall health of a regional transportation system can be typically characterized by the health of the major roadway network. The roadways being studied under this Transportation Plan update, along with the appropriate functional classifications, are shown on **Figure 2-1** and **Figure 2-2**. It should be noted that the functional classifications shown on these figures are recommended as part of the Transportation Plan and do not reflect the "federally approved" functional classification criteria which is based on current conditions rather than anticipated future conditions.

The "Federally Approved Functional Classification" system can be seen graphically via maps available at the Montana Department of Transportation's (MDT's) website at the following addresses:

www.mdt.mt.gov/other/urban_maps/fc_internet/BOZEMANFUNC.pdf (Urban Area)

www.mdt.mt.gov/travinfo/docs/funct-classification.pdf (Statewide Area)

Roadway functional classifications within the city of Bozeman include principal arterials; minor arterials; collector routes; and local streets. The rural areas of Gallatin County are also served by a similar hierarchy of streets. However, due to their rural nature the volumes on these streets are generally smaller than in urban areas. Although volumes may differ on urban and rural sections of a street, it is important to maintain coordinated right-of-way standards to allow for efficient operation of urban development. A description of these classifications is provided in the following sections.

Principal Arterial System – The purpose of the principal arterial is to serve the major centers of activity, the highest traffic volume corridors, and the longest trip distances in an urban area. This group of roads carries a high proportion of the total traffic within the urban area. Most of the vehicles entering and leaving the urban area, as well as most of the through traffic bypassing the central business district, utilize principal arterials. Significant intra-area travel, such as between central business districts and outlying residential areas, and between major suburban centers, is served by principal arterials.

The spacing between principal arterials may vary from less than one mile in highly developed areas (e.g., the central business district), to five miles or more on the urban fringes.

The major purpose of the principal arterial is to provide for the expedient movement of traffic. Service to abutting land is a secondary concern. It is desirable to restrict on-street parking along principal arterial corridors. The speed limit on a principal arterial could range from 25 to 70 mph depending on the area setting.

Minor Arterial Street System – The minor arterial street system interconnects with and augments the urban principal arterial system. It accommodates trips of moderate length at a somewhat lower level of travel mobility than principal arterials, and it distributes travel to smaller geographic areas. With an emphasis on traffic mobility, this street network includes all arterials not classified as principal arterials while providing access to adjacent lands.

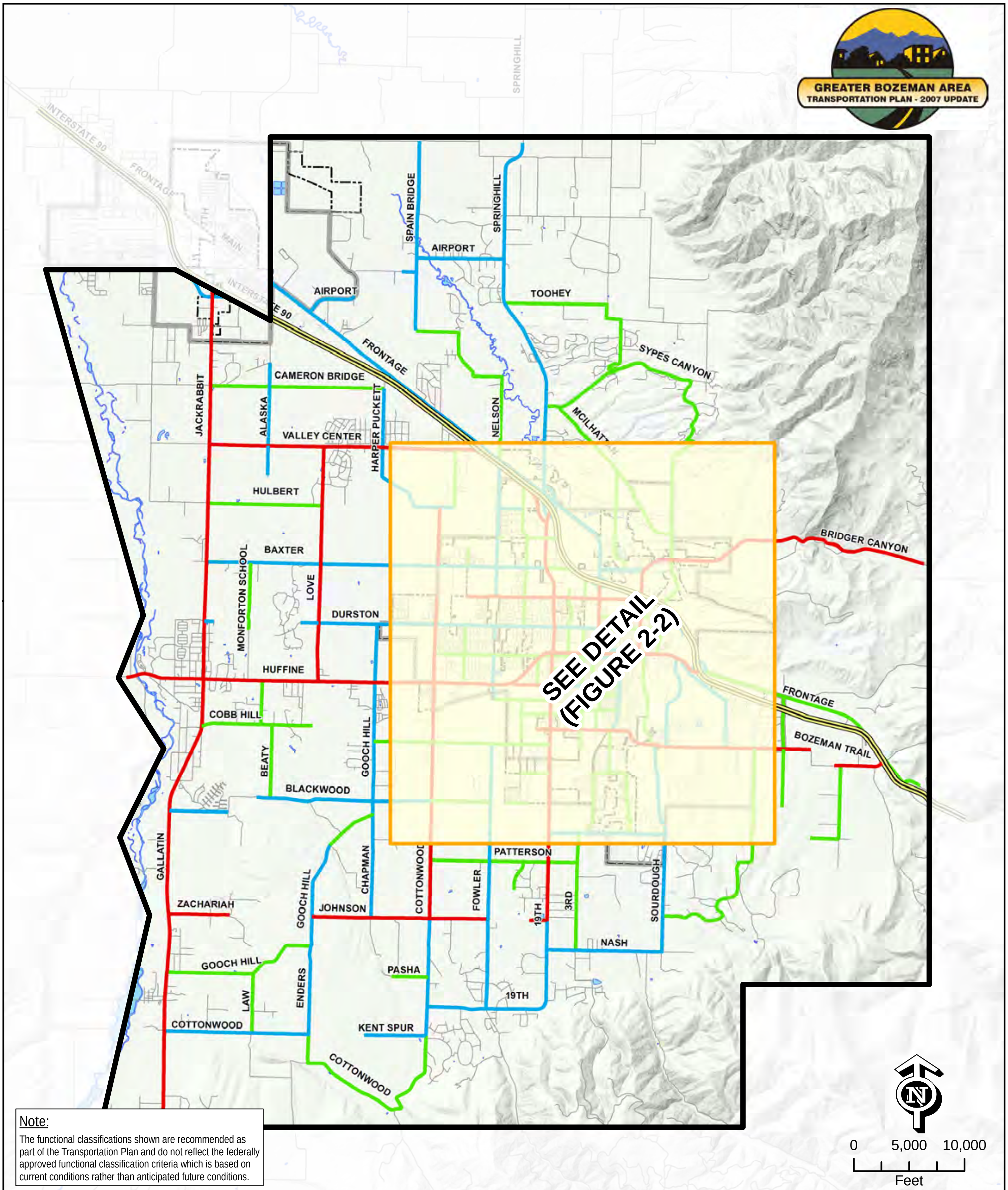
The spacing of minor arterial streets may vary from several blocks to a half-mile in the highly developed areas of town, to several miles in the suburban fringes. They are not normally spaced more than one mile apart in fully developed areas.

On-street parking may be allowed on minor arterials if space is available. In many areas on-street parking along minor arterials is prohibited during peak travel periods. Posted speed limits on minor arterials would typically range between 25 and 55 mph, depending on the setting.

Collector Street System – The urban collector street network serves a joint purpose. It provides equal priority to the movement of traffic, and to the access of residential, business, and industrial areas. This type of roadway differs from those of the arterial system in that collector roadways may traverse residential neighborhoods. The collector system distributes trips from the arterials to ultimate destinations. The collector streets also collect traffic from local streets in the residential neighborhoods, channeling it into the arterial system. On-street parking is usually allowed on most collector streets if space is available. Posted speed limits on collectors typically range between 25 and 45 mph.

The rural collector street network serves the same access and movement functions as the urban collector street network – a link between the arterial system and local access roads. Collectors penetrate but should not have continuity through residential neighborhoods. The actual location of collectors should be flexible to best serve developing areas and the public. Several design guidelines should be kept in mind as new subdivisions are designed and reviewed. The most important concept is that long segments of continuous collector streets are not compatible with a good functional classification of streets. Long, continuous collectors will encourage through traffic, essentially turning them into arterials. This, in turn, results in the undesirable interface of local streets with arterials, causing safety problems and increased costs of construction and maintenance. The collector street system should intersect arterial streets at a uniform spacing of one-half to one-quarter mile in order to maintain good progression on the arterial network. Ideally, collectors should be no longer than one to two miles and should be continuous. Opportunities need to be identified through good design and review of subdivisions to create appropriate collector streets in developing areas.

Local Street System – The local street network comprises all facilities not included in the higher systems. Its primary purpose is to permit direct access to abutting lands and connections to higher systems. Usually service to through-traffic movements is intentionally discouraged. On-street parking is usually allowed on the local street system. The speed limit on local streets is usually 25 mph.



Note:

The functional classifications shown are recommended as part of the Transportation Plan and do not reflect the federally approved functional classification criteria which is based on current conditions rather than anticipated future conditions.

Legend

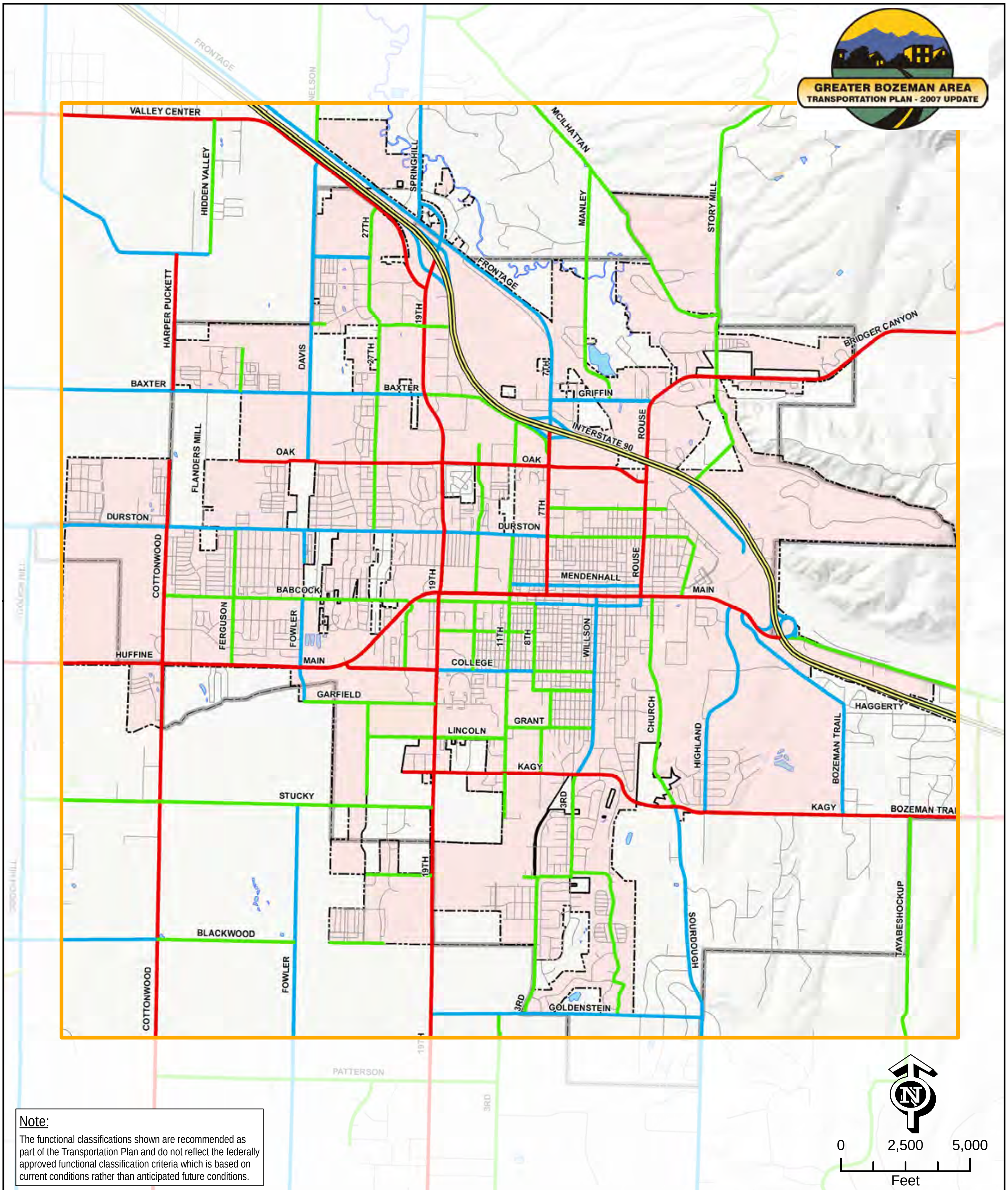
- Interstate
- Principal Arterial
- Minor Arterial
- Collector
- Local
- Study Area Boundary
- Detail Area
- City Boundary
- Urban Boundary

RPA

Greater Bozeman Area Transportation Plan (2007 Update)

Existing Functional Classification System

Figure 2-1



Note:

The functional classifications shown are recommended as part of the Transportation Plan and do not reflect the federally approved functional classification criteria which is based on current conditions rather than anticipated future conditions.

Legend

- Interstate
- Principal Arterial
- Minor Arterial
- Collector
- Local
- Detail Area
- City Boundary
- Urban Boundary

Greater Bozeman Area Transportation Plan (2007 Update)

Existing Functional Classification System

Figure 2-2

2.2.2 Existing Traffic Volumes and Corridor Facility Size

When evaluating a street system it is good practice to compare the traffic volumes to the approximate capacity of each road. Traffic volumes collected by the Montana Department of Transportation (MDT) were used to determine current traffic conditions, and to provide reliable data on historic traffic volumes.

Existing traffic volume data from 2005 was used to determine annual average daily traffic (AADT) volumes on major road segments within the community. This information is shown on **Figure 2-3** and **Figure 2-4**. These figures show that the most highly traveled corridors are Main Street, 19th Avenue, Huffine Lane and Jackrabbit Lane. Traffic volumes on these corridors range between 10,000 vehicles per day (vpd) and 25,000 vpd.

After identifying the current traffic volumes, the existing road network was examined to determine the current size of the major routes. This information is presented on the "Corridor Size" graphics on **Figure 2-5** and **Figure 2-6**. The information shows the following:

Existing five-lane corridors – Five-lane road corridors are generally defined as two travel lanes in each direction with a continuous center two-way turn lane or a raised median with left-turn bays at the major intersections. The five lane corridors found in the Greater Bozeman Area include:

- Huffine Lane (from Jackrabbit Lane to Main Street)
- Main Street (from Huffine Lane to 7th Avenue)
- Main Street (from Cypress Avenue to I-90)
- 19th Avenue (from Main Street to I-90)
- 7th Avenue (from Main Street to Griffin Drive)
- Valley Center Road (from 19th Street to 27th Avenue)
- Oak Street (from 7th Avenue to Davis Lane)
- Jackrabbit Lane (from Frank Road to W Madison Avenue)

Existing four-lane corridors – Four-lane road corridors have two travel lanes in each direction, with or without left-turn bays at major intersections. The four lane corridors found in the Greater Bozeman Area include:

- Main Street (from 7th Avenue to Cypress Avenue)

Existing three-lane corridors – Three-lane roads are one travel lane in each direction with a continuous center two-way turn lane, or any combination of three-lanes (i.e. two travel lanes in one direction with one lane in the opposite direction). The three lane corridors found in the Greater Bozeman Area include:

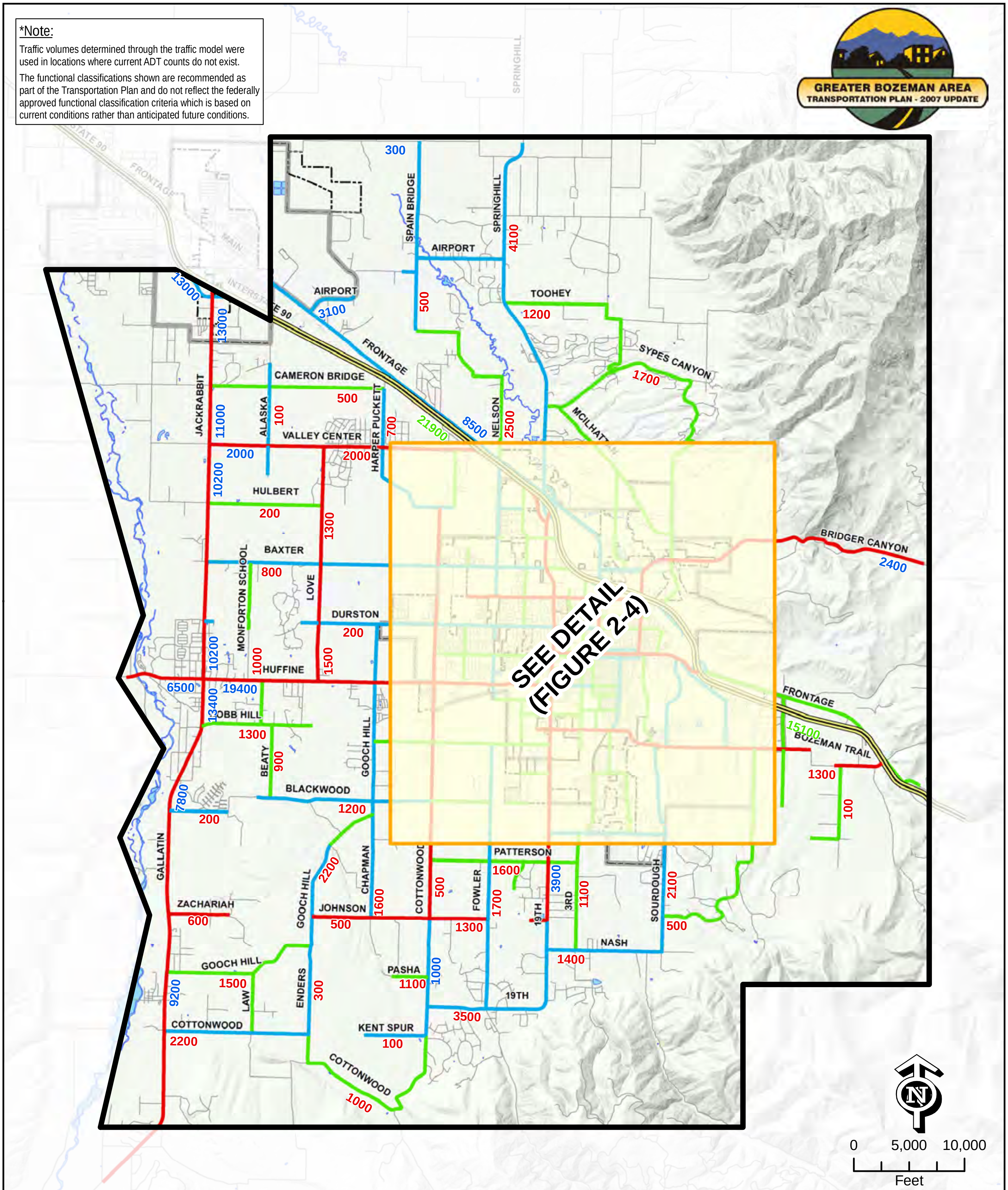
- 7th Avenue (from Flora Lane to Griffin Drive)
- Oak Street (from 7th Street to Wal-Mart entrance)
- Baxter Lane (East of 19th Avenue)
- Durston Road (from 7th Avenue to Fowler Road)

- Durston Road (from Ferguson Road to Flanders Mill Road)
- Babcock Street (from Main Street to Ferguson Road)
- 19th Avenue (from Main Street to Kagy Boulevard)
- Kagy Boulevard (from S Willson Avenue to Highland Boulevard)

Roadways not listed above are all two-lane corridors for the major street network with either two-way or one-way flow characteristics.

2.2.3 Existing Traffic Signal System

When analyzing the operation of an entire road network it is best to examine the existing signalized intersections. Forty-one (41) existing signalized intersections in the Greater Bozeman Area were evaluated as part of this *Transportation Plan 2007 Update.* Most of the signals are located along Main Street, 19th Avenue, 7th Avenue, or located in the downtown central business district (CBD). **Figure 2-7** and **Figure 2-8** shows all of the current signalized intersections and the coordinated signal system. It should be noted that the Montana Department of Transportation (MDT) is currently revising the signal timings for all of the signals located within the City of Bozeman. This effort is expected to be completed in the winter of 2007 and may change the current coordinated signal operations.



Legend

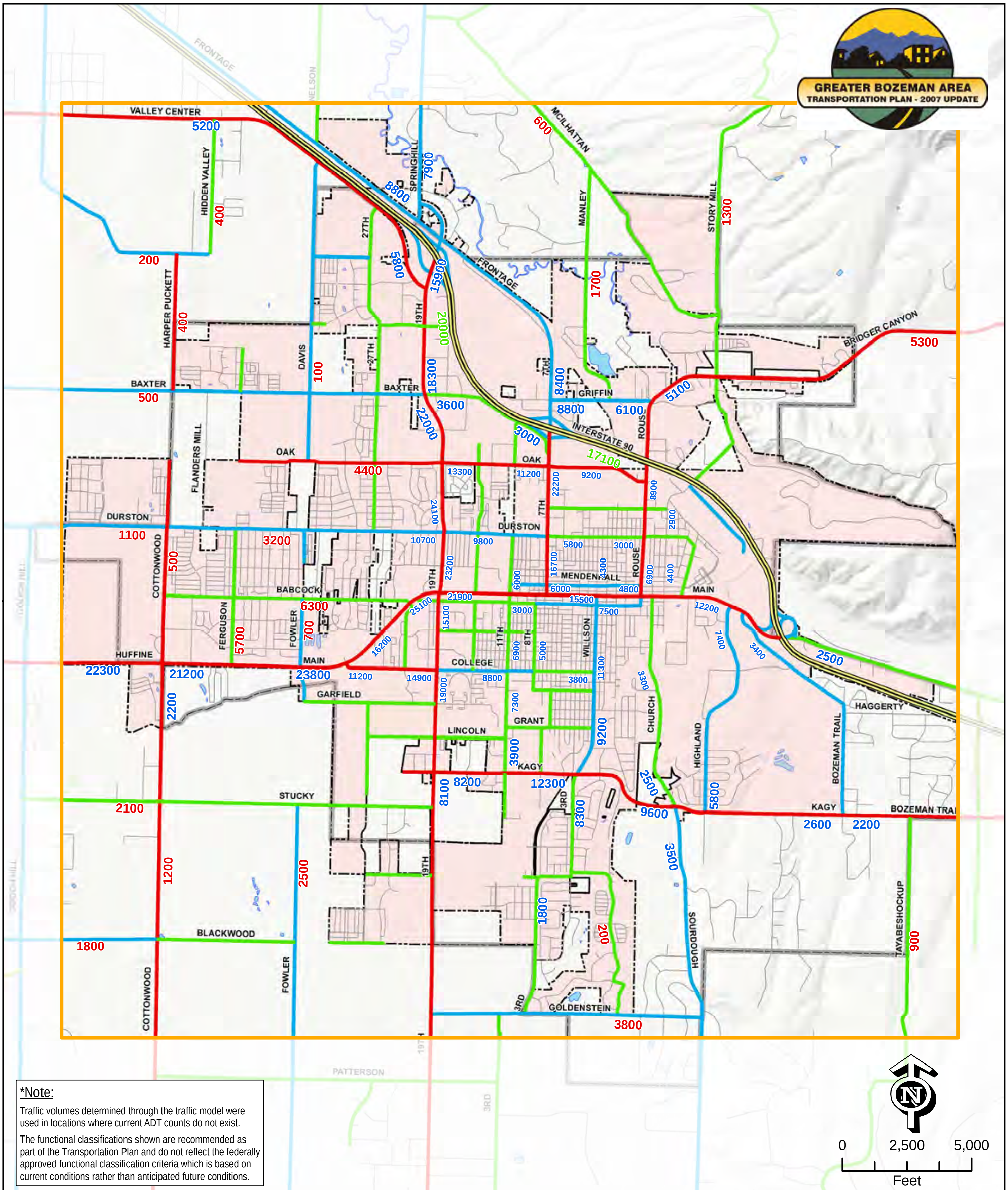
- Interstate
- Principal Arterial
- Minor Arterial
- Collector
- Local
- 1200 2005 Average Daily Traffic (ADT)
- 1200 2004 Average Daily Traffic (ADT)
- 1200 2005 Traffic Model Volume*
- Study Area Boundary
- Detail Area
- City Boundary
- Urban Boundary

RPA

Greater Bozeman Area Transportation Plan (2007 Update)

Existing (2005) ADT Traffic Volumes

Figure 2-3



Note:

Traffic volumes determined through the traffic model were used in locations where current ADT counts do not exist.

The functional classifications shown are recommended as part of the Transportation Plan and do not reflect the federally approved functional classification criteria which is based on current conditions rather than anticipated future conditions.

Legend

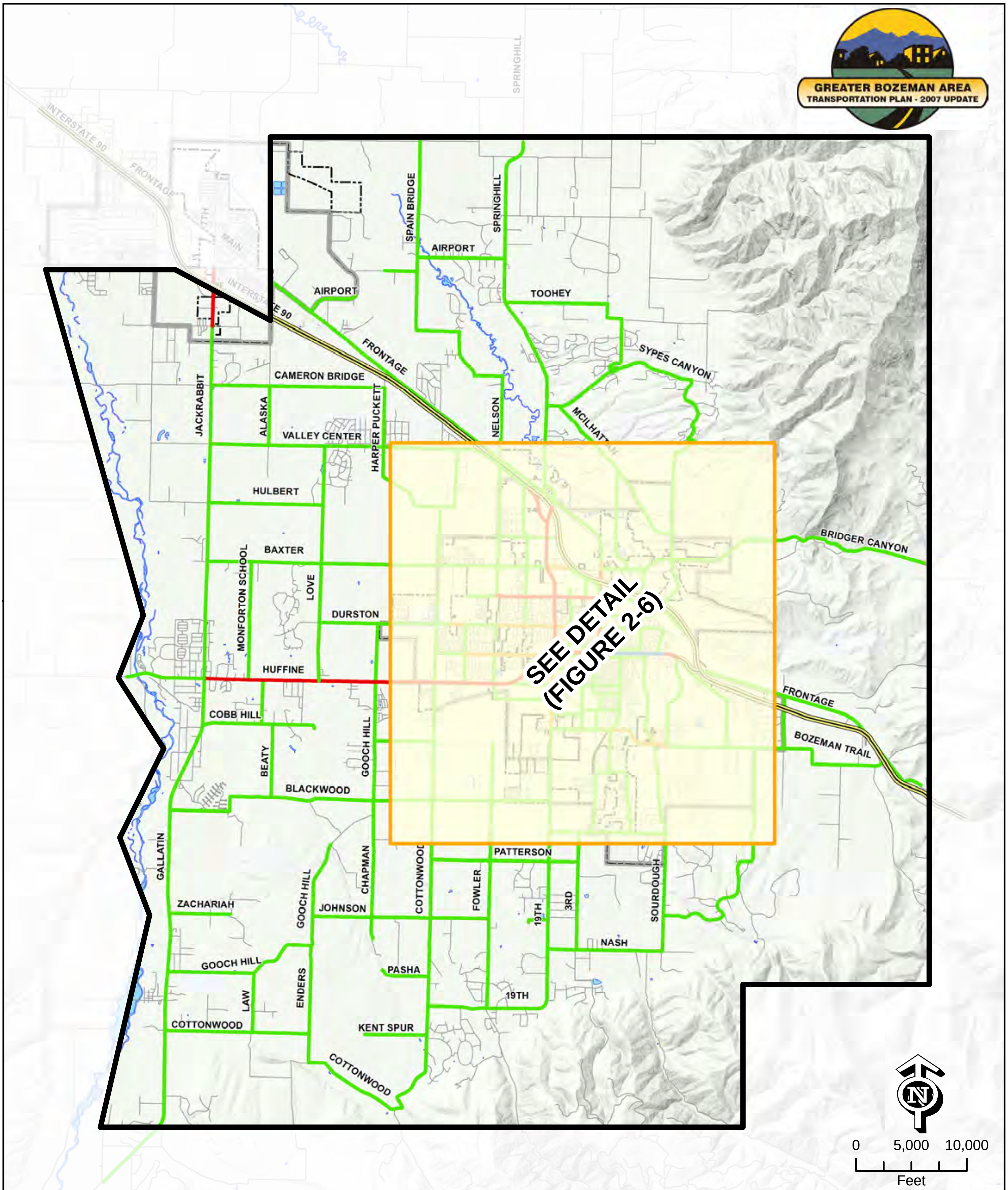
	Interstate		Detail Area
	Principal Arterial		City Boundary
	Minor Arterial		Urban Boundary
	Collector	1200	2005 Average Daily Traffic (ADT)
		1200	2004 Average Daily Traffic (ADT)
	Local	1200	2005 Traffic Model Volume*

RPA

Greater Bozeman Area Transportation Plan (2007 Update)

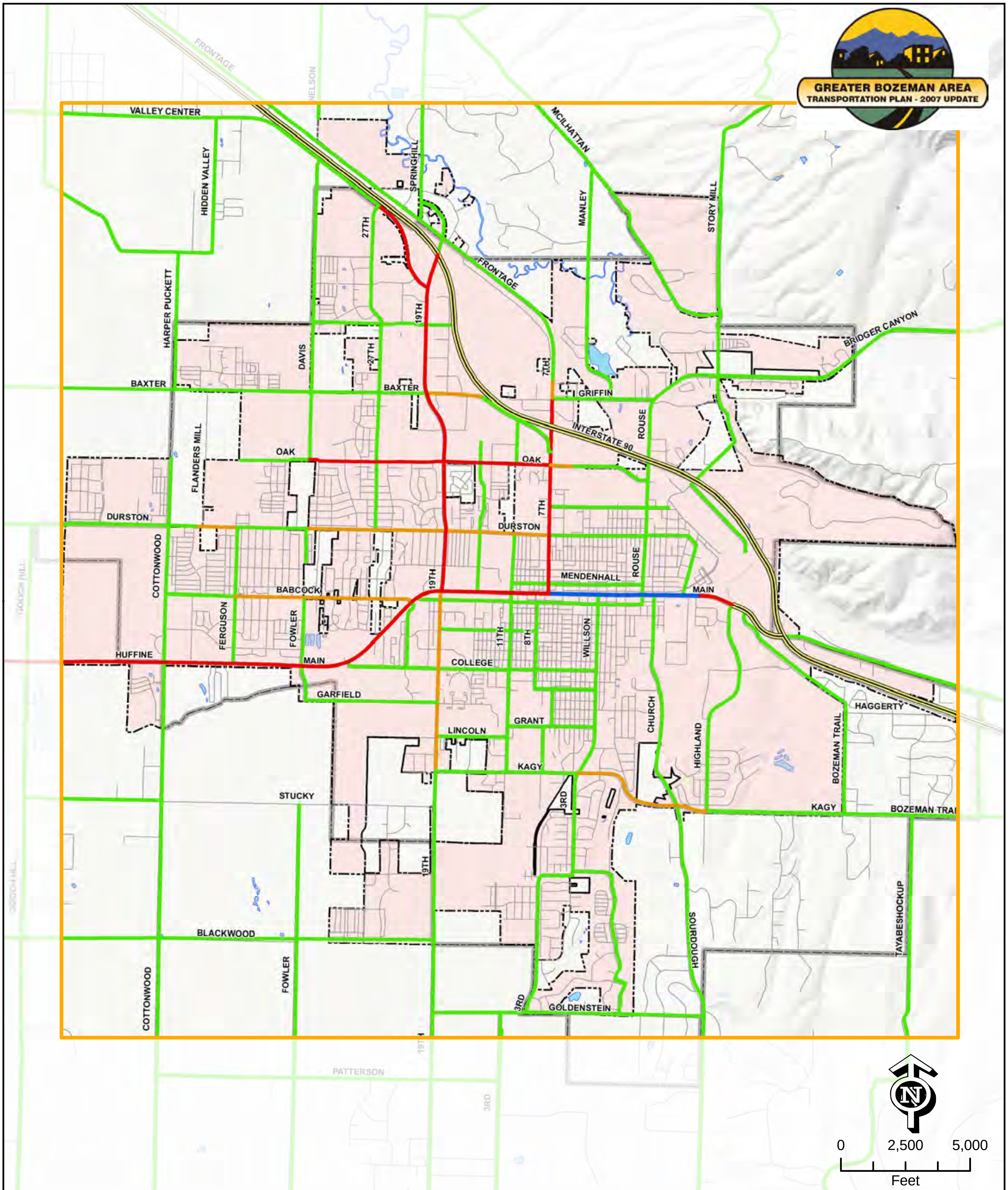
Existing (2005) ADT Traffic Volumes

Figure 2-4



Greater Bozeman Area Transportation Plan (2007 Update)

Existing Corridor Size
Figure 2-5



Legend

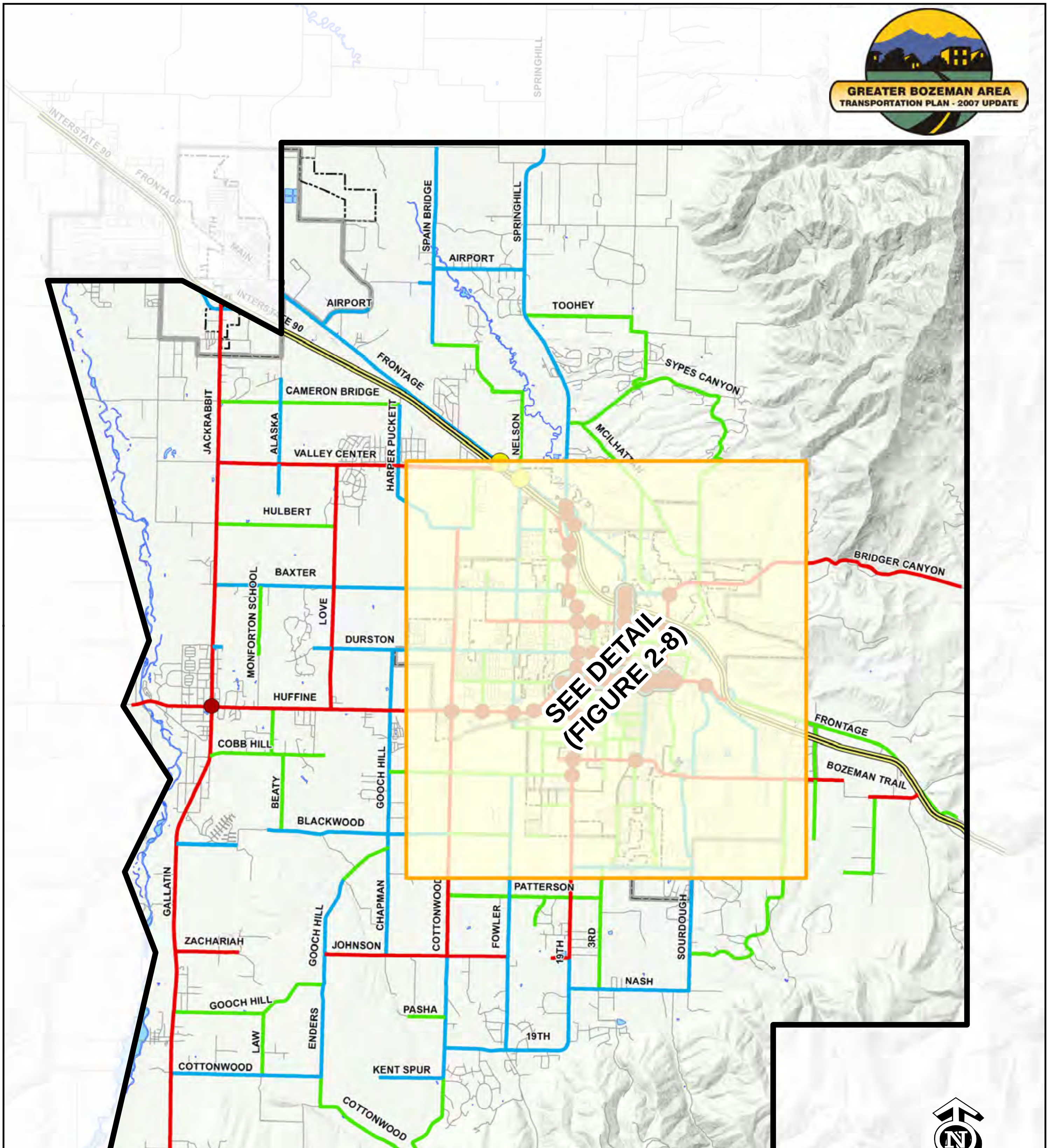
Corridor Size
- 2-Lane
- 3-Lane
- 4-Lane
- 5-Lane
- Interstate

- Detail Area
- City Boundary
- Urban Boundary

RPA

Greater Bozeman Area Transportation Plan (2007 Update)

Existing Corridor Size
Figure 2-6



Note:
The functional classifications shown are recommended as part of the Transportation Plan and do not reflect the federally approved functional classification criteria which is based on current conditions rather than anticipated future conditions.

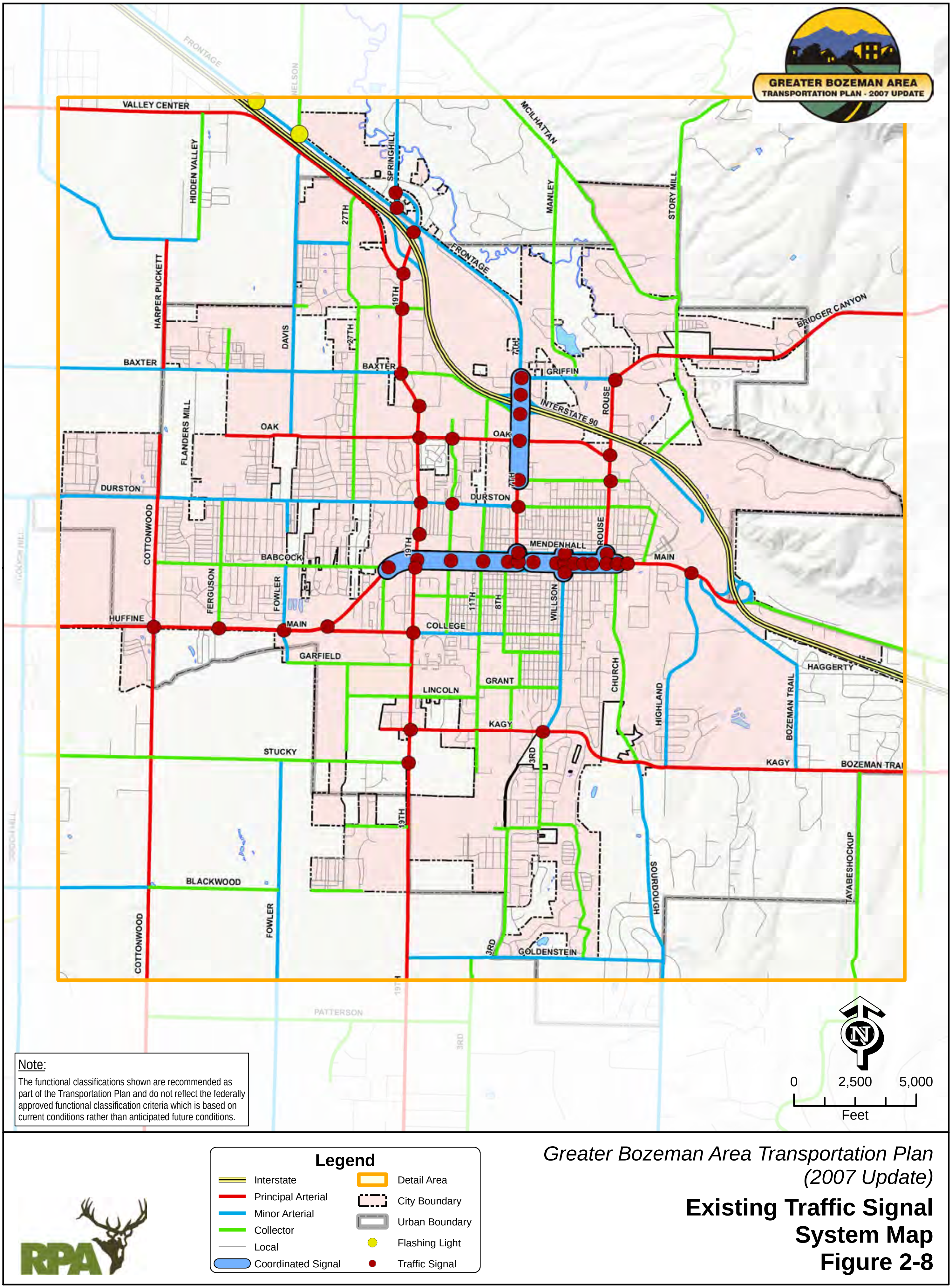
Legend

Interstate	Study Area Boundary
Principal Arterial	Detail Area
Minor Arterial	City Boundary
Collector	Urban Boundary
Local	Flashing Light
Coordinated Signal	Traffic Signal

RPA

Greater Bozeman Area Transportation Plan (2007 Update)

Existing Traffic Signal System Map
Figure 2-7



Note:
The functional classifications shown are recommended as part of the Transportation Plan and do not reflect the federally approved functional classification criteria which is based on current conditions rather than anticipated future conditions.

Greater Bozeman Area Transportation Plan (2007 Update)

Existing Traffic Signal System Map
Figure 2-8

2.2.4 Existing Levels of Service

Urban road systems are ultimately controlled by the function of the major intersections. Intersection failure directly reduces the number of vehicles that can be accommodated during the peak hours that have the highest demand and the total daily capacity of a corridor. As a result of this strong impact on corridor function, intersection improvements can be a very cost-effective means of increasing a corridor's traffic volume capacity. In some circumstances, corridor expansion projects may be able to be delayed with correct intersection improvements. Due to the significant portion of total expense for road construction projects used for project design, construction, mobilization, and adjacent area rehabilitation, a careful analysis must be made of the expected service life from intersection-only improvements. If adequate design life can be achieved with only improvements to the intersection, then a corridor expansion may not be the most efficient solution. With that in mind, it is important to determine how well the major intersections are functioning by determining their Level of Service (LOS).

LOS is a qualitative measure developed by the transportation profession to quantify driver perception for such elements as travel time, number of stops, total amount of stopped delay, and impediments caused by other vehicles. It provides a scale that is intended to match the perception by motorists of the operation of the intersection. LOS provides a means for identifying intersections that are experiencing operational difficulties, as well as providing a scale to compare intersections with each other. The LOS scale represents the full range of operating conditions. This scale is based on the ability of an intersection or street segment to accommodate the amount of traffic using it. The scale ranges from "A" which indicates little, if any, vehicle delay, to "F" which indicates significant vehicle delay and traffic congestion. The LOS analysis was conducted according to the procedures outlined in the Transportation Research Board's *Highway Capacity Manual – Special Report 209* using the Highway Capacity Software, version 4.1f.

In order to calculate the LOS, 74 intersections on the major street network were counted during the summer/fall of 2007. These intersections included 41 signalized intersections and 33 high-volume unsignalized intersections in the Greater Bozeman area (noting that eight signalized intersections could not be counted due to construction activities and that two intersections that were counted while unsignalized were recently signalized). Each intersection was counted between 7:00 a.m. to 9:00 a.m. and 4:00 p.m. to 6:00 p.m., to ensure that the intersection's peak volumes were represented. Based upon this data, the operational characteristics of each intersection were obtained.

2.2.4.1 Signalized Intersections

For signalized intersections, recent research has determined that average control delay per vehicle is the best available measure of level of service. Control delay takes into account uniform delay, incremental delay, and initial queue delay. The amount of control delay that a vehicle experiences is approximately equal to the time elapsed from when a vehicle joins a queue at the intersection (or arrives at the stop line when there is no queue) until the vehicle departs from the stopped position at the head of the queue. The control delay is primarily a function of volume, capacity, cycle length, green ratio, and the pattern of vehicle arrivals.

The following table identifies the relationship between LOS and average control delay per vehicle. The procedures used to evaluate signalized intersections use detailed information on geometry, lane use, signal timing, peak hour volumes, arrival types and other parameters. This information is then used to calculate delays and determine the capacity of each intersection. Generally, an intersection is determined to be functioning adequately if operating at LOS C or better. However, for the City of Bozeman, an intersection operating at a LOS D or better is considered to be functioning adequately. **Table 2-1** shows the LOS by control delay for signalized intersections.

Table 2-1
Level of Service Criteria (Signalized Intersections)

Level of Service	Control Delay per Vehicle (sec)
A	< 10
B	10 to 20
C	20 to 35
D	35 to 50
E	50 to 80
F	> 80

Source: The Transportation Research Board's *Highway Capacity Manual*

Using these techniques and the data collected in the summer/fall of 2007, the LOS for the signalized intersections was calculated. **Tables 2-2** & **2-3** show the AM and PM peak hour LOS for each individual leg of the intersections, as well as the intersections as a whole. The intersection LOS is shown graphically in **Figure 2-9** and **Figure 2-10**.

It should be noted that the LOS shown in the following tables for the intersections along Rouse Avenue may not be identical to those shown in the recently published *Rouse Avenue Environmental Assessment*. Variations to the LOS at these intersections may be the result of variations in the peak hour factor, type of analysis software, the amount of truck traffic observed, construction activities in the area, or the time of year and day of the week that the intersection traffic counts were made.

Table 2-2
2007 AM Peak Hour LOS (Signalized Intersections)

INTERSECTION	EB	WB	NB	SB	INT	INTERSECTION	EB	WB	NB	SB	INT
Huffine Lane & Ferguson Road[1]	F	B	-	C	E	North 19th Avenue & Beall Street[2]	D	C	A	A	B
Huffine Lane & Cottonwood Road[2]	B	A	D	D	B	North 19th Avenue & Durston Road[1]	B	B	C	C	B
Huffine Lane & Jackrabbit Lane	C	B	C	C	C	North 19th Avenue & Oak Street[1]	E	C	B	B	C
Huffine Lane & Fowler Lane[2]	B	B	C	D	B	North 19th Avenue & Baxter Lane[2]	C	C	B	B	B
Main Street & West College Street[1]	C	C	D	B	C	North 19th Avenue & Valley Center Road[2]	B	B	A	B	B
Main Street & West Babcock Street[1]	C	C	C	C	C	Springhill Road & Frontage Road[2]	A	A	-	C	B
Main Street & South 19th Avenue[1]	C	C	D	E	D	North 7th Avenue & Griffin Drive[2]	B	C	A	A	A
Main Street & North 15th Avenue[1]	B	C	C	C	B	North 7th Avenue & I-90 Interchange Ramp (north)[1]	-	C	B	C	B
Main Street & 11th Avenue[1]	D	C	C	C	C	North 7th Avenue & I-90 Interchange Ramp (south)[1]	B	-	C	B	C
Main Street & South 8th Avenue[1]	B	A	D	-	B	North 7th Avenue & Oak Street[1]	D	D	C	C	C
Main Street & North 7th Avenue[1]	B	C	C	C	C	North 7th Avenue & Tamarack Street[1]	-	C	C	B	B
Main Street & 5th Avenue[1]	A	A	B	B	A	North 7th Avenue & Durston Road[1]	D	D	C	D	D
Main Street & Rouse Avenue	B	B	B	B	B	North Rouse Avenue & Tamarack Street[1]	B	B	B	B	B
Main Street & Wallace Avenue	B	B	B	B	B	North 19th Avenue & Deadman's Gulch[2]	D	D	A	A	B
Main Street & Highland Boulevard	C	C	D	C	C	North 19th Avenue & Tschache Lane[2]	D	D	A	A	A
Mendenhall Street & North 7th Avenue[1]	-	C	B	B	B	North 19th Avenue & Springhill Road[2]	-	C	A	A	A
Mendenhall Street & North Willson Avenue[1]	-	A	C	B	B	North 19th Avenue & I-90 Interchange (north)[2]	-	D	A	A	A
Babcock Street & South Willson Avenue[1]	A	-	B	B	B	North 19th Avenue & Babcock Street[2]	C	C	A	A	A
Kagy Boulevard & South Willson Avenue	C	E	D	C	D	North 19th Avenue & Stucky Road[2]	C	-	A	A	A
Kagy Boulevard & South 19th Avenue[2]	C	B	B	C	B	Durston Road & 15th Avenue[2]	B	A	C	B	B
West College Street & South 19th Avenue[1]	D	D	F	F	E						

(Abbreviations used in the table are as follows: EB = eastbound; WB = westbound; NB = northbound; SB = southbound; INT = intersection as a whole)

[1] Signal timing and phasing from the Greater Bozeman Area Transportation Plan – 2001 Update.

[2] Signal timing and phasing optimized under pretimed conditions.

Table 2-3
2007 PM Peak Hour LOS (Signalized Intersections)

INTERSECTION	EB	WB	NB	SB	INT	INTERSECTION	EB	WB	NB	SB	INT
Huffine Lane & Ferguson Road[1]	F	B	-	C	E	North 19th Avenue & Beall Street[2]	D	C	A	A	B
Huffine Lane & Cottonwood Road[2]	B	B	C	D	B	North 19th Avenue & Durston Road[1]	B	B	D	C	C
Huffine Lane & Jackrabbit Lane	C	D	D	C	C	North 19th Avenue & Oak Street[1]	E	C	C	C	C
Huffine Lane & Fowler Lane[2]	B	B	D	C	B	North 19th Avenue & Baxter Lane[2]	C	C	C	B	C
Main Street & West College Street[1]	C	C	C	B	C	North 19th Avenue & Valley Center Road[2]	C	B	A	B	B
Main Street & West Babcock Street[1]	D	F	C	C	D	Springhill Road & Frontage Road[2]	A	A	-	C	B
Main Street & South 19th Avenue[1]	C	D	D	E	D	North 7th Avenue & Griffin Drive[2]	A	B	B	B	B
Main Street & North 15th Avenue[1]	B	C	C	D	C	North 7th Avenue & I-90 Interchange Ramp (north)[1]	-	C	B	B	B
Main Street & 11th Avenue[1]	C	C	C	C	C	North 7th Avenue & I-90 Interchange Ramp (south)[1]	C	-	C	B	C
Main Street & South 8th Avenue[1]	B	A	D	-	B	North 7th Avenue & Oak Street[1]	E	D	C	C	D
Main Street & North 7th Avenue[1]	F	D	C	C	E	North 7th Avenue & Tamarack Street[1]	-	C	C	B	C
Main Street & 5th Avenue[1]	A	A	B	B	A	North 7th Avenue & Durston Road[1]	D	D	D	D	D
Main Street & Rouse Avenue	B	B	B	B	B	North Rouse Avenue & Tamarack Street[1]	B	B	B	C	C
Main Street & Wallace Avenue	B	C	B	B	B	North 19th Avenue & Deadman's Gulch[2]	D	C	C	B	C
Main Street & Highland Boulevard	D	C	F	C	F	North 19th Avenue & Tschache Lane[2]	C	D	B	A	B
Mendenhall Street & North 7th Avenue[1]	-	D	B	B	C	North 19th Avenue & Springhill Road[2]	-	C	B	B	B
Mendenhall Street & North Willson Avenue[1]	-	A	C	B	B	North 19th Avenue & I-90 Interchange (north)[2]	-	D	C	B	C
Babcock Street & South Willson Avenue[1]	A	-	B	C	B	North 19th Avenue & Babcock Street[2]	C	C	A	A	B
Kagy Boulevard & South Willson Avenue	D	D	C	D	D	North 19th Avenue & Stucky Road[2]	B	-	A	A	B
Kagy Boulevard & South 19th Avenue[2]	B	C	B	B	B	Durston Road & 15th Avenue[2]	A	B	C	C	B
West College Street & South 19th Avenue[1]	D	F	F	E	F						

(Abbreviations used in the table are as follows: EB = eastbound; WB = westbound; NB = northbound; SB = southbound; INT = intersection as a whole)

[1] Signal timing and phasing from the Greater Bozeman Area Transportation Plan – 2001 Update.

[2] Signal timing and phasing optimized under pretimed conditions.

2.2.4.2 *Unsignalized Intersections*

Level of service for unsignalized intersections is based on the delay experienced by each movement within the intersection, rather than on the overall stopped delay per vehicle at the intersection. This difference from the method used for signalized intersections is necessary since the operating characteristics of a stop-controlled intersection are substantially different. Driver expectations and perceptions are also entirely different. For two-way stop controlled intersections, the through traffic on the major (uncontrolled) street experiences no delay at the intersection. Conversely, vehicles turning left from the minor street experience more delay than other movements and at times can experience significant delay. Vehicles on the minor street, which are turning right or going across the major street, experience less delay than those turning left from the same approach. Due to this situation, the LOS assigned to a two-way stop controlled intersection is based on the average delay for vehicles on the minor street approach.

Levels of service for all-way stop controlled intersections are also based on delay experienced by the vehicles at the intersection. Since there is no major street, the highest delay could be experienced by any of the approaching streets. Therefore, the level of service is based on the approach with the highest delay as shown in **Table 2-4**. This table shows the LOS criteria for both the all-way and two-way stop controlled intersections.

Table 2-4
Level of Service Criteria (Stop Controlled Intersections)

LEVEL OF SERVICE	DELAY (SEC/VEH)
A	< 10
B	10 to 15
C	15 to 25
D	25 to 35
E	35 to 50
F	> 50

Source: The Transportation Research Board's *Highway Capacity Manual*

Using the above guidelines, the data collected in the summer/fall of 2007, and calculation techniques for two-way stop controls and all-way stop controls, the LOS was calculated for 33 intersections. The results of these calculations are shown in **Table 2-5**. The intersection LOS is shown graphically in **Figure 2-9** and **Figure 2-10**.

Table 2-5

2007 LOS (Stop-Controlled Intersections)

INTERSECTION	AM	PM	INTERSECTION	AM	PM
Frontage Road & Nelson Road	C	C	Jackrabbit Lane & Valley Center Road	D	E
Frontage Road & Valley Center Underpass	C	E	Jackrabbit Lane & Hulbert Road	C	D
Highland Boulevard & Ellis Street	C	E	Jackrabbit Lane & Baxter Lane	C	D
Highland Boulevard & Kagy Boulevard	E	C	Jackrabbit Lane & Durston Road	C	D
East Main Street & Haggerty Lane	C	E	Jackrabbit Lane & Ramshorn Drive	D	C
Haggerty Lane & Bozeman Trail Road	A	A	Jackrabbit Lane & Forkhorn Trail	E	E
Kagy Boulevard & Bozeman Trail Road	B	B	Jackrabbit Lane & Shedhorn Trail	C	E
Kagy Boulevard & Sourdough Road	F	F	Jackrabbit Lane & Spanish Peak Drive	C	C
Main Street & I-90 Off-Ramp	C	B	Huffine Lane & Monforton School Road	B	C
Main Street & I-90 On-Ramp	B	B	Huffine Lane & Love Lane	C	C
Story Mill Road & Bridger Canyon Drive	B	C	Huffine Lane & Gooch Hill Road	B	C
North Rouse Avenue & Peach Street	C	C	Valley Center Road & Harper Puckett Road	B	B
South 11th Avenue & College Street	D	F	8th Avenue & College Street	C	D
College Street & Willson Avenue	E	F	U.S. 191 & Gooch Hill Road	B	C
South 11th Avenue & Kagy Boulevard	D	F	U.S. 191 & Mill Street	C	C
South 19th Avenue & Goldenstein Road	B	B	U.S. 191 & Cottonwood Road	B	C
Jackrabbit Lane & Cameron Bridge Road	D	F			

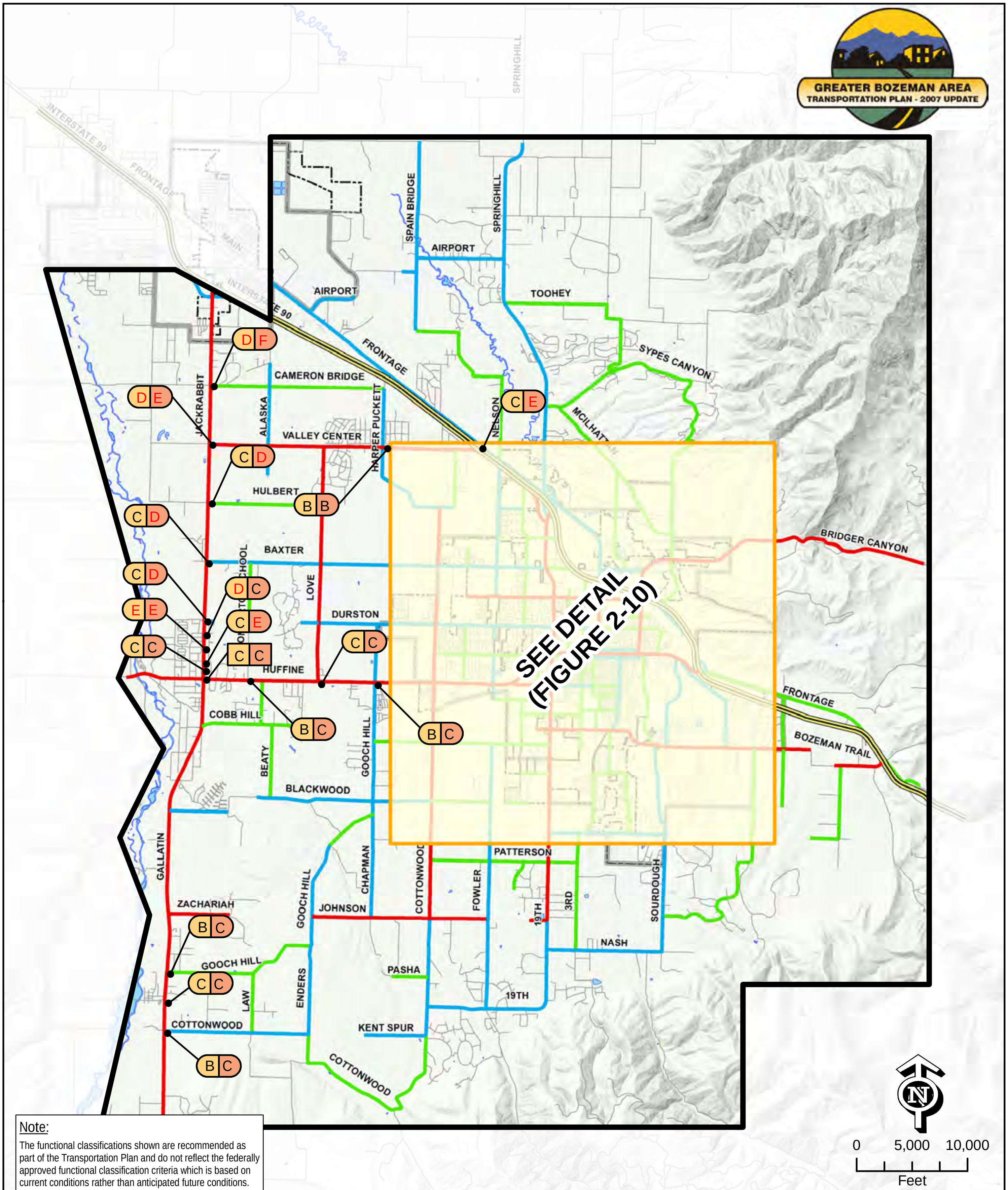
The LOS analyses of the existing conditions in the Greater Bozeman Area reveals that several signalized and unsignalized intersections are currently functioning at LOS D or lower. These intersections are shown in **Table 2-6** and are ideal candidates for closer examination and potential intersection improvements measures. Refer to **Table 4-3** in **Chapter 4** for a detailed performance level turning movement breakout for each unsignalized intersection.

Table 2-6
Existing Intersections Functioning at LOS D or Lower

INTERSECTION		AM PEAK	PM PEAK
8tth Avenue & College Street	U	C	D
College Street & Willson Avenue	U	E	F
East Main Street & Haggerty Lane	U	C	E
Frontage Road & Valley Center Underpass	U	C	E
Highland Boulevard & Ellis Street	U	C	E
Highland Boulevard & Kagy Boulevard	U	E	C
Huffine Lane & Ferguson Road	S	E	E
Jackrabbit Lane & Cameron Bridge Road	U	D	F
Jackrabbit Lane & Valley Center Road	U	D	E
Jackrabbit Lane & Hulbert Road	U	C	D
Jackrabbit Lane & Baxter Lane	U	C	D
Jackrabbit Lane & Durston Road	U	C	D
Jackrabbit Lane & Ramshorn Drive	U	D	C
Jackrabbit Lane & Forkhorn Trail	U	E	E
Jackrabbit Lane & Shedhorn Trail	U	C	E
Kagy Boulevard & South Willson Avenue	S	D	D
Kagy Boulevard & Sourdough Road	U	F	F
Main Street & 7th Avenue	S	C	E
Main Street & Babcock Street	S	C	D
Main Street & Haggerty Lane	U	C	E
Main Street & Highland Boulevard	S	C	F
Main Street & South 19th Avenue	S	D	D
North 7th Avenue & Durston Road	S	D	D
North 7th Avenue & Oak Street	S	C	D
South 11th Avenue & College Street	U	D	F
South 11th Avenue & Kagy Boulevard	U	D	F
West College Street & South 19th Avenue	S	E	F

(S)ignalized

(U)nsignalized



Legend

- Interstate
- Principal Arterial
- Minor Arterial
- Collector
- Local
- Study Area Boundary
- Detail Area
- City Boundary
- Urban Boundary

Signalized Intersection
A.M. A A P.M.

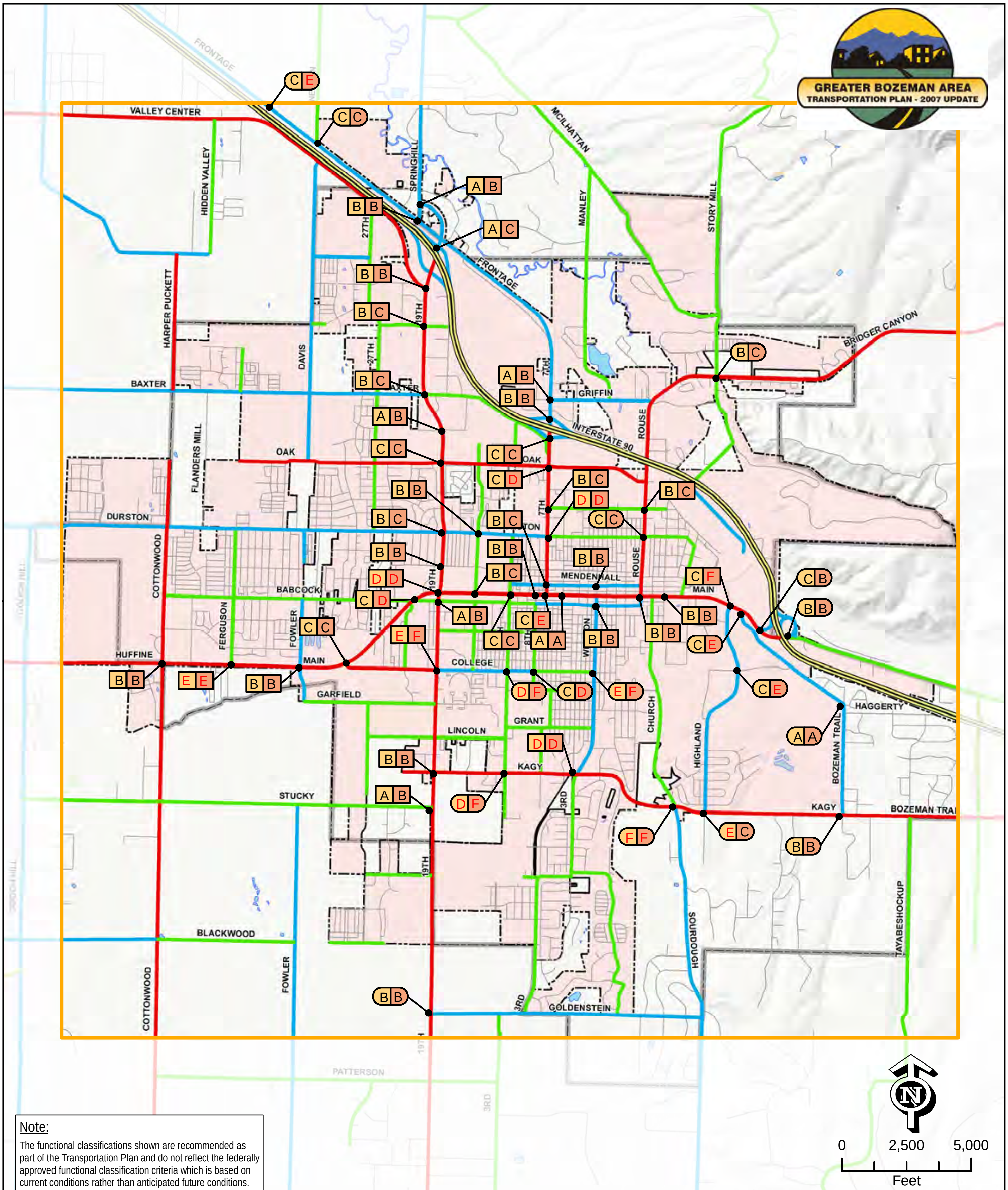
Unsignalized Intersection
A.M. C F P.M.

A, B, C, D, E, F = Level of Service

RPA

Greater Bozeman Area Transportation Plan (2007 Update)

Existing (2005) LOS
Level of Service
Figure 2-9



<u>Note:</u>

The functional classifications shown are recommended as part of the Transportation Plan and do not reflect the federally approved functional classification criteria which is based on current conditions rather than anticipated future conditions.

Legend

- Interstate
- Principal Arterial
- Minor Arterial
- Collector
- Local
- Detail Area
- City Boundary
- Urban Boundary

Signalized Intersection
A.M. A A P.M.
Unsignalized Intersection
A.M. C F P.M.
A, B, C, D, E, F = Level of Service

Greater Bozeman Area Transportation Plan (2007 Update)

Existing (2005) LOS Level of Service

Figure 2-10

2.2.5 Crash Analysis

The MDT Traffic and Safety Bureau provided crash information and data for use in the *Greater Bozeman Area Transportation Plan – 2007 Update*. The crash information was analyzed to identify intersections with crash characteristics that may warrant further study. General crash characteristics were determined along with probable roadway deficiencies and solutions. The crash information covers the three-year time period from January 1st, 2004 to December 31st, 2006.

Three analyses were performed to rank the intersections based on different crash characteristics. First, the intersections were ranked by number of crashes. For this analysis, intersections with 12 or more crashes in the three-year period were included. If an intersection did not have 12 crashes in the three-year period the data was available, it was not included at all in this analysis. A summary of these intersections, along with the number of crashes at each intersection, is shown in **Table 2-7**.

The second analysis involved a more detailed look at the crashes to determine the MDT "severity index rating". Crashes were broken into three categories of severity: property damage only (PDO), non-incapacitating injury crash, and fatality or incapacitating injury. Each of these three types is given a different rating: one (1) for a property damage only crash; three (3) for an injury crash; and eight (8) for a crash that resulted in a fatality.

The MDT severity index rating for the intersections in the analysis is shown in **Table 2-8**. The calculation used to arrive at the severity index rating is as follows:

$$\frac{[(\#\ PDO) \times (1)] + [(\#\ Non\text{-}Incapacitating\ Crashes) \times (3)] + [(\#\ Fatalities\ or\ Incapacitating\ Crashes) \times (8)]}{Total\ Number\ of\ Crashes\ in\ a\ Three\text{-}Year\ Period} = \mathbf{(MDT\ Severity\ Index\ Rating)}$$

The third analysis ranked the number of crashes against the annual average daily traffic (AADT) at each intersection, expressed in crashes per million entering vehicles (MEV). A summary of the intersections in the analysis is shown in **Table 2-9**. The calculation used to arrive at the crash rates, expressed in crashes per million entering vehicles (MEV), as shown in **Table 2-9**, is as follows:

$$\frac{Total\ Number\ of\ Crashes\ in\ a\ Three\text{-}Year\ Period}{(AADT\ for\ Intersection) \times (3\ years) \times (365\ days/year) / (1{,}000{,}000\ vehicles)} = \mathbf{(Crash\ Rate)}$$

Table 2-7
Intersections with 12 or More Crashes in the Three-Year Period (January 1, 2004-December 31, 2006)

INTERSECTION		# CRASHES
Intersections with 42 - 47 crashes		
I-90 & 7th Avenue*	S	43
Huffine Lane & Jackrabbit Lane	S	42
Intersections with 30 - 35 crashes		
Main Street & 19th Avenue	S	34
Intersections with 24 - 29 crashes		
7th Avenue & Oak Street	S	28
19th Avenue & Oak Street	S	27
19th Avenue & College Street	S	25
Intersections with 18 – 23 crashes		
Main Street & 7th Avenue	S	23
Main Street & 11th Avenue	S	23
I-90 & 19th Avenue*	S	19
19th Avenue & Baxter Lane	S	18
Intersections with 12 - 17 crashes		
Main Street & Babcock Street	S	17
Main Street & College Street	S	17
7th Avenue & Koch Street*	U-2W	16
19th Avenue & Durston Road	S	16
Huffine Lane & Shedhorn Lane*	U-2W	16
Huffine Lane & Ferguson	S	15
Jackrabbit Lane & Valley Center Road	U-2W	15
Main Street & 15th Avenue	S	15
19th Avenue & Tschache Lane	S	14
19th Avenue & Valley Center Road	S	14
Huffine Lane & Fowler Avenue	S	13
Main Street & 3rd Avenue*	S	13
Main Street & 5th Avenue	S	13
Willson Avenue & Babcock Street	S	13

* Intersections not identified in the Greater Bozeman Area Transportation Plan – 2007 Update
** "S" = Signalized intersection, "U-2W" = Unsignalized two-way stop controlled, "U-3W" = Unsignalized three-way stop controlled, "U-4W" = Unsignalized four-way stop controlled.

Note that there are some intersections listed in **Table 2-7** that are not specifically being studied as part of the *Greater Bozeman Area Transportation Plan – 2007 Update*. The intersections at I-90 & 7th Avenue and I-90 & 19th Avenue included above are the on and off-ramps on Interstate 90 and were not studied as part of this *Plan* due to budget limitations as defined in the project scoping plans.

Table 2-8
Intersection Crash Analysis - MDT Severity Index Rating

Intersection		PDO	Injury	Fatality/ Incapacitating Injury	Severity Index
Intersections with 2.75 – 2.50 Severity Index					
Jackrabbit Lane & Valley Center Road	U-2w	8	5	2	2.6
Intersections with 2.49 – 2.25 Severity Index					
Huffine Lane & Ferguson	S	8	6	1	2.27
Intersections with 1.99 – 1.75 Severity Index					
Main Street & 15th Avenue	S	11	3	1	1.87
19th Avenue & Baxter Lane	S	13	4	1	1.83
19th Avenue & Durston Road	S	12	3	1	1.81
Huffine Lane & Fowler Road	S	8	5	0	1.77
Intersections with 1.74 – 1.50 Severity Index					
Main Street & 7th Avenue	U-2W	15	8	0	1.7
19th Avenue & Oak Street	S	18	9	0	1.67
19th Avenue & College Street	S	17	8	0	1.64
7th Avenue & Oak Street	S	23	4	1	1.54
Main Street & 19th Avenue	S	25	9	0	1.53
Intersections with 1.49 – 1.25 Severity Index					
Main Street & Babcock Street	S	13	4	0	1.47
Main Street & 11th Avenue	S	18	5	0	1.43
19th Avenue & Tschache Lane	S	11	3	0	1.43
19th Avenue & Valley Center Road	S	11	3	0	1.43
Huffine Lane & Jackrabbit Lane	S	36	5	1	1.4
Main Street & 5th Avenue	S	11	2	0	1.31
Intersections with 1.24 – 1.00 Severity Index					
Willson Avenue & Babcock Street	S	12	1	0	1.15
Main Street & College Street	S	16	1	0	1.12

** "S" = Signalized intersection, "U-2W" = Unsignalized two-way stop controlled, "U-3W" = Unsignalized three-way stop controlled, "U-4W" = Unsignalized four-way stop controlled.

Table 2-9
Intersection Crash Analysis Crash Rate

Intersection		Number of Crashes	Volume	Rate
Intersections with 2.0 – 1.50 Crash Rate				
Huffine Lane & Jackrabbit Lane	S	42	21,124	1.82
Intersections with 1.49 – 1.0 Crash Rate				
19th Avenue & College Street	S	25	18,488	1.23
Jackrabbit Lane & Valley Center Road	U-2W	15	12,256	1.12
7th Avenue & Oak Street	S	28	24,281	1.05
19th Avenue & Oak Street	S	27	24,545	1
Intersections with 0.99 – 0.50 Crash Rate				
Main Street & 7th Avenue	S	23	21,306*	0.99
Main Street & 15th Avenue	S	15	14,231	0.96
Main Street & 19th Avenue	S	34	33,347	0.93
Willson Avenue & Babcock Street	S	13	13,818*	0.86
Main Street & College Street	S	17	18,107	0.86
Main Street & 5th Avenue	S	13	14,124*	0.84
Main Street & 11th Avenue	S	23	26,331*	0.8
19th Avenue & Baxter Lane	S	18	21,322	0.77
19th Avenue & Valley Center Road	S	14	18,190	0.7
19th Avenue & Tschache Lane	S	14	19,107	0.67
19th Avenue & Durston	S	16	23,421	0.62
Main Street & Babcock Street	S	17	24,950*	0.62
Huffine Lane & Fowler Lane	S	13	19,083	0.62
Huffine Lane & Ferguson	S	15	22,264	0.62

*Volume determined using Greater Bozeman Area Transportation Plan 2001 turning movement counts

** "S" = Signalized intersection, "U-2W" = Unsignalized two-way stop controlled, "U-3W" = Unsignalized three-way stop controlled, "U-4W" = Unsignalized four-way stop controlled.

In order to give the intersections included in the crash analysis an even rating, a composite rating score was developed based on the three analyses presented above. This composite rating score has the following criteria: First, the intersection had to have a minimum crash rate of 1.0 crash per million entering vehicles (MEV). Second it had to have 12 or more crashes in the three years combined. Third, it had to rate in the top 10 of one of the three previous categories. Using these criteria, the intersections were then rated based on their position on each of the three previous tables, giving each equal weight. For example, the intersection of Huffine Lane and Jackrabbit Lane was given a ranking of 2 for its position in **Table 2-7**, another ranking of 16 for its position in **Table 2-8**, and a ranking of 1 for its location in **Table 2-9**. Thus its composite rating is 19. Refer to **Table 2-10** for the composite rating of each intersection.

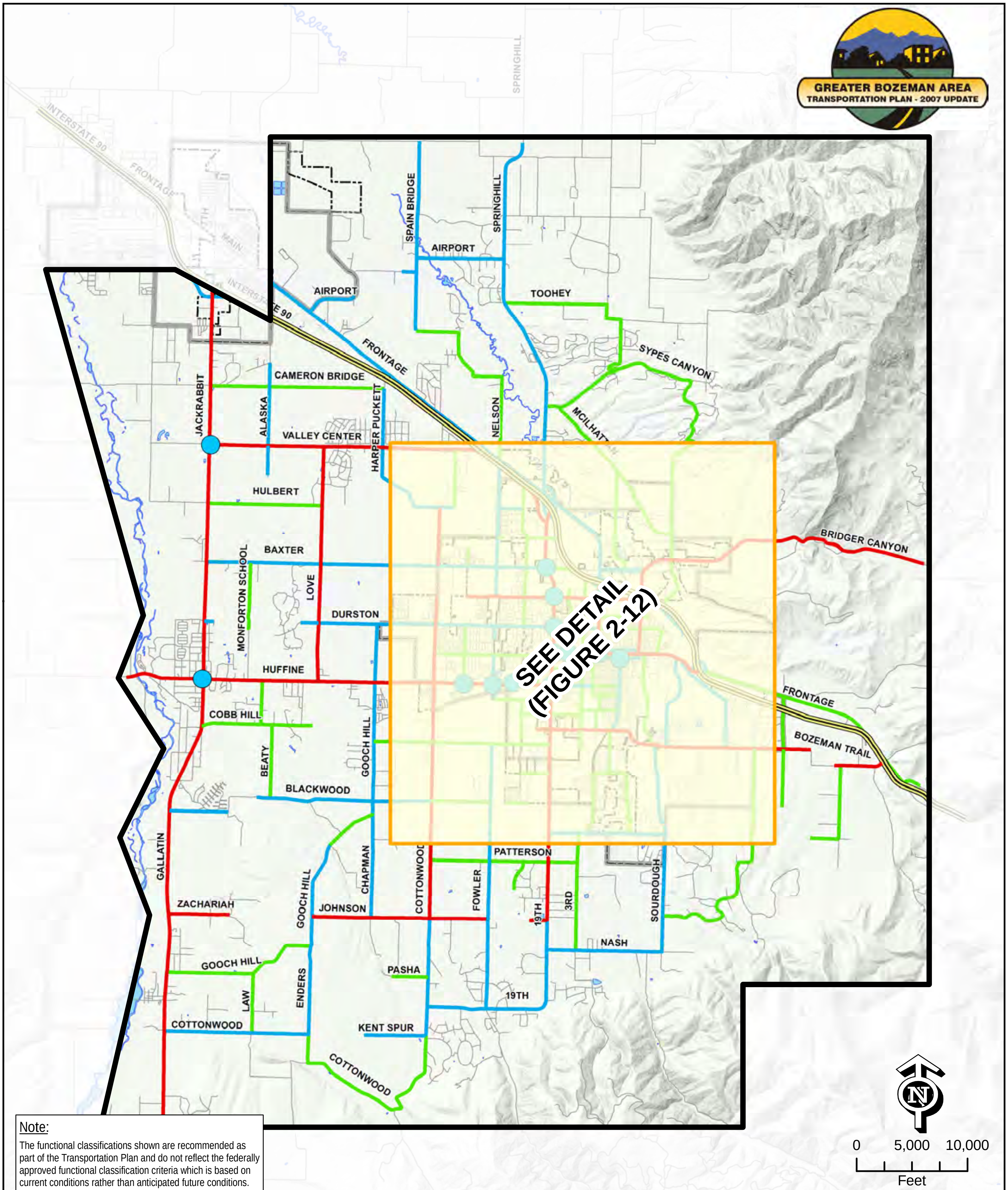
Table 2-10
Intersection Crash Analysis Composite Rating

Intersection	Crash no.	Severity No.	Rate No.	Composite Rating
Jackrabbit Lane & Valley Center Road	12	1	3	16
19th Avenue & College Street	5	9	2	16
19th Avenue & Oak Street	4	8	5	17
7th Avenue & Oak Street	3	10	4	17
Huffine Lane & Jackrabbit Lane	1	16	1	18
Main Street & 7th Avenue	7	7	6	20
Main Street & 19th Avenue	2	11	8	21
Main Street & 15th Avenue	14	3	7	24
19th Avenue & Baxter Lane	8	4	13	25
Main Street & 11th Avenue	6	13	12	31
19th Avenue & Durston Road	11	5	16	32
Huffine Lane & Ferguson	13	2	19	34
Main Street & College Street	9	19	10	38
Main Street & Babcock Street	10	12	17	39
Huffine Lane & Fowler	18	6	18	42
19th Avenue & Tschache Lane	15	14	15	44
Willson Avenue & Babcock Street	17	18	9	44
19th Avenue & Valley Center Road	16	15	14	45
Main Street & 5th Avenue	19	17	11	47

Intersections that were identified through the composite rating score method, as described previously, which warrant further study and may be in need of mitigation to specifically address crash trends are listed below. The locations of these intersections are shown on **Figure 2-11** and **Figure 2-12**. Note that the fourteen intersections listed below are in alphabetical order, and there is no significance to the order of their listing.

- 7th Avenue & Oak Street
- 19th Avenue & Baxter Lane
- 19th Avenue & College Street
- 19th Avenue & Durston Road
- 19th Avenue & Oak Street
- Huffine Lane & Ferguson Road
- Huffine Lane & Fowler Road
- Huffine Lane & Jackrabbit Lane
- Jackrabbit Lane & Valley Center Road
- Main Street & 7th Avenue
- Main Street & 15th Avenue
- Main Street & 19th Avenue
- Main Street & College Street
- Willson Avenue & Babcock Street

The identified intersections will be evaluated further to determine what type of mitigation measures may be possible to reduce specific crash trends (if any) and/or severity. These mitigation measures will be evaluated in the overall context of recommended improvements being evaluated via the *Greater Bozeman Area Transportation Plan – 2007 Update* development. It should be noted that several of the intersections have undergone significant reconstruction during the analysis period of January 1, 2004 to December 31, 2006 including the intersections of 7th Avenue & Oak Street, 19th Avenue & Baxter Lane, 19th Avenue & Durston Road, 19th Avenue & Oak Street, Huffine Lane & Ferguson Road, and Huffine Lane & Fowler Road that are listed earlier.



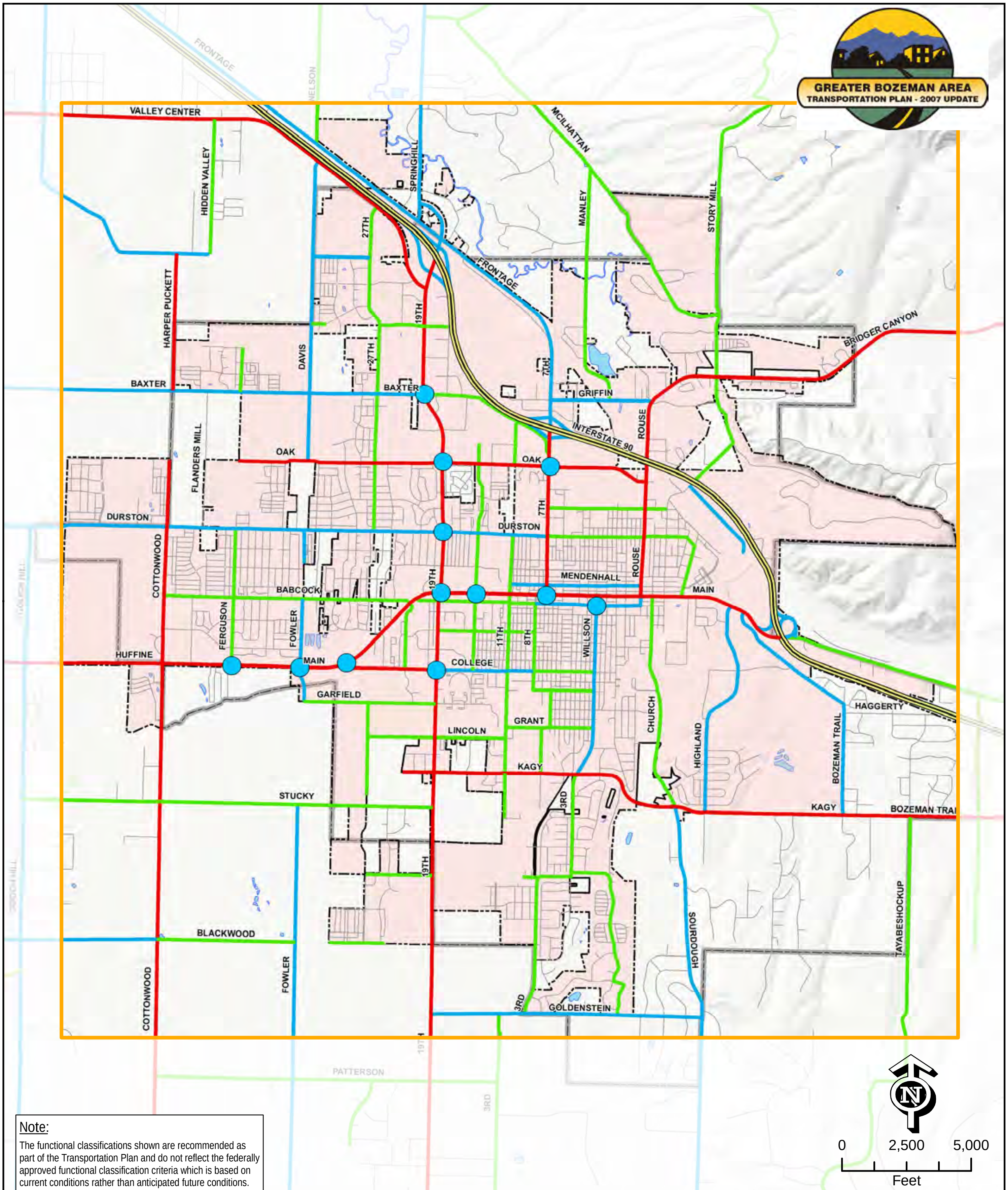
Note:
The functional classifications shown are recommended as part of the Transportation Plan and do not reflect the federally approved functional classification criteria which is based on current conditions rather than anticipated future conditions.

Legend

Interstate	Study Area Boundary
Principal Arterial	Detail Area
Minor Arterial	City Boundary
Collector	Urban Boundary
Local	Crash Location

Greater Bozeman Area Transportation Plan (2007 Update)

Crash Locations
Figure 2-11



Note:

The functional classifications shown are recommended as part of the Transportation Plan and do not reflect the federally approved functional classification criteria which is based on current conditions rather than anticipated future conditions.

Legend

- Interstate
- Principal Arterial
- Minor Arterial
- Collector
- Local
- Detail Area
- City Boundary
- Urban Boundary
- Crash Location

Greater Bozeman Area Transportation Plan (2007 Update)

Crash Locations
Figure 2-12

2.3 NON-MOTORIZED

2.3.1 Overview of Bozeman Demographics

The residents of the Bozeman area are by nature active and sturdy individuals who take year-round advantage of the area's natural beauty and nearly limitless outdoor recreational opportunities. Even on some of the coldest days in the winter the sidewalks will still be filled with pedestrians, and bicyclists can still be seen riding in the snow. Because the Bozeman area's relatively level topography and generally good weather, walking and bicycling play a significant role in the Bozeman area's transportation system and have sizable upward potential. This chapter of the Plan provides an analysis of the Bozeman area's existing conditions for pedestrian and bicycle policy, infrastructure, and programs. This analysis was performed using field work, information gathered though the public involvement process, and technical data provided by the City of Bozeman, Gallatin County and MDT.

Local data sources related to walking and bicycling within the study area are limited. Intersection counts done as part of the Transportation Plan to create a snapshot can be misleading, as many pedestrians and bicyclists prefer less-congested minor roads. The mood of Bozeman residents can perhaps be summarized by the 2007 National Citizen Survey commissioned by the City of Bozeman, which received 500 responses. Overall, residents seemed happy with the quality of life (83 percent) and amenities; however a serious concern about future growth and its potential to change quality of life was apparent. These concerns of residents included 82 percent feeling that the rate of growth in the area was "too fast" and that 48 percent listed concerns that the greatest challenge to the area was "growth, planning, and sprawl" as the biggest worry. As the Bozeman area grows, traffic congestion will likely worsen, and the area's roadway capacity may not be able to keep pace. Mode choice in the region's transportation system and the provision of safe and plentiful facilities for walking and bicycling will become more important as residents seek alternatives for some of their trips.

The results from the walking and bicycling survey as part of this Plan show that the primary reason given for not biking are the lack of bike lanes or paths. The lack of sidewalks or paths was also listed as the third most common reason for not walking. Other relevant data that supports this finding and illustrates the upward potential of walking and bicycling if improved facilities are provided includes the "2005-2006 West Babcock Street Pedestrian and Bicyclist Monitoring Project", which found a 256 percent increase in bicycling and walking along the corridor after the addition of sidewalks and bike lanes.

Photo 1: Sidewalks and bike lanes installed on West Babcock Street have resulted in more than three times as much bicycle and pedestrian traffic.

Despite it being over seven years since the last census, the 2000 US Census Journey to Work data provides the best dataset to compare Bozeman to the state of Montana and to the nation as a whole. Data for Gallatin County would not be meaningful because the study area composes only a fraction of the County. The census shows that the City of Bozeman had a walking mode share of 10.7 percent, while traveling by 'other means', which includes bicycling, composed 4.7 percent of all trips. The statewide mode share for walking was 5.5 percent while 'other means' was 1.7 percent. Nationally, the walking mode share was 2.9 percent with 'other means' combining to 1.2 percent. From this data it is apparent that Bozeman has a much higher mode share of walking and bicycling than both the state and national averages. This data only covers 'journey to work' data and does not include information on other utility or recreational trips. The U.S. Census Bureau estimates the 2007 population of Bozeman to be just under 38,000 people. Based on the data provided by the 2000 census, the transient student population of over 12,000 is somewhat, but not fully accounted for, in the total population estimate meaning that the overall population within the City limits is likely higher. Also important is the daytime population of Bozeman, which can swell to upwards of 50,000 people due to Bozeman's status as a regional employment center and shopping destination.

2.3.2 Study Area Land Use

Development patterns within the Study Area consist of low to medium suburban density in the communities of Bozeman, Four Corners, and Gallatin Gateway, surrounded by low-density rural development and agriculture. The study area has experienced a period of rapid growth in recent years with Bozeman in the process of rapid expansion with numerous annexations composing new residential and commercial development opportunities. Concurrently, Bozeman is enjoying some success with urban infill development adding higher densities and mixed-use projects in some of the older areas of the City. Most commercial and industrial areas line the major transportation corridors within the Study Area such as Huffine Lane, Gallatin Road (Hwy 191), Jackrabbit Lane, (Hwy 85), 19th Avenue, N. 7th Avenue, and Main Street. Parks are scattered throughout the city of Bozeman with substantial surrounding open space composed of private, State and Federal lands.

The City of Bozeman has all lands within the City Limits subject to zoning. Bozeman has undertaken the 2020 Community Plan, which develops land-use strategies to accommodate an expected population of 46,600 by 2020, a 45 percent increase with a 64 percent increase in employment. This underscores Bozeman's position as a regional employer within the Gallatin Valley and stresses the need for a balanced and efficient transportation system. The 2020 Community Plan outlines a future land-use scenario that encourages and supports compact development patterns and infill development, enhances community vitality and increases transportation choices for residents.

The majority of private lands within Gallatin County are unzoned. In 2003 the County adopted a Growth Policy in a comprehensive plan, which established goals and objectives for handling future growth in the County. Supplementing the Growth Policy, there are numerous zoning districts that establish guidelines for development within their boundaries. These zoning districts apply specific restrictions on uses and new development. The subdivision regulations within the Growth Policy and existing zoning districts are a major tool for regulating land use. With these, the County can require infrastructure improvements as a condition of new development.

2.3.3 Major Activity Generators and Attractors

Educational Facilities – From higher education facilities, such as Montana State University, to the elementary schools located throughout the county, providing safe facilities for students and staff to bike and walk is important.

Montana State University has an enrollment of approximately 12,000 and employs almost 3,500 people. The university has a sizable impact on local transportation and serves as one of the major destinations for area cyclists. With a dispersed student population and limited parking on campus, transportation to the campus is a major issue in Bozeman.

There are 30 public and private K – 12 schools within the project study area, 20 of which are in Bozeman. Each of these schools is a nexus of transportation activity concentrated during commute hours. A comprehensive bicycle and pedestrian network that connects the schools and neighborhoods provides alternative transportation options for students and teachers.

Schools can account for one quarter of morning vehicular traffic. Providing safe routes for students and staff to get to school has not only physical activity benefits, but can have a tangible effect on traffic.

Bozeman Deaconess Hospital – Bozeman Deaconess Hospital employs approximately 800 people and is a large generator of trips both local and throughout the Gallatin Valley and beyond. The Hospital is located on the East side of Bozeman off Highland Blvd and is well connected by popular trails via Burke Park and shared-use paths.

Downtown Bozeman – Downtown Bozeman serves as the cultural and entertainment heart of the region. The streets are busy day and night due to the complementary mix of businesses, restaurants, and bars. Scarcity of convenient vehicle parking, combined with the human scale streetscape, draws many pedestrian and bicycle trips. There are no dedicated bike lanes on Main Street, Mendenhall or East Babcock Ave, but bicycle racks are provided on the street frontage. Bicycles and skateboards are prohibited from downtown sidewalks. In the summer of 2007, Main St. underwent a refurbishment process that saw the addition of new streetlights with pedestrian countdown timers, new red concrete crosswalks and fully compliant ADA sidewalk ramps.

Photo 2: Bicyclists are often seen traveling along Main Street in downtown Bozeman.

Government/Civic – All of the public administration in the Gallatin Valley occurs within downtown Bozeman. Together the City and County employ approximately 700 people. A new public library was built in 2006.

Commercial Corridors – The study area has many commercial corridors with concentrated activity. The areas of Four Corners, the I-90 Frontage Road near Gallatin Field, and the North 19th, North 7th and Main Street/Huffine corridors all generate many automobile, walking, and bicycling trips. It is important that these corridors all be accessible by a variety of modes of transportation including bicycling.

Parks – The Bozeman Area has a large number and variety of neighborhood parks with varying facilities. Tennis courts, basketball courts, sports fields, winter ice skating rinks, skate parks, and dog parks can all be found sprinkled around the Study Area. Other public amenities include the Lindley center and Bogert pavilion. All recreational areas generate a significant amount of travel, and given the outdoor nature of this activity, a large percentage of that travel could be non-motorized if the proper facilities are provided. A new regional park is being developed at the intersection of Davis Lane and W. Oak Street. This will be a heavily used hub of activity in the future.

Photo 3: Newly reconstructed sidewalks in downtown Bozeman have ADA-compliant ramps.

2.3.4 Existing Policies and Goals

This section summarizes past planning efforts and establishes a policy framework to guide future transportation decisions and capital improvement programming for both unincorporated Gallatin County and the City of Bozeman. This undertaking is intended to promote regional planning, offer opportunities to coordinate infrastructure improvements and to incorporate past planning efforts into the current Plan. It is recommended that Gallatin County and the City of Bozeman adopt the recommended policies in this Plan to ensure their effective and consistent implementation throughout the greater Bozeman area.

Bozeman 2020 Community Plan (2001) – Adopted in 2001, the Bozeman Community Plan is a comprehensive planning document setting goals and policies for all aspects of community life, including transportation, housing, land use, and the environment. Chapters 9 (Parks and Open Spaces) and 10 (Transportation) contain specific policies relevant to walkers and cyclists.

- **Chapter 9: Parks, Recreation, Pathways, and Open Space** – The Community Plan incorporates a previously-adopted PROST (Parks, Recreation, Open Space and Trails) plan from 1997 that inventories existing parks; discusses the maintenance of existing parks; discusses future park, trail, and open space needs; provides park development and land acquisition recommendations; and provides a synopsis of responsible parties and a timeline. Parks form an important destination for walking and bicycling, while linear parks and pathways are essential facilities used by walkers and bicyclists. Chapter 9 defines a network of parks facilities including linear parks and pathways, defines trail facility types, and discusses strategies for trails acquisition, development and maintenance, and risk management.

Chapter 9 sets forth objectives and supporting implementation policies, including the explicit provision that the City "provide for pedestrian and bicycle networks, and related improvements such as bridges and crosswalks, to connect employment centers; public spaces and services, such as parks, schools, libraries; and other destinations." The Plan also recommends an update of the Parks, Recreation, Open Space, and Trails Plan.

- **Chapter 10: Transportation –** Chapter 10 contains policies to create a "true multi-modal and cost-effective transportation system." One sub-chapter covers basic definitions of "pathways," including bike lanes, bike routes, bike and pedestrian paths, and sidewalks. The entire chapter envisions a connected street network and a multimodal system, paired with transportation demand management programs.

  Notable objectives and policies related to bicycling and walking include:

  - Provide for pedestrian and bicycle networks, and related improvements such as bridges and crosswalks, to connect employment centers; public spaces and services, such as parks, schools, libraries; and other destinations.
  - Ensure that a variety of travel options exist which allow safe, logical, and balanced transportation choices.
  - For the purposes of transportation and land use planning and development, non-motorized travel options and networks shall be of equal importance and consideration as motorized travel options.
  - Develop and implement reliable and adequate funding mechanisms for the acquisition, development, and maintenance of urban parks, recreation trails, and public open spaces, including, but not limited to, a park maintenance district, general funds, and parkland dedications.
  - Provide for non-motorized transportation facility maintenance through the City's normal budgeting and programming for transportation system maintenance.
  - Continue the existing sidewalk and curb ramp installation, repair, and replacement program.
  - Develop City-sponsored trail maps and information, and provide signage for trail parking and trail facilities to encourage trail usage.
  - Reduce the impact of the automobile by supporting land use decisions that can decrease trip length of automobile travel and encourage trip consolidation.
  - Promote pedestrian and bicyclist safety.

- Encourage transportation options that reduce resource consumption, increase social interaction, support safe neighborhoods, and increase the ability of the existing transportation facilities to accommodate a growing city.
- Create and maintain an interconnected and convenient pedestrian and bicycle network for commuting and recreation as discussed and described in the transportation facility plan and in coordination with the design standards of the transportation facility plan and the Parks, Recreation, Open Space, and Trails Plan.
- Prepare and adopt clear criteria to determine when pedestrian and bicycle facilities are transportation improvements or recreational facilities.
- Prepare and adopt design, construction, and maintenance standards for pedestrian and bicycle transportation improvements versus recreational facilities.
- Work with neighboring jurisdictions to create and connect trails and corridors.
- Review, revise, and update trail/pathway standards to reflect the various types and uses of trails and other non-motorized travel ways.

Greater Bozeman Area Transportation Plan Update (2001) – The Transportation Plan Update (TPU), adopted in 2001, recommends a street network and street design standards for current and future conditions in Bozeman, and sets priorities and funding needs for projects to expand the street network. Chapter 6 analyzes bicycle and pedestrian facilities and needs, and includes an inventory of existing sidewalks, ADA curb ramps, and bikeways on major streets. The TPU includes bicycle and pedestrian facilities in street design guidelines, but did not make specific cross-section recommendations for primary bicycle corridors.

The TPU also discusses traffic calming measures and recommends a process for citizen request of traffic calming. The implementation plan focuses primarily on street widening projects, which typically have bicycle and pedestrian accommodation when adhering to the design standards.

Gallatin County Trails Report and Plan (2001) – This adopted report defines a trail network that connects residential neighborhoods with schools, parks, shopping and longer distance commuter trails in Gallatin County. High priority trails corridors include:

- Belgrade to Bozeman
- Valley Center Drive
- Bozeman to "M" Trailhead
- Springhill to Bozeman
- Four Corners to Bozeman
- Four Corners to Gallatin Gateway
- Three Forks to Trident.

While no enforceable language has been included, the Report does specify that "those who regulate development in Gallatin County should incorporate non-motorized commuter corridors whenever open lands are first developed." In addition to defining a network, the

Report includes information on trail development and sighting guidelines, as well as potential trail funding sources.

Gallatin County Growth Policy (2003) – The Gallatin County Growth Policy, adopted in 2003, contains a number of goals and policies related to managing growth in Gallatin County, focusing in part on limiting residential development in rural areas and encouraging new development in existing developed areas. Managed growth is known to create safer, more convenient, more appealing environments for walking and bicycling, so the Growth Policy generally supports walking and bicycling. Specific policies related to walking and bicycling includes:

- Requirements that subdivision review include analysis of the location and provision of multi-modal transportation facilities; including pedestrian and bicycle safety measures, and interconnectivity.
- Encouragement of compact development patterns that allow the "good accessibility to basic activities (neighbors, schools, activity centers) allowing use of alternative transportation forms (walking, bike) to satisfy needs."
- Promotion of multi-modal transportation opportunities.
- Encouragement that development be consistent with countywide trails plan.

Gallatin County/Bozeman Area Plan (2005) – The Bozeman Area Plan is a refinement of the Gallatin County Growth Policy specific to the Bozeman Area. It is organized around the same Goals as the Gallatin County Growth Policy, and like that policy, its fundamental goals of managing growth, maintaining compact development, and discouraging development in rural and agricultural areas will contribute to the creation of walking- and biking-friendly communities if implemented. The bulk of the policy language is identical to that of the Gallatin County Growth Policy. It explicitly states that "through the subdivision review process require development to comply with adopted plans for parks, recreation (including biking), open space, and trails.

US Mayors' Climate Protection Agreement (endorsed 2006) – This national resolution, endorsed by the City Commission in 2006, includes the following policy commitments to improve bicycling and walking conditions:

- Adopt and enforce land-use policies that reduce sprawl, preserve open space, and create compact, walkable urban communities;
- Promote transportation options such as bicycle trails, commute trip reduction programs, incentives for car pooling and public transit.

Design and Connectivity Plan for North 7th Avenue Corridor – The purpose of this plan was to provide a design framework plan for improvement projects along the corridor that will enhance connectivity for the pedestrian, bicyclist and automobile, to illustrate the vision for the plan, and to provide implementation strategies and funding mechanisms. This plan provides recommendations for enhancements along the corridor in addition to suggesting various implementation methods.

Revised Draft Bozeman Environmental Action Plan (2007) – The Draft Bozeman Environmental Action Plan expands on the goals set forward in the US Mayors' Climate Protection Agreement. Those specific to walking and bicycling are below:

- Adopt and enforce land-use policies that reduce sprawl, preserve open space, and create compact, walkable urban communities.
  - During the 2020 Community Growth Plan Update, consider any objectives and policies not already in place that would help reduce carbon emissions as the community grows;
  - Promote mixed use.

- Promote transportation options such as bicycle trails, commute trip reduction programs, incentives for car pooling and public transit.
  - During the Transportation Plan Update, consider any objectives not already in place to help reduce carbon emissions as the community grows;
  - Continue improving walkability and bikeability of community through completing networks of walking and biking lanes/routes/paths, completing safe routes for children to walk and bike to all schools, and improve intersection and arterial crossing safety for pedestrians;
  - Ask Bike Board, Pedestrian Traffic Safety Committee, Transportation Coordinating Committee, and interested community groups to participate in developing recommendations.

PROST (Parks, Recreation, Open Space, and Trails) Plan (2007) – The PROST Plan proposes a plan to improve and build a system of parks, recreation facilities, open space, and trails in the City of Bozeman. It includes policy, a prioritized project list, a planning framework, and likely funding sources. Where the 2020 Plan provides the overarching goals and vision for parks, recreation, open space and trails, the PROST Plan provides the detailed background information, inventories, analysis and recommendations to support that vision.

The trails element of this plan is most relevant to walking and bicycling conditions in the community, though parks remain a popular walking and bicycling destination. In the PROST Plan, development is seen as the primary source of trail funding and implementation, while maintenance is a City-funded activity. Chapter 8 sets policies for Shared Use Paths, while Chapter 10 includes specific recommendations for trail acquisition, development, and maintenance. The PROST Plan includes a current and planned trails map, but the recommendations made in the current Transportation Plan Update shall take precedence once this plan is adopted. The PROST Plan was adopted in 2007.

2.3.5 Existing Bicycle Facilities and Programs

Definition of Bikeways

There are five basic types of bikeways:

1. **Shared Use Path** – Sometimes called a "bike path," a shared use path provides bicycle travel on a paved right-of-way completely separated from any street or highway.

2. **Wide Unpaved Trails** – In Bozeman, there are a number of unpaved linear trails that are long, wide and smooth enough to serve longer bicycle trips.

3. **Bike Lane** – A bike lane provides a striped and stenciled lane for one-way travel on a street or highway.

4. **Signed bike routes** – Signed bike routes, also known as shared roadways, provide for shared use with motor vehicle traffic and are usually identified only by signing.

5. **Shoulder Bikeways** – Typically found in rural areas, shoulder bikeways are paved roadways with striped shoulders wide enough for bicycle travel. Shoulder bikeways often include signage alerting motorists to expect bicycle travel along the roadway. If a rumble strip is present or found to be necessary it should be as close to the white line as possible with ample room for bicyclists to the right, and have regular breaks to facilitate bicycle entry and exit to the shoulder.

Photo 4: The popular Galligator Trail is a wide unpaved trail that serves many bicycle and pedestrian trips each day.

It is important to note that bicycles are permitted on all public roads in the State of Montana and in Gallatin County and the City of Bozeman. As such, the Bozeman area's entire street network is effectively the region's bicycle network, regardless of whether or not a bikeway stripe, stencil, or sign is present on a given street. The designation of certain roads as having bike lanes or shared roadway signage is not intended to imply that these are the only roadways intended for bicycle use, or that bicyclists should not be riding on other streets. Rather, the designation of a network of bike lane and shared roadway on-street bikeways recognizes that certain roadways are optimal bicycle routes, for reasons such as directness or access to significant destinations, and allows the City of Bozeman and Gallatin County to then focus resources on building out this primary network.

Shared use paths are an important type of facility in any bikeway network provided they are located and designed properly. Nationally, there is some difference of opinion between those who feel paved shared use paths, separated from roadways, should be constructed wherever physically possible, versus those who feel more comfortable riding on streets on lanes or routes. This preference is usually based on "personal feelings" regarding comfort and safety.

In general, shared use paths are desirable for transportation and cycling by slower cyclists, families and children, or anyone who prefers physical separation from the roadway. Although sometimes referred to as "bike paths," shared use facilities are multi-use facilities that will likely see use by a wide mix of non-motorized uses, including pedestrians, joggers, rollerbladers, dog walkers, wheelchairs, and other personal mobility devices. Given this mix of uses, there is the potential for conflicts on heavily-used shared use facilities, necessitating lower bicycle speeds on these paths. Shared use paths are ideally suited for corridors along waterways, rail corridors, or utility corridors where there are few intersections or crossings, to reduce the potential for conflicts with motor vehicles.

Photo 5: This cyclist chooses to ride along the shoulder of Highland Blvd. rather than on the adjacent shared use path.

Shared use facilities located immediately adjacent to roadways are often referred to as "sidepaths". Sidepaths are sometimes less desirable due to the numerous potential conflicts with motor vehicles turning on or off of side streets and driveways, and due to the fact that they act as two-way facilities that are typically situated on only one side of a roadway. Due to their linear off-street nature, opportunities for developing shared use paths in an urban setting are typically much more limited. As such, shared use paths will normally comprise a much smaller fraction of the total designated bikeway network than on-street bike lanes and routes.

Most commuter bicyclists would argue that on-street facilities are the safest and most functional facilities for bicycle transportation. Bicyclists have stated their preference for marked on-street bicycle lanes in numerous surveys. Many bicyclists, particularly less experienced riders, are far more comfortable riding on a busy street if it has a striped and signed bike lane. Part of the goal of this Plan is to encourage new riders, and providing marked facilities such as bike lanes is one way of helping to persuade residents to give bicycling a try.

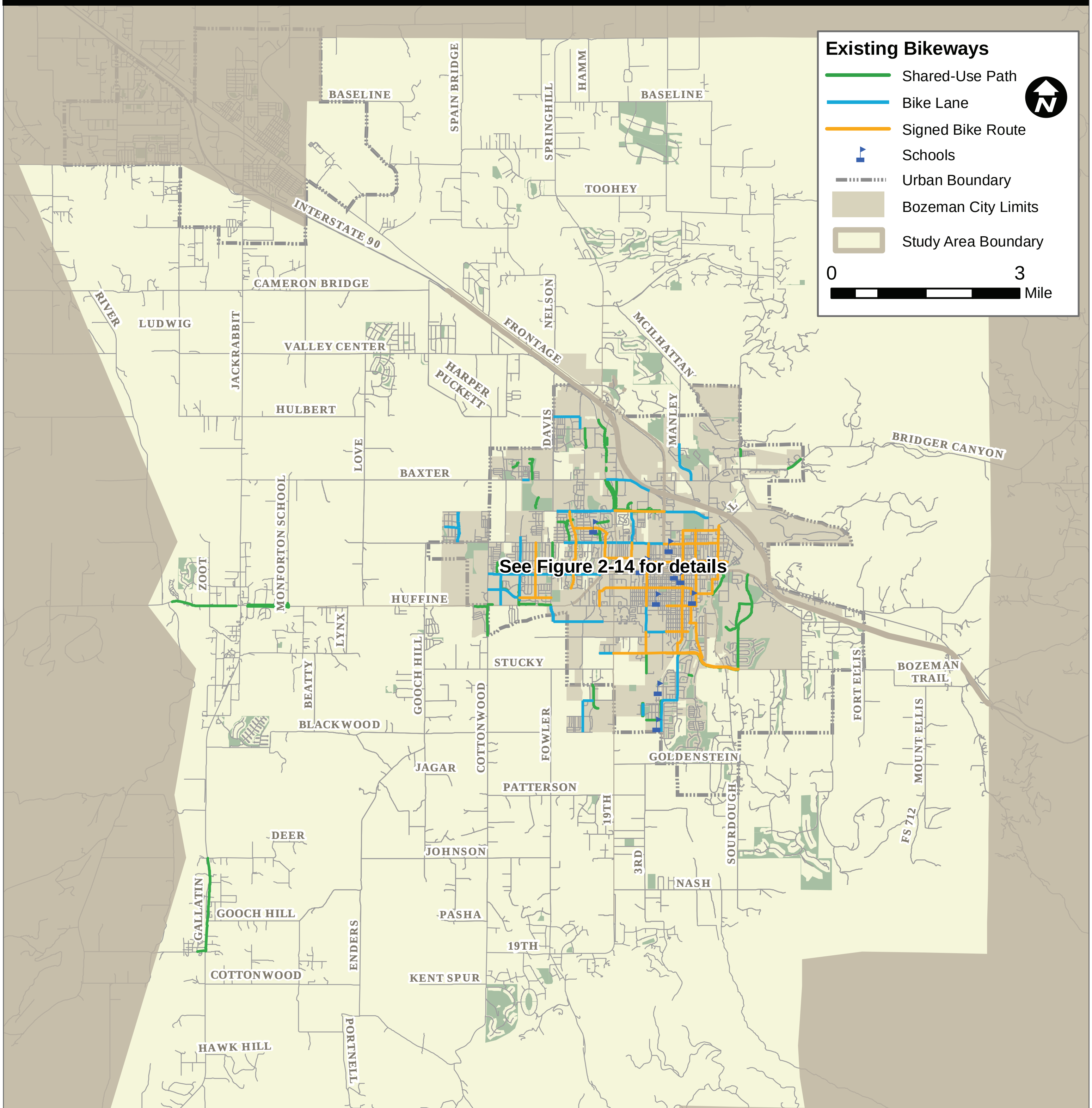
This Plan takes the approach that a connected, comprehensive network of shared-use paths, bike lanes, and shared roadways is the best approach to increasing bicycle use.

Bike lanes help to define the road space for bicyclists and motorists, reduce the chance that motorists will stray into the cyclists' path, discourage bicyclists from riding on the sidewalk, and remind motorists that cyclists have a right to the road. In addition to the considerable benefits to bicyclists, bike lanes have some important safety benefits to vehicles. Bike lanes create a visibly narrower roadway for drivers (even though the driving lane width is standard) creating a traffic calming effect by causing slower average speeds. One key consideration in designing bike lanes in an urban setting is to ensure that bike lane and adjacent parking lane are wide enough so that cyclists have enough room to avoid a suddenly opened vehicle door.

On streets with low traffic volumes and speeds (usually defined as under 5,000 vehicles per day and under 30 mph vehicle speeds), striped bike lanes may not be needed at all for cyclists to comfortably share the road with low risk of conflicts. On these types of low-traffic neighborhood streets, designated and signed bike routes can serve as important connectors to schools and recreational areas such as parks. Signed bike routes may also be desirable on certain commute routes where installing bike lanes is not possible, provided that appropriate signage is installed to alert motorists to the presence of bicycles on the roadway. Bike route signing should also include "Share the Road" signs.

There are no designated shoulder bikeways in the City of Bozeman or Gallatin County at the time of writing. However, there are roads in the City of Bozeman and Gallatin County that do have shoulders wide enough for bicycle travel. These facilities are typically inconsistent in width, can have rumble strips that render them ineffective, and can become mired in road debris. Because of this, many cyclists prefer to travel in the vehicle lane.

Existing Study Area Bicycle Network



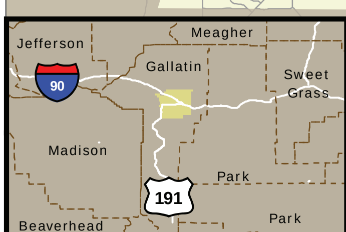
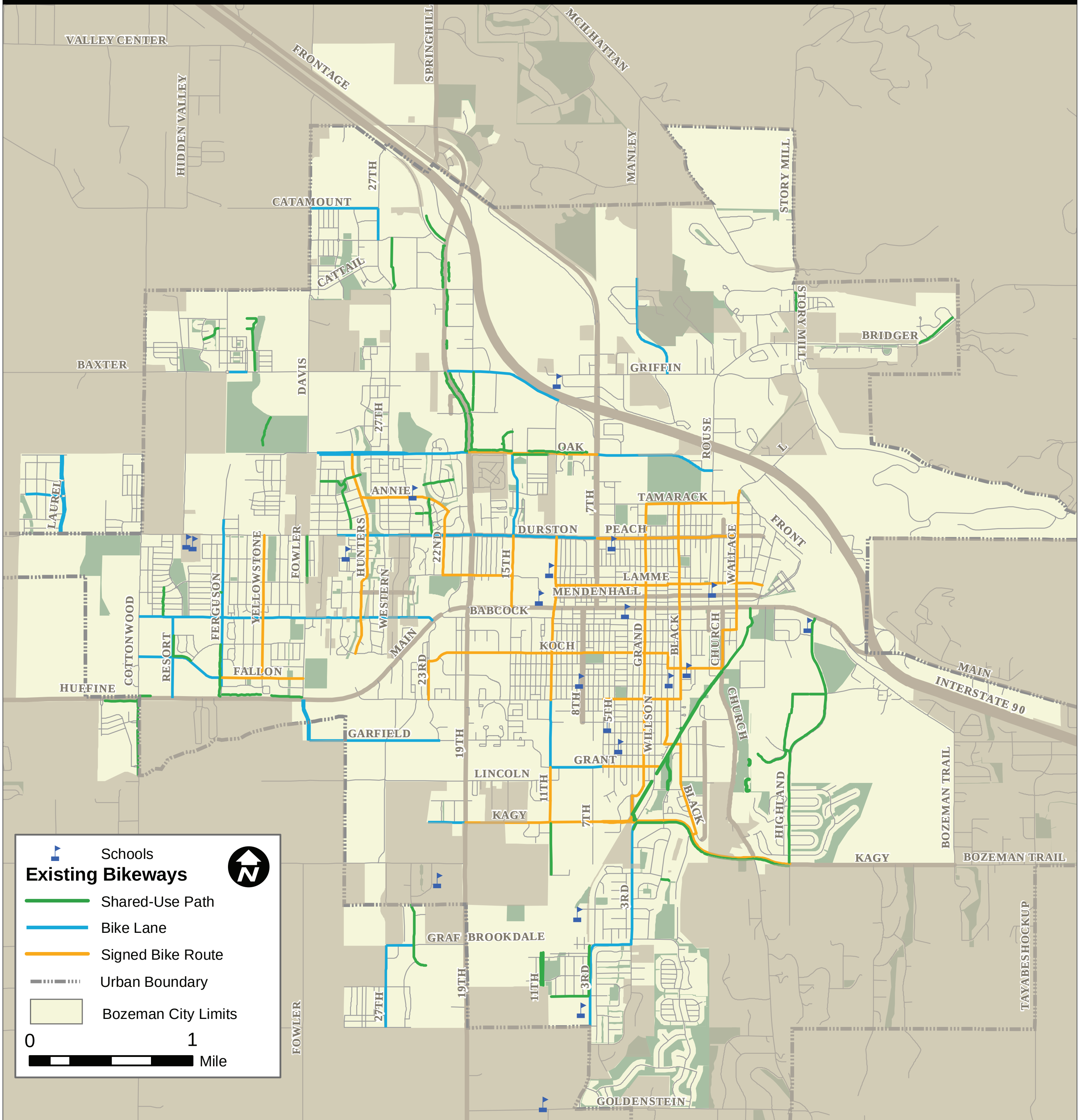


FIGURE 2-13
Existing Study Area Bicycle Network
January 2009
Data Provided by: City of Bozeman, Alta Planning & Design
Map Prepared by: Alta Planning+Design January, 2009

Greater Bozeman Area Transportation Plan

alta PLANNING + DESIGN

Existing Bozeman City Bicycle Network



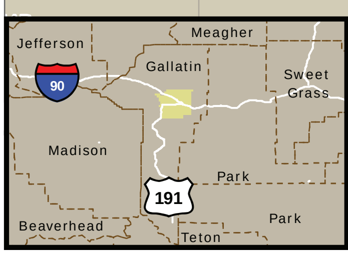


FIGURE 2-14
Existing Bozeman City Bicycle Network
January 2009
Data Provided by: City of Bozeman, Alta Planning & Design
Map Prepared by: Alta Planning+Design January, 2009

Greater Bozeman Area Transportation Plan

alta PLANNING + DESIGN

2.3.6 Existing Bicycle Facilities

As shown in **Figure 2-13**, Bozeman's existing on-street bikeway network is composed of a mix of on-street bike lanes (15.6 total miles) and signed bike routes (20.9 total miles). A number of shared use paths (8.3 total miles) also complement the on-street facilities. **Tables 2-11**, **2-12**, and **2-13** show the limits and lengths of existing bike lanes, signed bike routes, and shared use paths, respectively.

In addition to the total mileage of a bikeway system, it is important to consider the *quality* and *completeness* of the system. A high-quality bicycle facility provides treatments that result in a comfortable, welcoming experience for users.

Bike lane quality includes factors such as lane width, number of adjacent vehicle lanes, speed and volume of vehicular traffic, number of turning conflicts with driveways and parking, completeness of the system (few or no gaps), maintenance (pavement quality, sweeping, etc.) and signal detection that senses bicycles. Signed bike route quality includes factors such as wayfinding signs and markings, maintenance (pavement quality, sweeping, etc), traffic calming measures, crossing treatments at higher-order streets, speed and volume of vehicular traffic, and completeness of the system (few or no gaps).

Photo 6: Opportunities exist for new bicycle facilities through roadway reconstruction such as Durston Road where a new bike lane and bike pocket were built at the intersection with South 19th Avenue.

It should be noted that in Bozeman, two-way shared-use paths have largely been constructed parallel to major roadways in lieu of sidewalks and bike lanes. In some places the path is on one side of the street only. There are some safety concerns related to replacing sidewalks and bike lanes with two-way parallel paths due to conflicts caused by limited visibility and unexpected vehicle patterns at driveways and intersections. These shared-use paths have also been constructed in many cases when the adjacent property develops instead of when the roadway is constructed or reconstructed, leading to a fragmented network that can be difficult for users.

There are no bike lanes or signed bike routes in the rural study area (beyond the Bozeman city limits). There are shoulder bikeways on some rural arterials and collectors and some shared use paths, primarily near schools in Gallatin Gateway and Four Corners (see **Figure 2-13**).

Table 2-11

Existing Bicycle Facilities: Bike Lanes[1]

Street	From	To	Length
Annie Street	Saxon Way	Laurel Parkway	0.2 mi
Baxter Lane	N 19th Avenue	East of Sacco	0.4 mi
Catamount Street	Davis Lane	N. 27th Avenue	0.4 mi
Durston Road	Springbrook Avenue	N. 7th Avenue	1.6 mi
E Baxter Lane	Ferguson Avenue	Gallatin Green Road	0.1 mi
Fallon Street	Cottonwood Road	Ferguson Avenue	0.5 mi
Ferguson Avenue	Diamond Street	Valley Commons Drive	1.0 mi
Fowler Avenue	W Main Street	W Garfield Street	0.3 mi
Kagy Road	Eastern city boundary	S 19th Avenue	0.2 mi
Laurel Parkway	W Oak Street	Durston Road	0.3 mi
Manley Road	North of Gallatin Park	Griffin Drive	0.7 mi
N 15th Avenue	W Oak Street	Durston Road	0.5 mi
N 27th Avenue	Catmount Street	Catron Street	0.2 mi
Oak Street	New Holland Drive	N. 19th Avenue	0.9 mi
Oak Street	N 7th Avenue	N Rouse Avenue	0.7 mi
Resort Drive	W Babcock Street	Huffine Lane	0.5 mi
S 11th Avenue	W College Street	W Grant Street	0.4 mi
S 11th Avenue	North of Brookdale Drive	South of Alder Creek Drive	0.2 mi
S 3rd Avenue	Kagy Boulevard	W Graf Street	0.8 mi
S 3rd Avenue	W Graf Street	Dartmouth Drive	0.5 mi
W Babcock Street	Cottonwood Road	W Main Street	1.3 mi
W Garfield Street	Fowler Avenue	Research Drive	0.8 mi
W Graf Street	Westridge Drive	S 3rd Avenue	0.2 mi
W Grant Street	S 11th Avenue	S 6th Avenue	0.4 mi

[1]Source: City of Bozeman 2007 GIS data

Table 2-12
Existing Bicycle Facilities: Signed Bike Routes[2]

Street	From	To	Length
Annie Street	N Hunters Way	N 22nd Avenue	0.6 mi
Black Avenue	E Tamarack Street	E College Street	1.2 mi
Carol Place	S Black Avenue	E Kagy Road	0.03 mi
College Street	S 6th Avenue	S Black Avenue	0.5 mi
E Garfield Street	S Tracy Avenue	S Black Avenue	0.1 mi
E Olive Street	S Church Avenue	S Wallace Avenue	0.1 mi
E Story Street	S Tracy Avenue	S Church Avenue	0.3 mi
Fallon Street	Ferguson Avenue	Fowler Avenue	0.5 mi
Grand Avenue	W Tamarack Street	S 3rd Avenue	1.8 mi
Grant Street	S 6th Avenue	Galligator Trail	0.3 mi
Kagy Road	S 19th Avenue	Highland Road	2.1 mi
Koch Street	S 23rd Avenue	S Tracy Avenue	1.5 mi
Lamme Street	N 11th Avenue	N Broadway Avenue	1.3 mi
N 11th Avenue	Durston Road	W College Street	1.0 mi
N 15th Avenue	Durston Road	W Main Street	0.4 mi
N 22nd Avenue	Annie Street	W Beall Street	0.4 mi
N Hunters Way	W Oak Street	W Babcock Street	1.0 mi
N Yellowstone Avenue	Durston Road	Fallon Street	0.9 mi
Peach Street	N 7th Avenue	N Wallace Avenue	0.9 mi
S 11th Avenue	W Grant Street	W Kagy Road	0.3 mi
S 23rd Avenue	W Koch Street	W College Avenue	0.2 mi
S 3rdAvenue	S Grand Avenue	W Kagy Road	0.1 mi
S Black Avenue	E Garfield Street	Carol Place	0.6 mi
S Church Avenue	E Olive Street	E Story Avenue	0.2 mi
S Tracy Avenue	E Koch Street	E Story Street	0.1 mi
S Tracy Avenue	E College Street	E Garfield Avenue	0.3 mi
Virginia Way	W Babcock Street	Donna Avenue	0.2 mi
W Beall Street	N 22nd Avenue	N 15th Avenue	0.4 mi
W Oak Street	N 19th Avenue	N 7th Avenue	0.8 mi
W Tamarack Street	N Grand Avenue	N Wallace Avenue	0.6 mi
Wallace Avenue	Front Street	E Olive Street	0.9 mi

[2]Source: City of Bozeman 2007 GIS data

Table 2-13
Existing Bicycle Facilities: Shared Use Paths[3]

Street/trail name	From	To	Length	Notes
Cambridge Drive	West of Hidden Springs	S 3rd Avenue	0.2 mi	South side of street only
E Kagy Road	S 3rd Avenue	Highland Road	1.0 mi	On sidewalk; south side of street only
Ellis Street	Highland Road	Old Highland	0.2 mi	South side of street only
Ferguson Avenue	Ravalli Street	Huffine Lane	0.3 mi	West side of street only
Galligator Trail	Corner of Church & Story	Graf Street	2.0 mi	Trail is treated as shared-use because of its characteristics and transportation value.
Highland Road	E Main Street	E Kagy Road	1.5 mi	West side of street only
Huffine Lane	Fowler Avenue		0.2 mi	Extends west from Fowler to mid-block
Main Street to the Mountains – Library Extension	E Main Street	Corner of Church & Story	0.4 mi	Paved shared-use path, currently under construction. Not in roadway right of way.
N 19th Avenue	E Valley Center Road	W Oak Street	1.5 mi	Fragmented construction
Oak Street	N 19th Avenue	N 7th Avenue	0.7 mi	Fragmented construction
Old Highland Road	Ellis Street	Burke Park	0.5 mi	One side of street only; switches sides
S 11th Avenue	Kagy Road	Opportunity Way	0.3 mi	East side of street only
S 11th Avenue	North of Brookdale	South of Alder Creek	0.2 mi	Both sides of street
S 3rd Avenue	Graf Street	Cambridge Drive	0.3 mi	West side of street only
Simmental	Baxter Lane	Tschache	0.2 mi	
Unnamed trail			0.1 mi	Northeast from intersection of 27th & Cattail
Unnamed trail	Equestrian Lane	E Baxter Lane	0.1 mi	Mid-block greenway trail between Gallatin Green and Vaquero

[3]Source: City of Bozeman 2007 GIS data

2.3.7 Bikeway Signage

Well-designed roads usually require very little signing, because they are built so all users understand how to proceed. Conversely, an overabundance of warning and regulatory signs may indicate a failure to have addressed problems. The attention of drivers, bicyclists and pedestrians should be on the road and other users, not on signs along the side of the road.

Photo 7: Example of a bike route sign installed in Bozeman in 2002

Over-signing of roadways is ineffective and can degrade their usefulness to users. Too many signs are distracting and a visual blight, they create a cluttered effect and waste resources.

Photo 8: Main Street to the Mountains Trail Sign

The message conveyed by the sign should be easily understandable by all roadway users. The use of symbols is preferred over the use of text.

Bikeway signage includes wayfinding signs (e.g. trailhead signage or bike route numbering), facility type signs (e.g. "Bike Lane" signs posted along a roadway with a bike lane), regulatory signs (e.g. "Bike Xing" warning signs or bicycle-sized "Stop" signs), or etiquette signs (such as trail signs). All traffic control signage and markings should conform to the Manual of Uniform Traffic Control Devices (MUTCD Part 9 – Traffic Controls for Bicycle Facilities).

Photo 9: Share the Road signs have been installed in Bozeman on streets like W. College Street

The City of Bozeman has experienced a dramatic increase in bicycle-related signage in recent years. In 2002 a project funded through the Bozeman City Commission provided unique signs to designate a City-wide network of bike routes. Complementing the bicycle route signs are an expanding network of bike lanes stemming both from new development and reconstruction of some of Bozeman's major arterials such as Durston Road, West Babcock, and Baxter Lane. All of these new bike lanes use the MUTCD standard signage and markings. In addition to bike lanes and bike routes the City has provided "Share the Road" signs in some areas where space is limited along popular cycling routes such as W. College Street, S. Church Avenue, and N. 7th Avenue. Shared-use paths in both the City and County typically lack signage such as stop signs for cyclists or warning signs for motorists. Some of the newer shared-use paths being constructed, such as the path along Bridger Drive, do offer basic signage.

Photo 10: Bike Lane Sign

The trail network in and surrounding Bozeman has flourished with assistance from the Gallatin Valley Land Trust, and much of this system has wayfinding signage and trail kiosks.

Outside the Bozeman City limits, bicycle facilities and accompanying signage are scarcer. The County has installed Caution signs on some of its roadways such as Sourdough Road and Bridger Drive. The County currently has no designated bicycle routes or bike lanes, however there are shared use paths along the east side of Highway 191 from Gallatin Gateway north, the south side of Norris Rd (Hwy 84) from the Gallatin river to Four Corners, and from Four Corners towards Bozeman on Huffine Lane (see **Figure 2-13**).

Photo 12: Rural roads in the Bozeman area frequently have no bicycle facilities.

2.3.8 Bicycle Detection at Intersections

Traffic signal actuation in Bozeman involves a variety of technologies and is changing rapidly. Older signalized intersections in and around Bozeman rely on timers that allow cyclists the same opportunities for crossing as vehicles. While there is no priority or detection given to cyclists, delay is not usually long as the light will change according to its timing.

The majority of signals in the study area use embedded inductive loops to detect vehicles. Loops can be sensitive enough to detect bicycles provided they are located and calibrated properly. Detection performance also depends on the material composition of the bicycle. If a bicycle is not detected by the embedded loop, the cyclists can still press the crosswalk button if one is available. If the cyclist is not detected by the signal and there are no pedestrian crossings, cyclists are forced to either make an unsafe movement through the intersection, or wait for a vehicle to trigger the signal.

Newer signals recently installed in the City, such as some on N. 19th Avenue, W. Main Street and Durston Road, have video detection technology that is sensitive enough to detect a bicycle waiting by itself at an intersection. This method of actuation is the most reliable and user-friendly for bicyclists.

2.3.9 Bicycle Parking

Bicycle parking is an important component in planning bicycle facilities and encouraging people to use their bicycles for everyday transportation. Bicycles are one of the top stolen items in most communities, with components often being stolen even when the bicycle frame is securely locked to a rack. Because today's bicycles are often high-cost and valuable items, many people will not use a bicycle for transportation unless they are sure that there is secure parking available at their destinations.

Cyclists' needs for bicycle parking range from simply a convenient piece of street furniture, to storage in a bicycle locker that affords weather, theft and vandalism protection, gear storage space, and 24-hour personal access. Where a cyclist's need falls on this spectrum is determined by several factors:

- Type of trip being made: whether or not the bicycle will be left unattended all day or just for a few minutes.
- Weather conditions: covered bicycle parking is apt to be of greater importance during the wetter months.
- Value of the bicycle: the more a cyclist has invested in a bicycle, the more concern she or he will show for theft protection. Most new bicycles cost $400-500, and often considerably more.

Bicycle parking can be broadly defined as either short-term or long-term parking:

- **Short-term parking**: Bicycle parking meant to accommodate visitors, customers, messengers and others expected to depart within two hours; requires approved standard rack, and appropriate location and placement. Racks are relatively low-cost devices that typically hold between two and eight bicycles, allow bicyclists to securely lock their frames and wheels, are secured to the ground, and are located in highly visible areas. Racks should not be designed to damage the wheels by causing them to bend. Bike racks should be located at schools, commercial locations, and activity centers such as parks, libraries, retail locations, post offices, churches, and civic centers, or anywhere personal or professional business takes place.

- **Long-term parking**: Bicycle parking meant to accommodate employees, students, residents, commuters, and others expected to park more than two hours. This parking is to be provided in a secure, weather-protected manner and location.

(a)  (b) 

Photo 13: (a) Short-term bicycle parking – "Inverted-U". (b) Long-term bicycle parking.

Bozeman Unified Development Ordinances related to bicycle parking

Ordinance 18.46.040.E
Bicycle Racks Required. All site development, exclusive of those qualifying for sketch plan review per Chapter 18.34, BMC, shall provide adequate bicycle parking facilities to accommodate bicycle-riding residents and/or employees and customers of the proposed development. Bicycle parking facilities will be in conformance with standards recommended by the Bozeman Area Bicycle Advisory Board.

Ordinance 18.19.070.E.3
In Urban Mixed Use Zoning Districts, covered bicycle parking shall be provided. The covered spaces shall be at least one-half of the total minimum bicycle parking. The minimum number of covered spaces shall be the greater of either 10 bicycle parking spaces or 5 percent of motor vehicle parking provided on-site.

Existing Bicycle Parking Facilities

Currently there are bike racks provided in downtown, on the MSU campus, at Bozeman area schools, at grocery stores, commercial centers, and at parks and community centers. However, many of the racks are outdated designs such as "wheelbender" racks and comb racks that only allow a wheel, not the bicycle frame, to be locked. The main rack at the MSU campus appears to be the "coat hanger" rack made by Cora. For a bicycle rack to be the most functional it should require low maintenance, meet the bicycle parking requirements of it, it should complement its surroundings, and support the frame of the bicycle and not just the wheel.

In general, the quantity of bike racks is usually adequate, but some of the outdated designs provide a lower quality of experience compared to modern racks (making them harder to use and less secure).

Photo 14: Bike racks are provided along Main Street, but the presence of bikes locked to street trees and railings may indicate that additional bike racks are needed.

Photo 15: These outdated "comb" type bike racks at a local restaurant are considered a less desirable rack design because it is difficult to lock the frame to the rack.

Recent suburban commercial development has been providing bicycle parking as required by City ordinance. Bozeman also has many examples of temporary bicycle parking of the "comb" variety that have been sponsored by and contain advertising for local bicycle shops. Racks such as these can be found chained near many businesses in downtown Bozeman. On Main Street and at the recently-completed Bozeman Public Library, the number of bikes often exceeds the number of racks, indicating a need for more racks.

No bike parking, short- or long-term, was observed in the study area outside of the city of Bozeman. No long-term bike parking facilities were observed in the Bozeman area.

2.3.10 Bikeway Maintenance

Currently, the City of Bozeman includes bikeway maintenance such as sweeping, striping, vegetation trimming, and snow removal in routine street maintenance, as well as providing residents with opportunities to request service through the pothole hotline and the City Shop phone number, which is publicized in water bills, online, and through the Bike Board. Vegetation trimming and snow removal on sidewalks fronting residences is the homeowner's responsibility. See **Table 2-14** for a list of maintenance activities and their frequency.

Gallatin County does not have any on-street bikeways at this time, so maintenance is not directly relevant. However, it should be noted that the County does not own a sweeper truck, but does attempt to coordinate with the City for sweeping services as possible. Local cyclists note that riding in the spring can be rough going until rains and traffic begin to naturally clear the roads and shoulders. It is worth noting that the FY '09 budget includes money for a street sweeper and employee time specifically to sweep bike lanes.

Table 2-14

Bikeway Maintenance Activities & Frequency[4]

Activity	Bikeway type	Frequency	Agency
Sweeping	City bike lanes	Weekly as weather permits; focus on bike lanes	City of Bozeman
Sweeping	City bike route streets	At least twice yearly during Fall and Spring Clean-up; more as weather and staffing permit	City of Bozeman
Sweeping	On-demand; any city street	Per citizen request via call to City Shop	City of Bozeman
Sweeping	County facilities	N/A (no County bike facilities; County does not own sweeper truck)	Gallatin County
Striping	City bike lanes	Annually for painted lanes and markings; as needed/requested for thermoplastic lanes and markings	City of Bozeman
Pothole patching	Any city street	As requested through City's pothole hotline; response time is within 7 days	City of Bozeman
Vegetation trimming	Any city street	If sight triangle is blocked, City Forester will trim. Other streets are per citizen complaint; City will fix these as staffing permits and/or send letter to homeowner explaining their responsibility.	City of Bozeman
Snow removal	City bike lanes and bike routes	City removes snow from curb to curb (working around parked cars as possible). Removal starts on collectors when 2" of snow has accumulated, and after 4" on residential streets.	City of Bozeman
Snow removal	County facilities	N/A (no County bike facilities)	Gallatin County

[4]Source: Conversation with John Van Delinder (Bozeman Street Superintendent, on 9-25-07)

2.3.11 System Deficiencies

Bicyclists face various issues, including:

Maintenance Issues – Gravel, glass and other debris are routinely present on the bikeway system. This typically occurs when passing motor vehicles blow debris into the adjacent bicycle lane or shoulder. Gravel from snow removal on shoulders and in bike lanes is common during the winter and spring months.

Lack of Signage – Bozeman's bikeway system lacks wayfinding signage and other tools to orient riders and direct them to and through major bicycling destinations like MSU and downtown.

Photo 16: Some bike facilities have yet to be completed and present gaps in the bikeway network.

Conflicts Between Cyclists and Other Transportation Users – Cyclist safety and comfort issues arise on higher volume roadways lacking dedicated bicycle facilities or traffic-calming treatments. These roadways are most commonly high-volume 5- to 7-lane suburban arterials with frequent driveway access. For example, Huffine Lane and 7th Avenue are major north-south thoroughfares that connect to major commercial districts as well as schools and parks. However, these high-volume, high-speed streets lack bike lanes and have a relatively high number of driveways associated with commercial development, creating an uncomfortable bicycling environment. While S. 19th Avenue currently lacks bike lanes, a contract to reconstruct the roadway with full-fledged bicycle facilities has been awarded and will be constructed beginning summer 2009.

Photo 17: Bridger Drive has a variable shoulder along much of its length.

Main Street is also a major destination for all residents, including bicyclists, but a lack of bike lanes on this street forces bicyclists to share the lane with high volumes of motor vehicles (or, in most cases, ride on the sidewalk despite a sidewalk riding prohibition). Similarly, the one-way couplet of Mendenhall Street and Babcock Street also lack bicycle facilities.

Bozeman's historic downtown street grid provides numerous lower-volume street and crossing choices for bicyclists. Lower-density, less-connective street patterns in newer areas of the city force cyclists onto higher-order streets. When these streets do not have bicycle facilities, it discourages bicycle use.

Rural roads in the greater Bozeman area are generally low-volume, high-speed facilities with no shoulder bikeways and in some cases rumble strips. Bicyclists have nowhere to go when cars approach from behind, creating a facility where cyclists feel both uncomfortable and unsafe. Examples of uncomfortable rural facilities include Valley Center Drive and Sourdough Road and Bridger Drive.

Photo 18: Opportunities exist to make Kagy Boulevard, a designated bike route, a more comfortable bicycling environment.

Difficult Intersections – When signed bike routes or shared-use paths cross a major roadway with no crossing accommodation, it makes crossing difficult, especially for less-confident users, or especially during peak vehicle traffic periods. These major roadways then act as barriers to bicycle travel for many users. For example, it can be very difficult for bicyclists using Lamme Street (a signed bicycle route) to cross N. 7th Avenue. Likewise, users of the new Main Street to the Mountains shared-use path near the library may find it difficult to cross Main Street.

Cyclist Behavior – Local bicyclists were observed riding in an unsafe manner throughout the study area. Such behavior includes riding on sidewalks, riding against traffic, running red lights and stop signs, and riding without lights at night. This behavior may indicate the need for education efforts concerning safe bicycling techniques.

2.3.12 Encouragement and Education Programs

Bicycle Encouragement and Education programs in the Gallatin Valley are mainly organized at the grassroots level by local bicycle and health related groups. Momentum in this area is growing with more community involvement and interest. As part of National Bike Month, Bike to Work/School week during the third week of May is the region's signature event. Bike to Work/School week is sponsored each year by the Bozeman Bicycle Advisory Board. 2007 Activities included a free breakfast at a different location each day of the week, a bicycle repair clinic and a bike rodeo at Bozeman Deaconess Hospital. The rodeo, organized by the Bozeman Police Department, included helmet fits, free helmets to needy individuals and safety lessons.

The Bozeman Area Bicycle Advisory Board has published a bicycle map for the City of Bozeman. The first version was published in 2005 with a second printing with updated facilities in 2007.

In 2007, a newly organized Safe Routes to School task force was developed. The new National Safe Routes to School program provided funding through the State program administered by MDT for educational and encouragement materials for Emily Dickinson School. The program also funds educational and encouragement materials, and the purchase of several radar equipped speed signs adjacent to the school. This group also publicized National Walk to School Day in October.

In addition to the Bike to Work/School rodeo at Deaconess Hospital, the Bozeman Police Department organizes 3-4 bicycle safety events (by request) at Bozeman elementary and middle schools. These rodeos are voluntary in attendance and typically occur after school hours. These events teach safe riding through obstacle courses, stopping drills, helmet safety, and visibility awareness. Children are also quizzed on road signs and rules of the road. These events typically draw over 200 children and can last up to four hours.

The Bozeman Police Department also acknowledges the need for better bicyclist and driver education and participates in periodic local radio and television talk shows to discuss road safety as well as contributes editorials to the Bozeman Daily Chronicle. Representatives from the Police Department also serve on the Pedestrian Safety Committee and the Safe Routes to School Taskforce.

2.3.13 Bicycles and Transit

Photo 19: New Streamline buses can carry three bicycles.

Linking bicycles with Streamline mass transit effectively increases the distance cyclists can travel, provides options in the event of a bicycle breakdown, and gives cyclists alternatives to riding at night or in hot, cold or rainy weather. In August of 2006 Streamline began serving the Gallatin Valley with free service over four lines that serve Belgrade, Four Corners and Bozeman.

In August of 2007 Streamline unveiled its new fleet of 23 passenger yellow 'bustle-back' buses, which closely resemble older Yellowstone National Park tour buses. Each of the 6 buses has a rack that can hold up to three bicycles on the front of the vehicle. The system is still quite new and supporting infrastructure such as bus pullouts and shelters are following slowly. Bozeman is in the process of building a new parking garage and intermodal facility on Mendenhall Avenue between Black Avenue and Tracy Avenue. This facility will serve as a formalized transfer point with a protected bus pullout. Bicycle parking will be installed within the parking garage and at street frontage.

2.3.14 Bicycle Collision History

Crash data was analyzed from January 2002 through June 2007 and was provided by Gallatin County 911 and the Bozeman Police Department (see **Figure 2-15** and **Figure 2-16**). Gallatin County 911 codes bicycle accidents as 'bicycle/motorcycle' thus reported accidents outside the Bozeman city limits may not in fact involve a bicycle. Despite this concern, these crashes were treated as bicycle accidents as no determination could be made. City of Bozeman accident data does specify data as bicycles only.

Since 2002, 83 bicycle/vehicle or bicycle/pedestrian accidents were reported in the greater Bozeman study area with 69 occurring within the Bozeman City limits. This number is likely lower than the actual number of collisions that have occurred, as many may have not been reported. In addition, the Police Department reports that accident tracking methods have improved in the last few years causing the years 2002-2005 likely being under represented in the number of collisions. Due to these factors trends between years cannot be ascertained. Data collected from the Bozeman Police Department does show that of the 69 recorded incidents 43 percent of the collisions were the fault of the bicycle, 14 percent were the fault of the vehicle and 42 percent undetermined.

Main reasons for bicycle rider fault involved riding on sidewalk or riding the wrong direction against traffic. Several accidents at night involved no lights or reflectors and in several cases the bicyclist lost control while braking. There were several instances where the bicycle rider ignored stop signs or red signals and swerving into or through traffic. A few cases involved intoxicated bicycle riders.

With vehicles at fault, there were several cases of opening doors on a rider and several cases of not yielding to the bicycle when turning or in a crosswalk.

Generally, rural crashes are concentrated on higher-order streets such as Huffine Lane and Cameron Bridge Road. Within Bozeman, crashes are likewise clustered along high-volume corridors such as 7th Avenue, 19th Avenue, and Main Street, but a smaller number of crashes were reported on lower-volume streets as well, including College Street, Garfield Street, and 11th Avenue. One thing nearly all the crash locations have in common are that they are principal arterials and collectors – almost none had dedicated bicycle facilities.

Study Area Reported Bicycle/ Motorcycle Collisions, 2002-2007

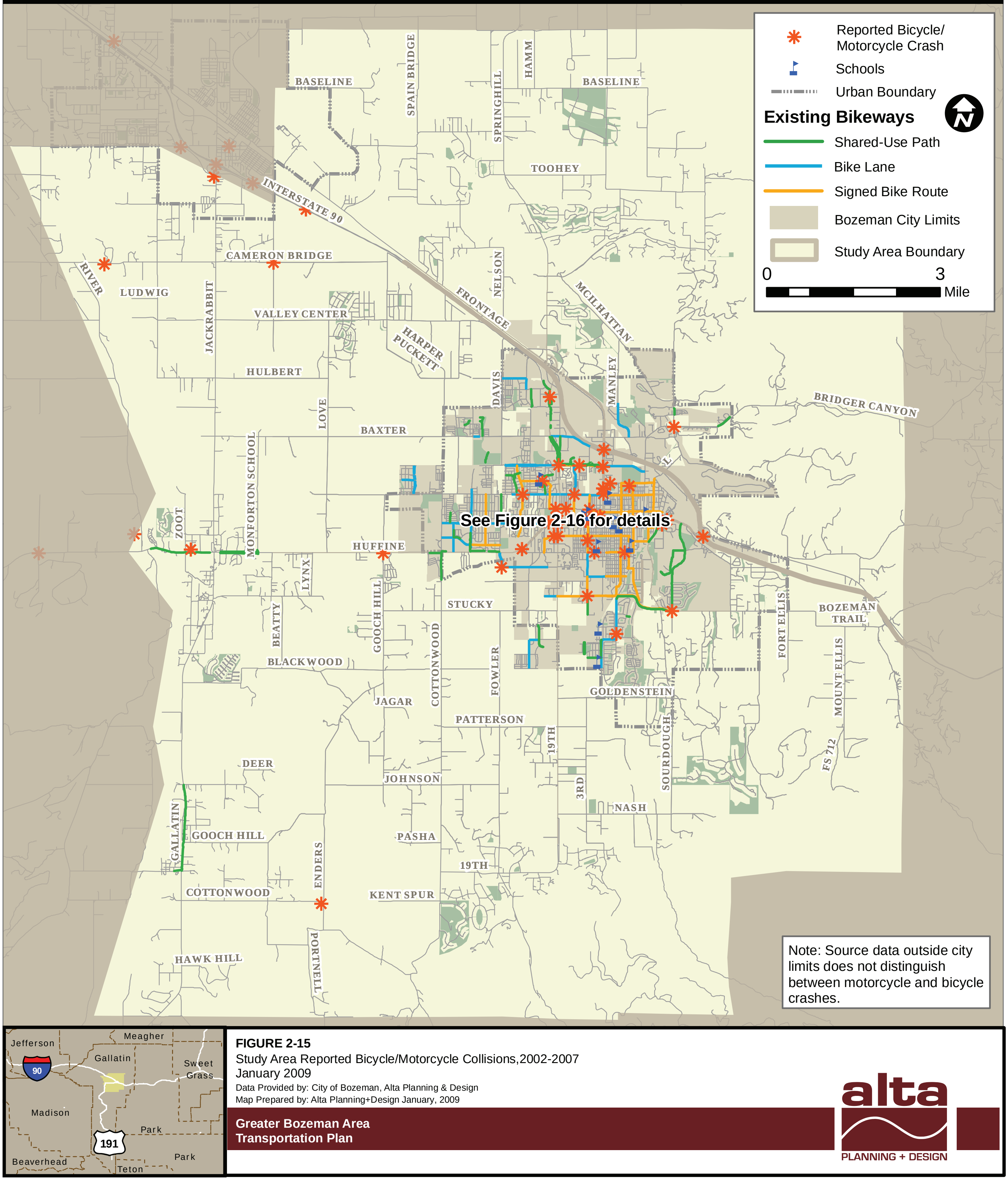


FIGURE 2-15
Study Area Reported Bicycle/Motorcycle Collisions,2002-2007
January 2009

Data Provided by: City of Bozeman, Alta Planning & Design
Map Prepared by: Alta Planning+Design January, 2009

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Bozeman Reported Bicycle/ Motorcycle Collisions, 2002-2007

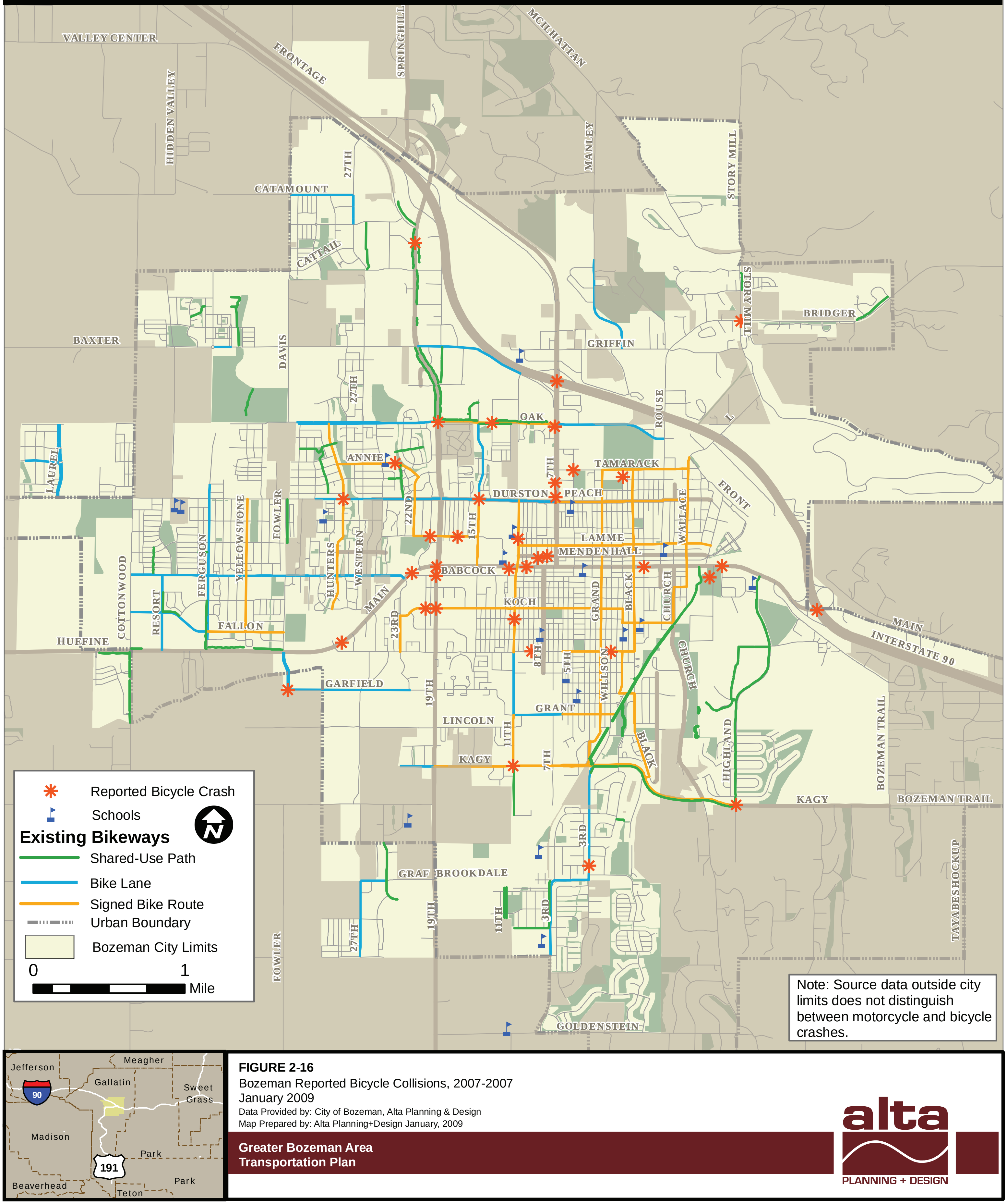

FIGURE 2-16
Bozeman Reported Bicycle Collisions, 2007-2007
January 2009
Data Provided by: City of Bozeman, Alta Planning & Design
Map Prepared by: Alta Planning+Design January, 2009

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2.3.15 Existing Pedestrian Facilities and Programs

Overview of Pedestrian Facilities

Photo 20: A shared-use path has been installed on Oak Street.

The most basic elements of the pedestrian network are sidewalks, pathways, crosswalks, and curb ramps. Sidewalks provide a space for pedestrian activity completely separated from motor vehicle traffic. Pathways (most commonly shared-use paths) also provide a separation from motor vehicle traffic, although pedestrians may have to share pathways with bicyclists and other non-motorized users. Crosswalks provide a legal extension of the sidewalk across a roadway, and curb ramps provide a transition between the raised sidewalk and the crosswalk for persons using mobility assistance devices. These elements should form a connected network to be functional, safe, and encourage people to walk.

2.3.16 Existing Pedestrian Gaps in Arterials and Major Collectors

The City of Bozeman requires that as development occurs, sidewalks be provided on both sides of public streets frontages. This requirement has resulted in a city that is generally very well equipped with sidewalk facilities. Areas still lacking pedestrian facilities include older arterials that have not undergone refurbishment, and some subdivisions constructed in the 1970s (some of which were originally part of the County).

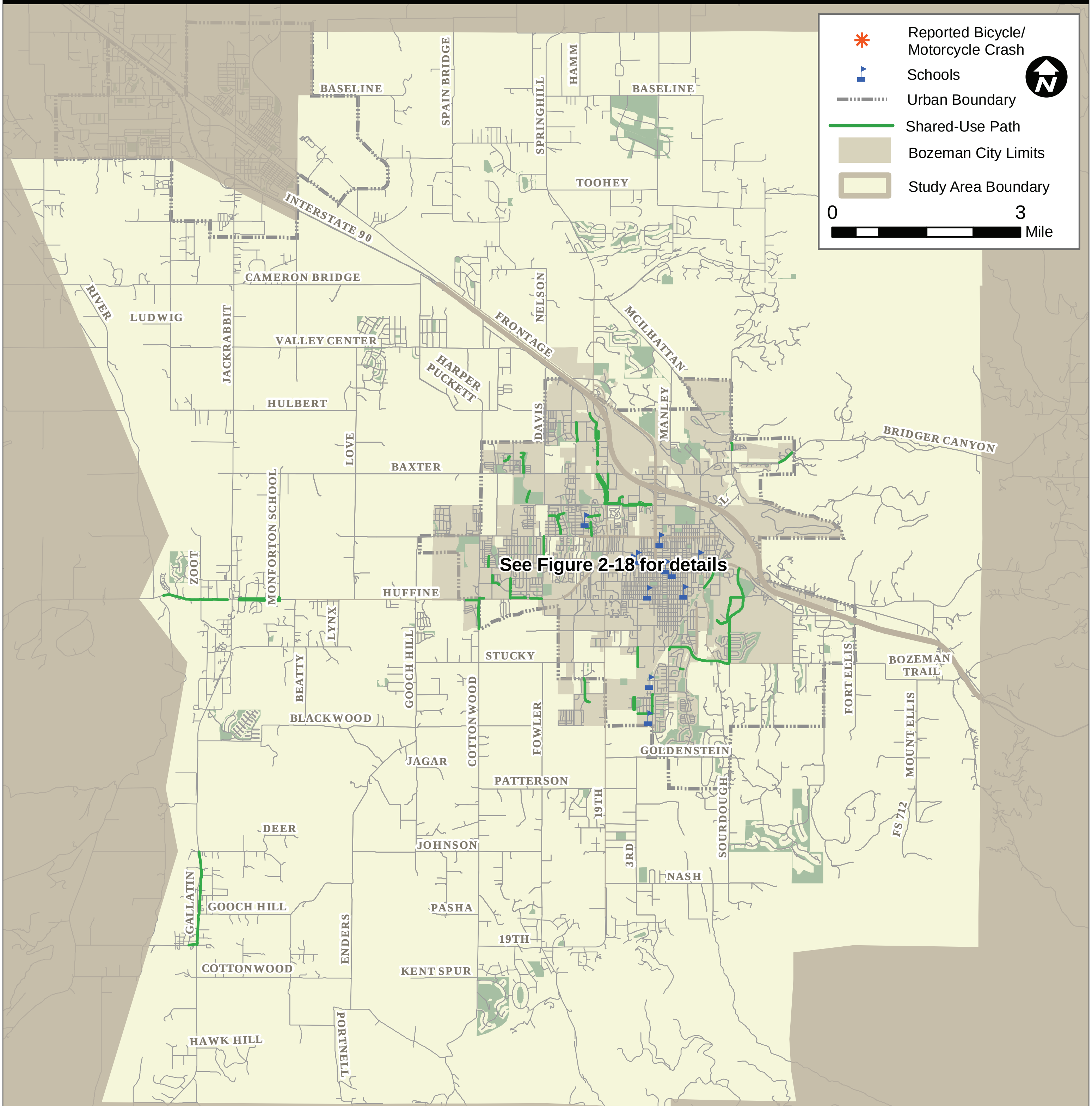
The City has been reconstructing many of its older roadways such as Durston Road, and West Babcock Street. The results have been popular with residents and the “2005-2006 West Babcock Street Pedestrian and Bicyclist Monitoring Project” found a 256 percent increase in bicycling and walking along the corridor with the addition of sidewalks and bike lanes. **Figure 2-18** details arterials and collectors in the City of Bozeman with no sidewalk facilities.

Main Street has also been reconstructed recently, and has wide, smooth sidewalks with fully ADA-accessible curb ramps and attractive street furniture, such as bike racks and street trees.

Gallatin County experiences a more spread out and less dense development pattern than the City of Bozeman. Distances are typically greater and the availability of adequate pedestrian facilities is sparse. Along major roadways within the study area, Gallatin County has few dedicated pedestrian facilities with the exception of a few short sidewalks in Four Corners and some shared use paths in Gallatin Gateway and Four Corners. Currently, the County addresses the issue of sidewalks and other pedestrian circulation facilities on a subdivision by subdivision basis. County planners have been working to improve opportunities for inter-modal transportation within subdivisions by encouraging the County Commission to require trail systems, sidewalks, and bike lanes where appropriate. **Figure 2-17** details the existing pedestrian network within the unincorporated study area.

Photo 21: Main Street's wide sidewalks with features such as trees, awnings, decorative lampposts, and benches are comfortable and welcoming to pedestrians.

Existing Study Area Pedestrian Facilities



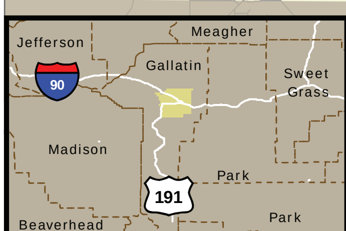


FIGURE 2-17
Existing Study Area Pedestrian Facilities
January 2009
Data Provided by: City of Bozeman, Alta Planning & Design
Map Prepared by: Alta Planning+Design January, 2009

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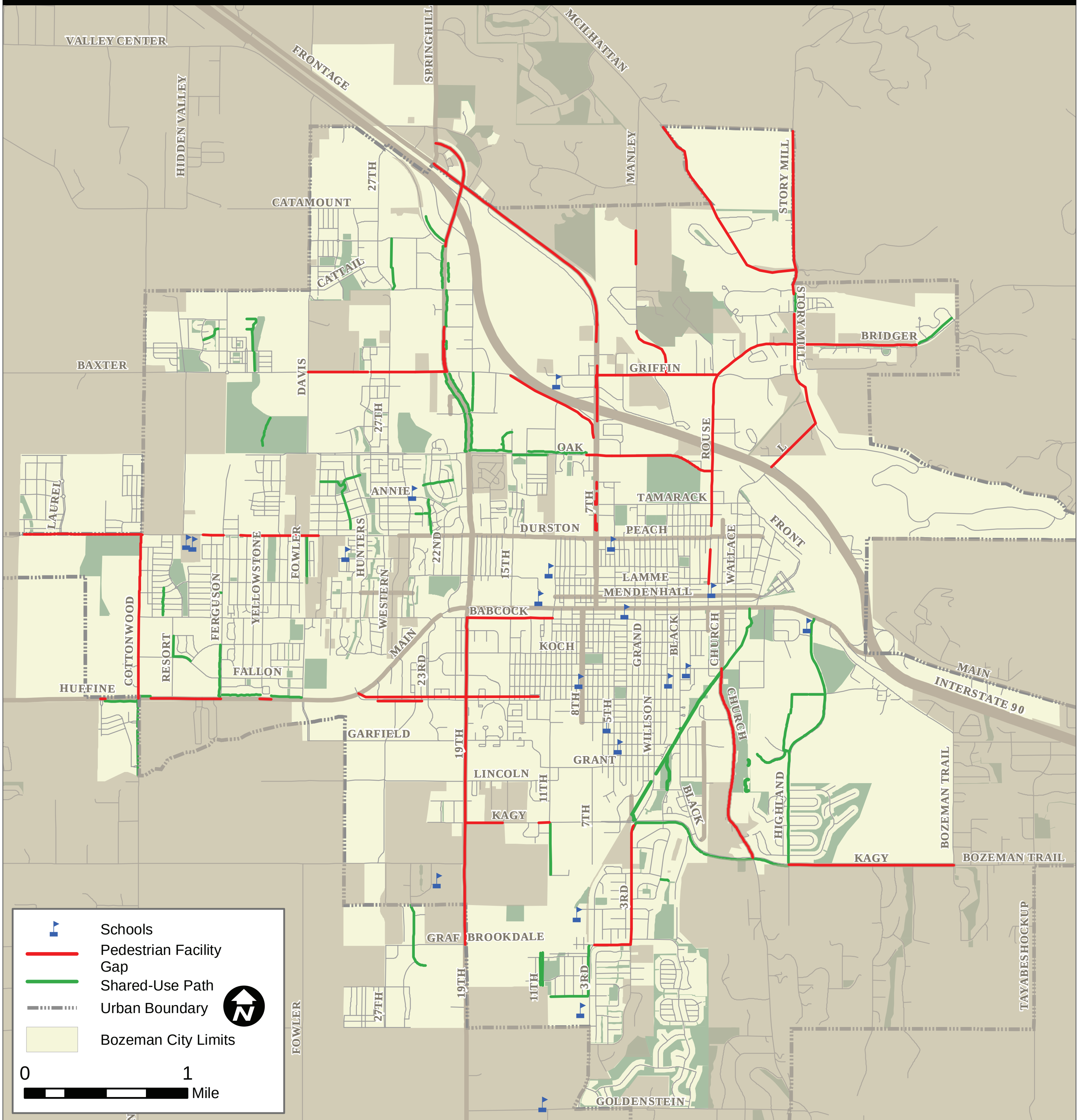
Existing Bozeman Arterial Pedestrian Gaps



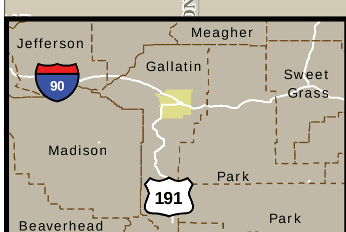


FIGURE 2-18
Existing Bozeman Arterial Pedestrian Gaps
January 2009
Data Provided by: City of Bozeman, Alta Planning & Design
Map Prepared by: Alta Planning+Design January, 2009

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2.3.17 Pedestrian Collision History

Crash data from January 2002 through June 2007 provided by the Bozeman Police Department were analyzed (see **Figure 2-19** and **Figure 2-20**). Fifteen crashes involving a pedestrian were reported in the greater Bozeman study area since 2002, all of which were within the Bozeman city limits. Seven of these crashes were on Main Street, two were on 7th Avenue, two were on Durston/Peach, and others were distributed throughout the city. These numbers, like the bicycle collision data, are likely underreported. The Bozeman Police Department reported that about half of the time the pedestrian was at fault, crossing mid block (jaywalking), or crossing against the signal. There were also several instances of riding on cars or jumping out into traffic.

2.3.18 Pedestrian Facility Maintenance

The City of Bozeman assumes maintenance responsibilities for sidewalks that run adjacent to parks that are adjacent to arterials in residential areas, and where residential lots are double fronted. Currently, all sidewalk maintenance in the City of Bozeman for sidewalks fronting residences is the responsibility of the homeowner. However, the City seeks to provide some level of maintenance support, in large part because there are few contractors willing to take on small concrete jobs, so residents are often unable to find a professional to undertake patching. **Table 2-15** lists pedestrian facility maintenance activities and their frequency. Gallatin County does not have any sidewalks at this time, so maintenance is not directly relevant.

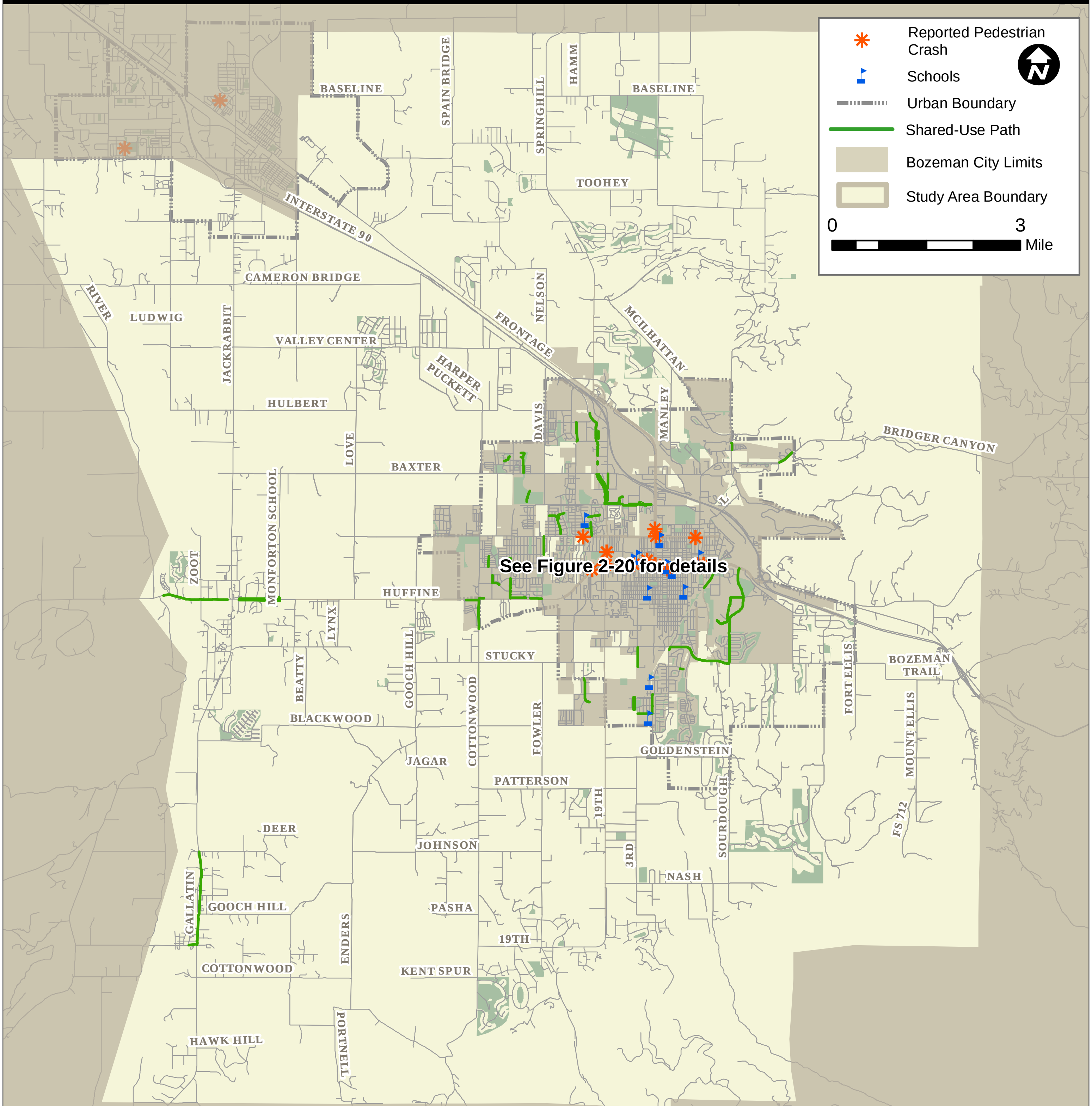
Table 2-15

Pedestrian Maintenance Activities & Frequency[5]

Activity	Frequency	Agency
Sidewalk patching/ root removal	Is homeowner responsibility but City will patch as staffing permits and/or send letter to homeowner explaining their responsibility	City of Bozeman
Vegetation trimming	If sight triangle is blocked, City Forester will trim. Other streets are per citizen complaint; City will fix these as staffing permits and/or send letter to homeowner explaining their responsibility.	City of Bozeman
Snow removal	Is property owner responsibility; City removes snow on sidewalks in front of City facilities, along arterials, and in residential areas with double fronted lots.	City of Bozeman

[5]Source: conversation with John Van Delinder, Bozeman Street Superintendent, on 9-25-07

Study Area Reported Pedestrian Collisions, 2002-2007



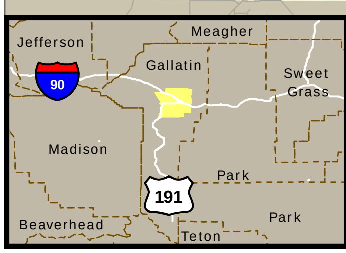


FIGURE 2-19
Study Area Reported Pedestrian Collisions, 2002-2007
January 2009
Data Provided by: City of Bozeman, Alta Planning & Design
Map Prepared by: Alta Planning+Design January, 2009

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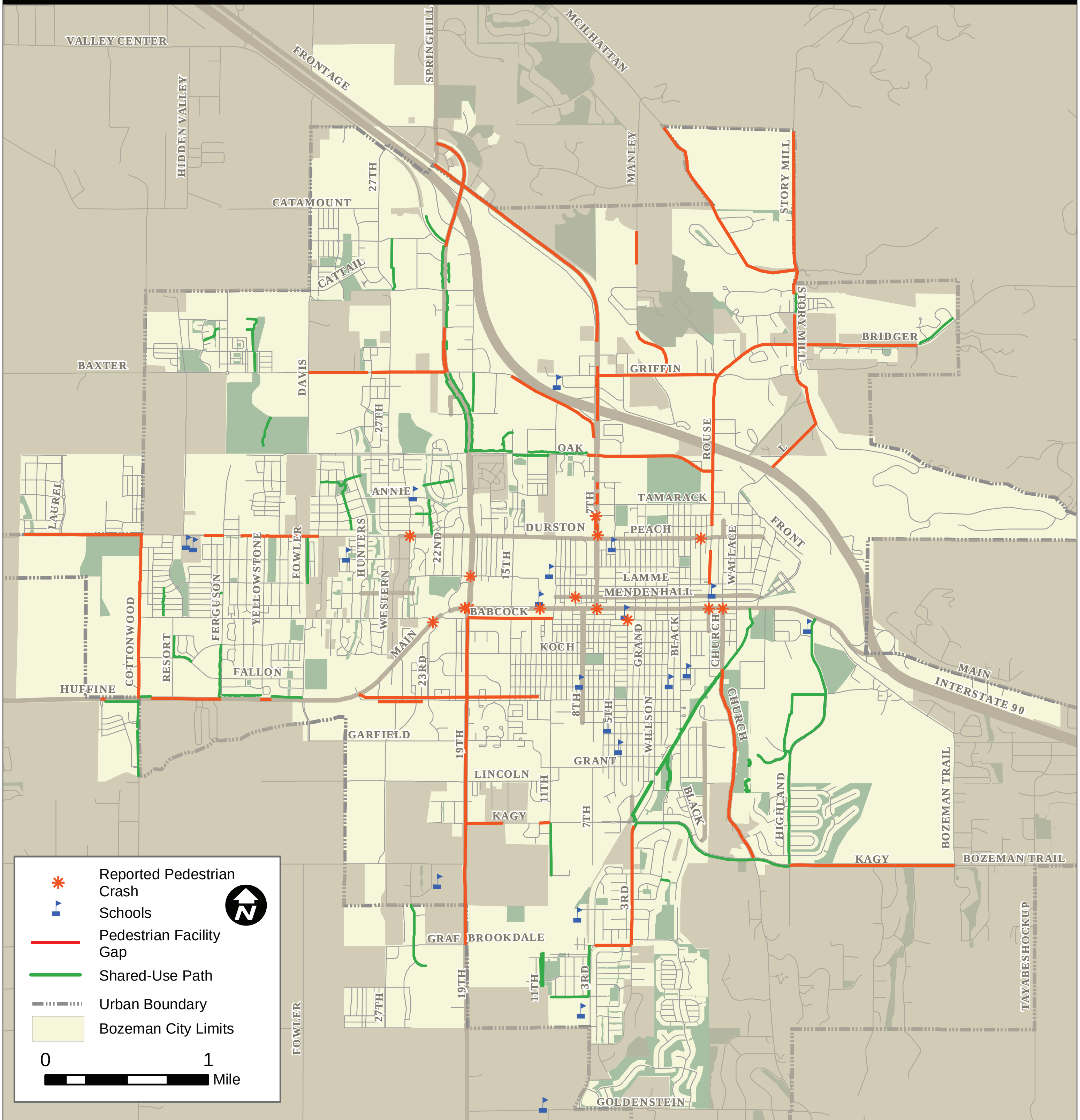
Bozeman Reported Pedestrian Collisions, 2002-2007



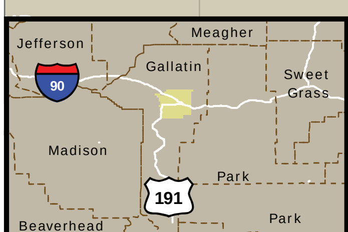


FIGURE 2-20
Bozeman Reported Pedestrian Collisions, 2002-2007.
January 2009
Data Provided by: City of Bozeman, Alta Planning & Design
Map Prepared by: Alta Planning+Design January, 2009

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2.3.19 System Deficiencies

Pedestrians face daily obstacles in Bozeman, as described below.

Maintenance Issues

Existing sidewalks in many parts of Bozeman (e.g., older portions of N. 7th Avenue) suffer from cracking or heaving. Additionally, overgrown vegetation obstructs the sidewalk in some places, forcing pedestrians to walk in the adjacent boulevard strip (if one exists) or road. Construction gravel and debris is not always removed from sidewalks promptly, and during the winter, not all residents remove snow as well as the law requires.

Photo 22: Opportunities exist to improve the conditions of older sidewalks such as this located along Main Street.

Lack of Transit Stop Amenities

The Streamline transit system is relatively new, and designated stops lack shelters, benches, and posted schedules. Walkways providing access to some stops are also in substandard condition.

Lack of Signage

Bozeman's pedestrian system would benefit from signage and other wayfinding tools to orient pedestrians and direct them to and through major destinations like MSU and downtown.

Fragmented Sidewalk Network

Although a relatively complete sidewalk network exists in downtown Bozeman and adjacent neighborhoods, the system is fragmented in other areas. Several major streets (e.g., Huffine Lane and S. 19th Avenue) lack sidewalks altogether while others (e.g. Rouse Avenue and N. 7th Avenue) have partial sidewalks.

While a complete sidewalk inventory was not performed on non-arterial streets, multiple field visits, resident comments in surveys, public meetings, and stakeholder interviews indicated that the residential sidewalk network has numerous gaps and fragments. Sidewalk installation is required on a lot-by-lot basis when the lot is developed, as opposed to when a subdivision is developed; if a lot remains undeveloped for any length of time, the sidewalk system remains incomplete. The City of Bozeman ordinance 18.74.030 addresses this issue by requiring the developer to construct unfinished sidewalks regardless of any other improvements to the lot on the 3rd anniversary of plat recordation.

Rural roadways in the greater Bozeman area generally lack any pedestrian accommodation (though some sidewalks were observed near Four Corners). Some unpaved trails have been provided as development occurs.

Photo 23: Sidewalk gaps in new development areas can exist for up to 3 years. At the end of 3 years the developer is required to finish any undeveloped sidewalk sections.

Photo 24: West Babcock Street (S. 19th to S. 11th Ave) acts as a major pedestrian corridor. Opportunities exist for expanded pedestrian facilities.

Difficult Crossings

Pedestrians face a variety of difficult street crossing conditions:

- Crossing Main Street west of 7th Avenue is challenging due to the street width (5 lanes) and due to relatively long distances between signalized intersections and marked crossings. This discourages pedestrians from walking to services along the roadway. Many chose to dart across the roadway to reach their desired destinations. Many pedestrians are students and families trying to cross between residential neighborhoods south of Main Street and Bozeman High School to the north of Main Street. Likewise, crossing Main Street east of downtown is challenging due to higher vehicle speeds and a lack of crossing treatments.

- Similarly, major arterials throughout the city can be difficult to cross (including 7th Avenue, 19th Avenue, Rouse Avenue, and Kagy Boulevard), with minimal or no crossing treatments. For example, pedestrians encounter relatively high vehicle traffic volumes when crossing Rouse Avenue from Hawthorne School to the north. Additional treatments beyond an existing crosswalk may be necessary to facilitate safe and convenient crossings.

- Pedestrians with disabilities experience crossing difficulties in Bozeman. Main Street has been retrofitted with an accessible sidewalk including curb ramps at every intersection, but curb ramps at intersections in other parts of the city are in poor condition or disrepair, while some intersections lack curb ramps altogether. This can make traveling by wheelchair or motorized mobility device challenging, if not impossible. Visually and mobility impaired pedestrians experience difficulty navigating through intersections with curb ramps oriented diagonally toward the intersection's center rather than perpendicular toward a crosswalk. Signalized intersections also lack audible pedestrian signals to facilitate safe crossings for the visually impaired.

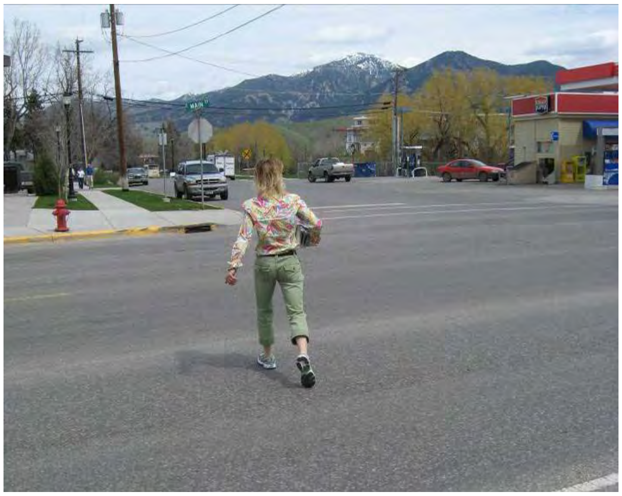


Photo 25 and 26: This intersection along Main Street has a recently installed crosswalk to accommodate crossing pedestrians. The above photos show a before and after of the intersection.

2.3.20 Bicycle and Pedestrian Enforcement

The Bozeman Police Department does enforce vehicle code by stopping and citing pedestrians, bicycles and the vehicles that endanger them. It is typically more difficult to enforce the laws to pedestrians and bicyclists without foot and bicycle units on the streets. The Police Department is frequently understaffed and unable to commit such resources. Generally, enforcement is left to officer discretion. If not responding to a call, officers are encouraged to patrol school zones during student arrival or departure times, stopping vehicles that speed or behave dangerously. Typically citations are made about half the time when a vehicle is stopped; officers also use these stops as an opportunity for driver education. Pedestrian infractions are also enforced, although these rarely end up as citations. The Police Department does also engage in periodic focused enforcement in certain areas. For example, between 50 and 60 citations were issued to drivers and pedestrians in Downtown Bozeman crosswalks over a two-day operation in 2006. In addition, parking officers are encouraged to stop people to correct behavior even though they have no authority to cite.

2.3.21 Public Involvement

The Gallatin Valley and its proximity to a wealth of outdoor activity has in all regards created an active resident base. Trails, bicycle facilities and sidewalks are not typically considered as fringe amenities, but essential components of the lifestyles of area residents. As such, analysis done on the bicycle and pedestrian network within the study area should include the input of stakeholder groups as well as members of the general public. The information collected through the following activities has been included in this analysis of the existing conditions.

Stakeholder Interviews – Five stakeholder groups were interviewed in June of 2007. The groups were selected based on their influence and proximity to local bicycle and pedestrian issues. The meetings gave the stakeholder groups an in-depth opportunity to share their concerns, plans, questions, and hopes for the bicycle/pedestrian element of the transportation planning process. The stakeholder groups included:

- Montana State University
- The Pedestrian and Traffic Safety Committee
- The Bozeman Area Bicycle Advisory Board
- The Safe Trails Coalition
- The Gallatin Valley Land Trust

Each stakeholder group provided the project team with a history of their organization, goals for the bicycle and pedestrian element of the transportation plan, perceived problems and problem areas. A detailed summary of these stakeholder group interviews can be found in the Appendix.

Public Workshop #1 – The first of three public workshops was held on June 27th, 2007 at Bozeman High. This workshop drew over 60 members of the public and was held as part of the Transportation Plan update. After a primer, attendees were allowed to participate in smaller workshop groups. The non-motorized workshop was focused on bicycle and pedestrian issues within the study area. The workshop gave attendees the opportunity to provide open-ended input about problem areas, gaps in the network, or ideas for new facilities. Blank large format maps and comment sheets were provided for attendees to mark up.

Greater Bozeman Area Bicycling and Walking Survey – The public involvement process was expanded further with the launching of the Greater Bozeman Area Bicycling and Walking Survey in August of 2007. The survey was created for online participation with supplemental paper versions being made available at various places around Bozeman including the Senior Center and Library. In addition, the survey was sent out via hard copy to 9,000 households with the September 2007 City of Bozeman water bill. The response to the survey was tremendous, with over 3,200 responses received. Of these responses approximately 1,700 responses were submitted electronically with minimal advertising. Of the 9,000 paper copies distributed though the water bills, 1,581 were returned for a 17.6 percent response rate.

Because of the large response brought by the City of Bozeman water bills the number of responses by location within the Study Area cannot be considered representative, however the responses of certain groups have been analyzed separately where needed.

- **Question 1 – Where do you live?**

Of the participants, 89 percent lived within the City of Bozeman, 8 percent lived in unincorporated Gallatin County, 1.5 percent lived in Four Corners and 1 percent lived in Gallatin Gateway.

- **Question 2 – What age group do you belong to?**

Of the survey respondents, 6 percent were under 25 years old, 7 percent were over 70 and 86 percent fell into the 26-69 age group. Of the aged responses, 4.5 percent of respondents were a student of some kind and 4.8 percent were retired.

- **Question 3 – Do you have children under 16 at home?**

This question helps to identify trends and views of parents with children in school. Of the total responses, nearly 28 percent could be classified as 'parents'.

Questions about walking

- **Question 4 – How often do you walk (transportation or recreation)?**

This question shows that the vast majority of respondents are pedestrians and do use pedestrian facilities very frequently. Fully 84 percent of respondents walked at least weekly with almost 60 percent walking daily or almost daily.

- **Question 5 – If you walk, why do you walk?**

This question distinguishes motives for walking. From a utility point of view, almost 47 percent of respondents walk for errands or other transportation. 32 percent of respondents walk as a means of commuting to work or school. Recreationally, 79 percent of respondents walk for exercise or fitness, of these 62 percent walk for fun. Pets and children had a very large impact on walking with over 55 percent of respondents stating this as a reason for walking – more than for errands or transportation.

- **Question 6 – What are the reasons you don't walk or don't walk more frequently?**

Eleven choices greeted respondents in this question. Of these the top five reasons were distance, the need to carry items, lack of sidewalks or paths, lack of time, and perceived danger from the number and speed of vehicles. The third most stated response (33 percent of respondents) was the lack of sidewalks or paths.

Questions about bicycling

- **Question 7 – How often do you ride a bicycle?**

While nearly all the respondents are pedestrians, fewer rode bicycles frequently. Fully 52 percent of respondents road a bicycle at least weekly with 67 percent several times a month. Of these respondents 30 percent or almost 900 ride a bicycle daily or almost daily. This figure alone means there are a significant amount of bicycles on the roads each day. 17 percent of respondents rode a bicycle rarely, with the final 15 percent not riding a bicycle at all.

- **Question 8 – If you ride a bike, why do you ride?**

This question distinguishes motives for bicycling. From a utility point of view, 57 percent of respondents ride a bike for errands or other transportation with 53 percent riding as a means for commuting to work or to school. Unlike walking, cyclists do not seem to make a distinction between exercise/fitness and recreation or fun. Both choices were even at almost 77 percent. People view riding bikes for fitness as fun.

- **Question 9 – What are the reasons you don't ride a bike or don't ride more frequently?**

The two primary concerns respondents had with cycling were the lack of facilities (bike lanes or paths) (57 percent) and the number of cars/motorists and speed of traffic on the roads (53 percent). These reasons were given almost twice as often as the need to carry things (33 percent), far away destinations (30 percent), poor conditions of existing bicycle facilities (26 percent) and the weather (26 percent).

- **Question 10 – Where would you like to walk and/or bicycle from your home?**

Responses for each of the categories given were high. Transportation related destinations such as neighborhood stores (70 percent), place of work (61 percent) and shopping centers (52 percent) all rated high. Recreational destinations also ranked very high. Parks, swimming pools and recreation areas were cited by 55 percent of respondents while off-road paths garnered the most responses of all destinations with 71 percent. Of interest here is that survey respondents regarded good off-road paths as being not only a facility to make it easier to get places, but they view these facilities as destinations in their own right.

- **Question 11 – Please rate the following potential projects for improving walking and/or biking according to their priority to you.**

This question was the most extensive and perhaps the most important of the survey. Respondents were asked to rate types of projects by importance ranging from high, moderate, neutral, low priority, and an oppose option. Respondents were also given the opportunity to provide their own projects and 558 chose to participate.

Because of the large amount of data generated though this question a system was developed to weight each type of response to produce a score out of a possible 150 points. Positive feedback contributed to this score while negative feedback detracted from it. **Table 2-16** on the following page summarizes the information from this question.

Table 2-16

Potential Project Ranking From Question 11

Ranking	Score/150	Projects
1	117	On-road bike lanes or paved shoulders
2	109	New/improved unpaved trails
3	104	New/improved paved shared-use paths
4	102	Safe Routes to School programs and improvements
5	102	Increased maintenance (sweeping/plowing of bike lanes, sidewalks, and trails, hedge trimming, etc.)
6	101	Increased enforcement for traffic violations (e.g. speeding, red light running, parking violations)
7	99	Traffic calming projects to slow/reduce vehicles
8	96	Education or promotional programs for children
9	94	Signed on-road bike routes
10	92	Intersection/crossing improvements
11	91	Improved pedestrian/bicycle connection to MSU
12	87	New/improved marked crosswalks
13	86	Education or promotional programs for cyclists
14	86	Improve sidewalks for disability access
15	82	Education or promotional programs for drivers
16	77	New/improved sidewalks
17	69	Access to transit (bike racks on buses, sidewalks leading to stops, etc.)
18	66	More/better bicycle parking

From the above analysis it is apparent that new on and off-street bicycle facilities ranked consistently the highest in desire by survey respondents. Safe Routes to School related programs and improvements ranked fourth among respondents. Also of high importance was increased maintenance and enforcement of bicycle and pedestrian facilities. Educational programs received a moderate amount of importance and surprisingly, bicycle parking ranked lowest. This may indicate that finding a place to park a bicycle is not a significant deterrent to bicycling in the Bozeman Area and that for the most part bicycle parking is adequate.

- **Question 12 – Please provide the specific locations and a description of up to three high-priority projects identified in question 11.**

Responses related to bicycling had high instances of new bike lane projects around problem streets. The most numerous responses, based on the response of 2005 separate written comments, were received and included the following:

- Connections to Belgrade and Four Corners
- More trails and shared-use paths
- Better connections to many local trailheads
  - “M” Trail
  - Bozeman Creek Trail
  - Sourdough Trail

- Bike Lanes
    - Main Street
    - Willson Street
    - Babcock Street
    - Durston Road
    - Rouse Avenue
    - Mendenhall Street
    - Sourdough Road
    - 19th Street – Access to shopping
    - Kagy Boulevard
    - College Street
    - 11th Avenue
    - N. 7th Ave
    - S. 8th Ave
    - Highland Boulevard
    - Garfield Street
    - Bridger Drive
- More bike racks on Main Street (and downtown) and at the Library
- Shoulders on rural roadways
    - Goldstein Lane
    - Bridger Drive
    - Sourdough Road
    - Frontage Roads
    - Church Street
- High Speeds of cars
- Red light enforcement
- Driver awareness

Responses related to pedestrian conditions focused primarily on the following areas:

- Winter snow removal
- Sidewalk maintenance (including vegetation)
- New sidewalks where there aren't any currently
- Disability access
- Difficult crossings – new crosswalks
- High speeds of cars
- Driver awareness
- Red light enforcement
- More trails that connect to places

Additional areas that exhibited high instances of responses were calls for traffic calming on residential streets that have high speeds.

- **Question 13 – Is there anything else you'd like to tell us about walking and/or bicycling in the Bozeman area?**

This question produced 1,647 almost totally unique responses. The responses were reviewed, however many of the conclusions that can be made mirror those from question 12.

- **Question 14 – Would you like to receive information about future public meeting for the Transportation Plan?**

This question provided the project team with 1,043 new email addresses for project related newsletter and information distribution.

2.3.22 Equestrian Issues

There are no public trail systems in the City of Bozeman that allow for equine travel. Historically, equestrians have used the rural road network of unpaved roads to travel between the many equestrian facilities within the planning boundary, as well as to MSU and the Fairgrounds. As Bozeman grows, it is becoming increasingly difficult for them to access these sites.

Photo 27: A group of equestrians traveling along a rural roadway in Gallatin County.

3.1 INTRODUCTION

The method and process used to predict growth in the Bozeman area up to the year 2030 is contained in this chapter of the Transportation Plan. By using population, employment and other socioeconomic trends as aids, the future transportation requirements for the Bozeman area were defined. A model of the transportation system for the Bozeman area was built with the additions and changes to the system that are projected to occur up to the year 2030 being applied to the model to forecast the future transportation conditions. From this model, various scenarios were developed to test a range of transportation improvements to determine what affects they would have on the transportation system.

3.2 SOCIO-ECONOMIC TRENDS

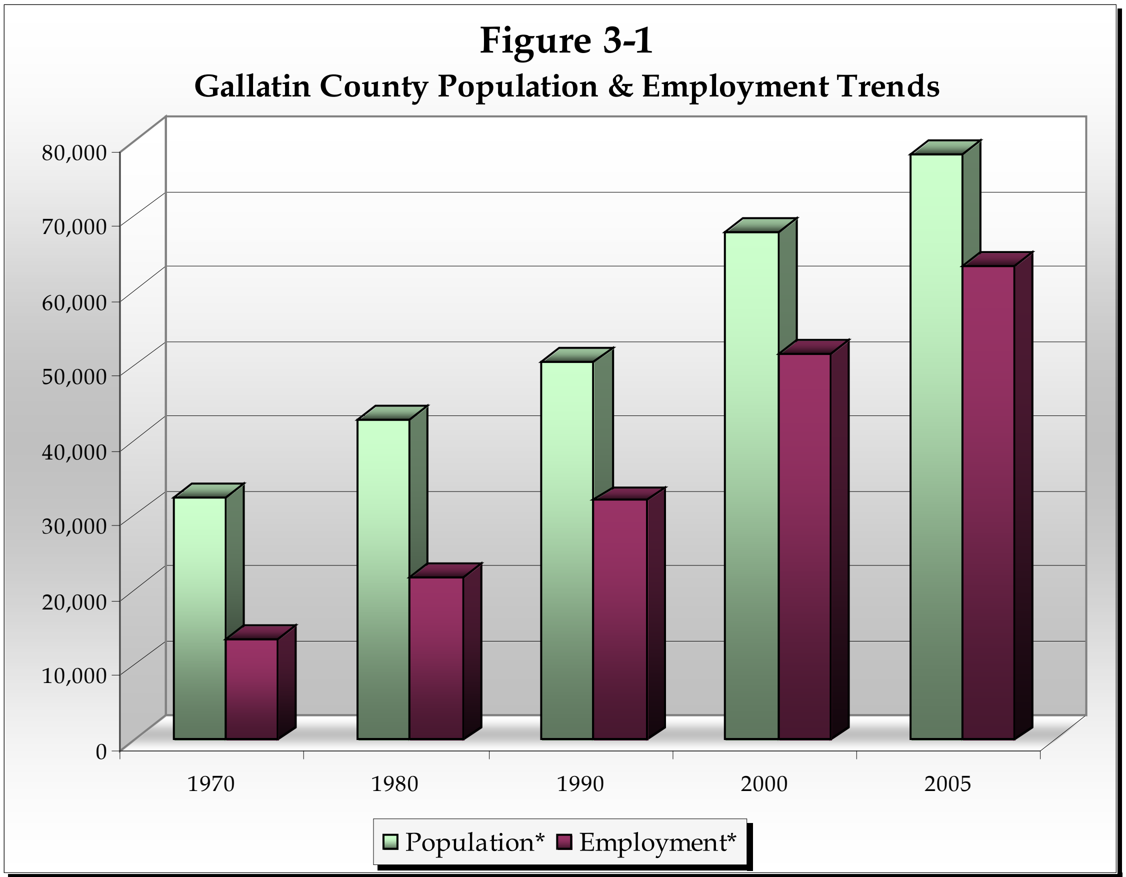
There is a direct correlation between motor vehicle travel growth and population and economic growth. The influx of traffic relating to the MSU campus being located in Bozeman is also of significant concern. The population in Gallatin County has seen significant increases since 1990 and has nearly doubled since 1980. There has been a 55 percent increase in population in Gallatin County between 1990 and 2005 alone. The employment numbers have also seen significant growth; between 1990 and 2005 the employment in Gallatin County has doubled. **Table 3-1** and **Figure 3-1** show the population and employment numbers for Gallatin County between 1970 and 2005.

Table 3-1
Gallatin County Population and Employment Trends (1970-2005)

Year	Population*	Employment**
1970	32,505	13,396
1980	42,865	21,797
1990	50,463	31,978
2000	67,831	51,586
2005	78,262	63,379

*Source: Us Bureau of the Census, Census of Population

**Source: US Department of Commerce, Bureau of Economic Analysis, REIS Data Series

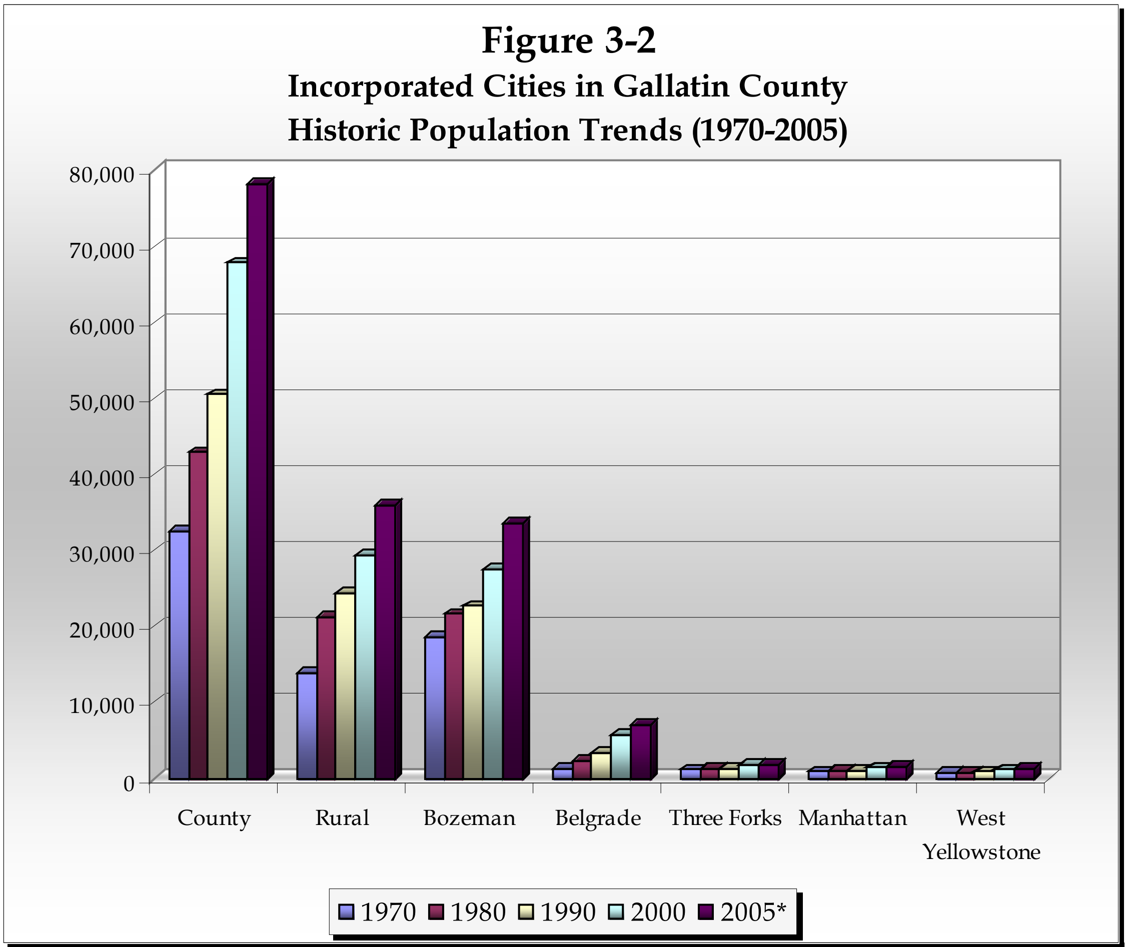


The population trends within Gallatin County in relation to the incorporated cities and the rural area are shown in **Table 3-2** and **Figure 3-2**. The incorporated cities in Gallatin County are Bozeman, Belgrade, Three Forks, Manhattan, and West Yellowstone. The population has increased significantly in each incorporated city as well as the rural areas since 1980. Bozeman has had a population increase of 44.6 percent between 1990 and 2005, while Belgrade has more than doubled in population in the same time period.

Table 3-2
Incorporated Cities in Gallatin County Historic Population Trends (1970-2005)

Year	County	Rural	Bozeman	Belgrade	Three Forks	Manhattan	West Yellowstone
1970	32,505	13,835	18,670	1,307	1,188	816	756
1980	42,865	21,220	21,645	2,336	1,247	988	735
1990	50,463	24,392	22,660	3,411	1,203	1,059	905
2000	67,831	29,371	27,509	5,728	1,728	1,396	1,177
2005*	78,262	35,943	33,535	7,033	1,845	1,465	1,223

Source: US Bureau of the Census, Census of Population
*Population data are estimates



In recent decades there were other notable changes in Gallatin County's population. In Gallatin County, and elsewhere in Montana and the nation, the population's age profile got older. Between 1970 and 2000, the number of county residents under the age of 18 increased by 5,232 persons, residents age 18 to 64 increased by 26,942 persons, and residents 65 and older increased by 3,152 persons. As "Baby Boomers" got older, they simply had fewer children than their parents. The change in age can be seen in **Table 3-3**. The percentage of each age group is shown graphically in **Figure 3-3**. From this figure, it is apparent that there has been an increase in the age group of 18-64 and a decrease in people less than 18 years of age. A more detailed age distribution for Gallatin County for the year 2000 is shown in **Figure 3-4**.

Table 3-3
Gallatin County Age Distribution (1970-2000)

Year	Age			Total
	<18	18-64	65+	
1970	9,667	20,220	2,618	32,505
1980	10,202	29,448	3,215	42,865
1990	12,263	33,709	4,491	50,463
2000	14,899	47,162	5,770	67,831
Change (1970-2000)	**5,232**	**26,942**	**3,152**	**35,326**

Source: US Bureau of the Census, Census of Population

Figure 3-3
Gallatin County Age Distribution (1970-2000)

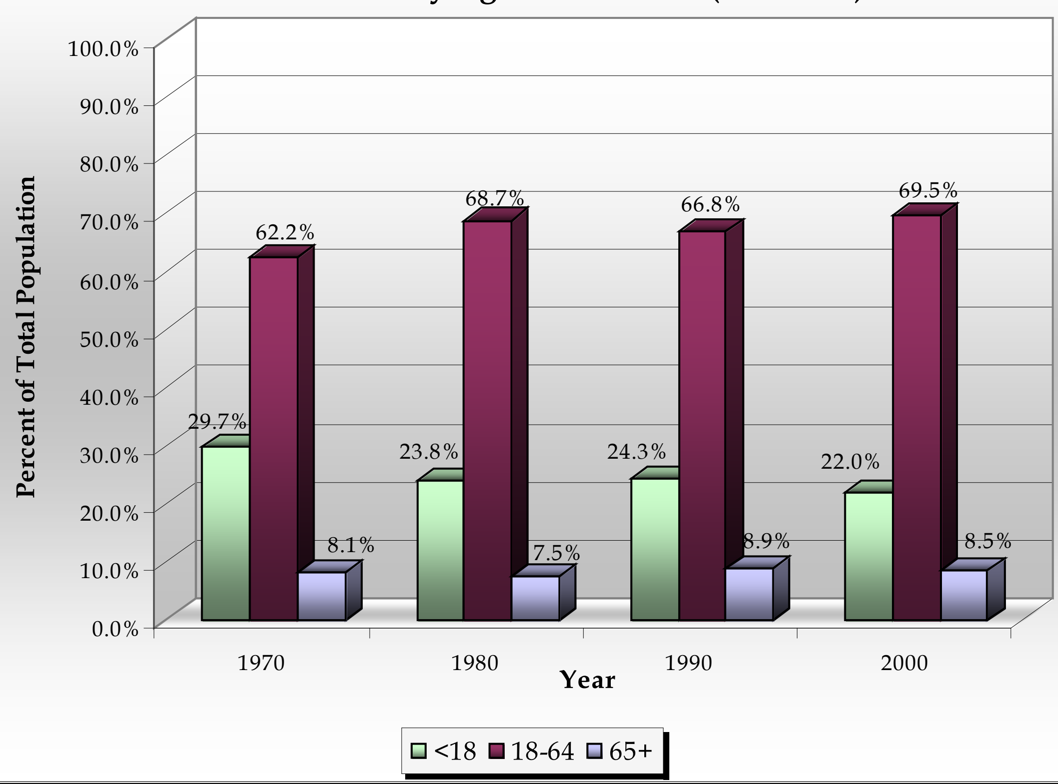
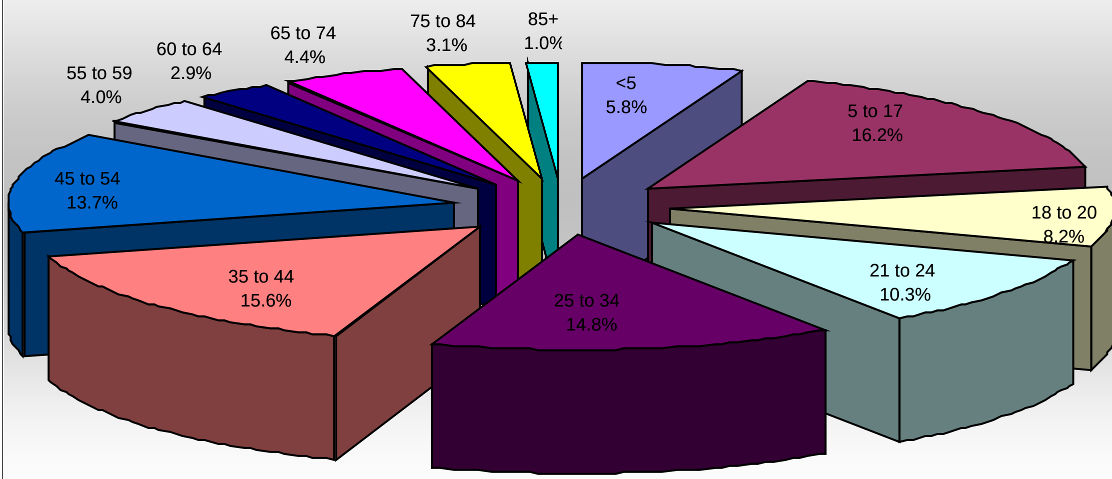


Figure 3-4
Gallatin County Age Distribution (2000)

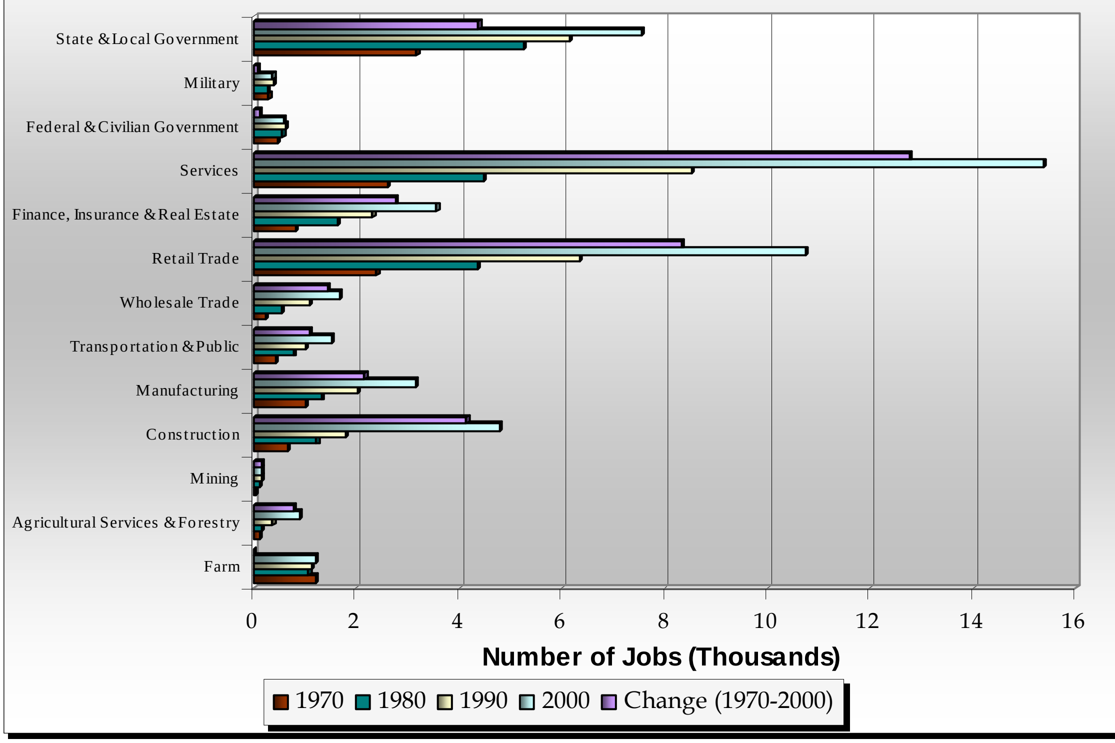


In 2000, there were 51,586 jobs in Gallatin County. This number is almost four times the amount of 13,396 jobs that existed in 1970. Every sector has seen an increase in jobs since 1970 except for farming. **Table 3-4** displays countywide employment by economic sector from 1970 through 2000. This information is shown graphically in **Figure 3-5**.

Table 3-4
Gallatin County Employment Trends by Economic Sector (1970-2000)

Economic Sector	1970	1980	1990	2000	Change (1970-2000)
Farm	1,212	1,075	1,128	1,193	-19
Agricultural Services & Forestry	106	172	370	882	776
Mining	30	105	174	173	143
Construction	656	1,227	1,805	4,801	4,145
Manufacturing	1,002	1,328	2,030	3,164	2,162
Transportation & Public Utilities	420	772	1,025	1,519	1,099
Wholesale Trade	247	555	1,101	1,692	1,445
Retail Trade	2,394	4,355	6,334	10,733	8,339
Finance, Insurance & Real Estate	812	1,622	2,315	3,562	2,750
Services	2,598	4,491	8,527	15,360	12,762
Federal & Civilian Government	454	567	610	580	126
Military	293	279	404	374	81
State & Local Government	3,172	5,249	6,155	7,553	4,381
Total Employment	**13,396**	**21,797**	**31,978**	**51,586**	**38,190**

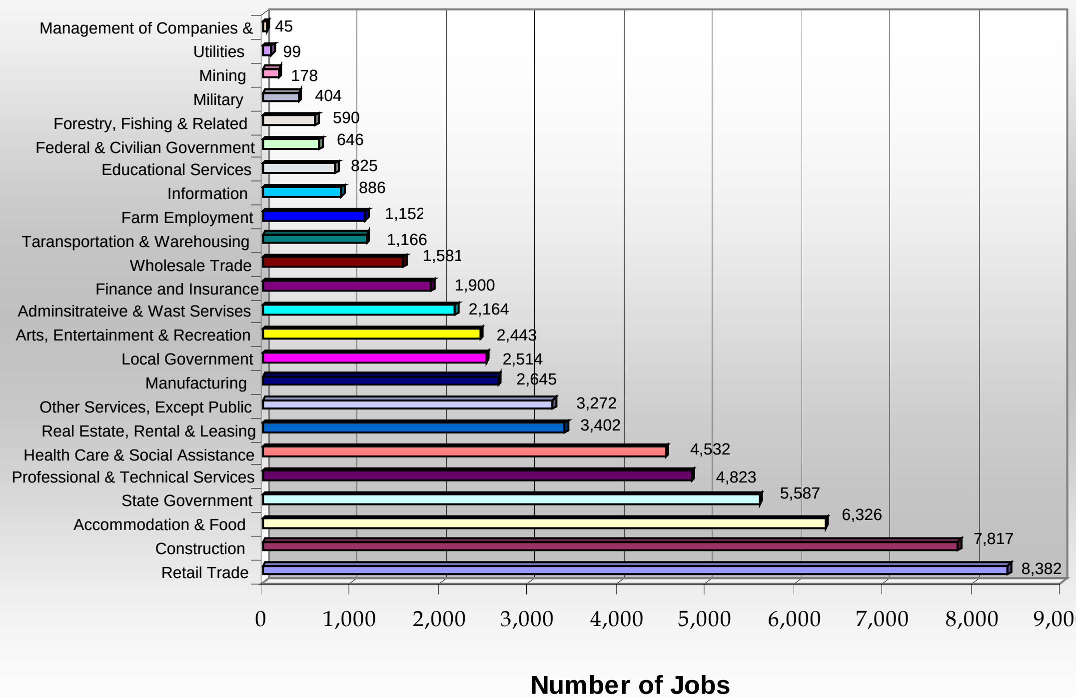
Figure 3-5
Gallatin County Employment Trends by Economic Sector (1970-2000)



An employment breakdown for Gallatin County in 2005 is shown in **Figure 3-6**. The employment in this graphic is broken out by economic sector based on classification by the *North American Industry Classification System (NAICS)*. This type of classification is the standard for all employment figures after 2000. NAICS classification is a more detailed approach to show employment figures than the economic sector approach. The highest employment sector for Gallatin County based on NAICS is retail. Construction is close behind retail for the second highest employment sector, followed by accommodation and food services.

Figure 3-6

Gallatin County Employment Trends by NAICS (2005)



The economic trend data presented in **Figure 3-5** and **Figure 3-6** is not surprising, given the amount of growth in Gallatin County. There has been a large increase in the amount of part-time jobs, many of which are in the retail and food service industry. The increase in population to Gallatin County has also sparked a large increase in construction and real estate related jobs. The increase in the number of jobs in technical and high end jobs can be partially attributed to an increase in the number of people with college educations. With MSU being located in Bozeman, there are a large number of college graduates that elect to stay in the Bozeman area after they graduate. The fundamental importance of understanding economic trends is that eventually, the numbers and types of jobs correlate to vehicle travel on our transportation system.

3.3 Population and Employment Projections

Population and economic projections are used to predict future travel patterns, and to analyze the potential performance capabilities of the Bozeman area transportation system. Projections of the study area's future population and employment are developed from Gallatin County trends (regression line projections), ongoing Growth Policy discussions, and estimates presented by *Woods and Poole Economics, Inc.* Three projection scenarios are provided through the year 2030 (the planning horizon) and are discussed below.

The first scenario that is presented is referred to as the "Moderate Growth" scenario. This is the scenario that is most likely to occur, based on past trends and what has happened in other Montana community's over the past thirty years. This scenario was selected as the basis for the transportation modeling. It represents a continuation of the current population and growth trends already observed as presented in **Section 3.1**, such that adequate services and infrastructure will be planned for if the current levels of development continue. It assumes that the Gallatin County population and economy will grow to the numbers specified by *Woods and Poole Economics, Inc.* If this growth rate pattern does not develop further, or is not sustained, then demand will not occur as planned for in this Transportation Plan, and projects may be delayed or avoided.

A second scenario was also developed, and is referred to as the "Low Growth" scenario. It builds from much of the population and employment trends that were realized in the 1980's, where growth was fairly flat due to many different circumstances.

Lastly, a third growth scenario, referred to as a "High Growth" situation, was developed to reflect a more aggressive growth pattern in both population and employment. This growth trend is patterned after population and employment trends that were realized between 1990 and 2005, where growth was higher than in past years. A breakdown of the population and employment projections produced in each scenario are presented in **Table 3-5** and shown graphically in **Figure 3-7** and **Figure 3-8**.

Table 3-5
Gallatin County Population and Employment Projections (2005-2030)

Year	Low Growth		Moderate Growth		High Growth	
	Population	Employment	Population	Employment	Population	Employment
2005	78,262	63,379	78,262	63,379	78,262	63,379
2010	84,935	68,277	87,406	69,680	90,727	73,474
2015	92,177	73,554	97,618	76,607	105,187	85,176
2020	100,037	79,238	109,023	84,223	121,930	98,742
2025	108,567	85,362	121,760	92,596	141,350	114,470
2030	117,824	91,959	135,986	101,802	163,863	132,702

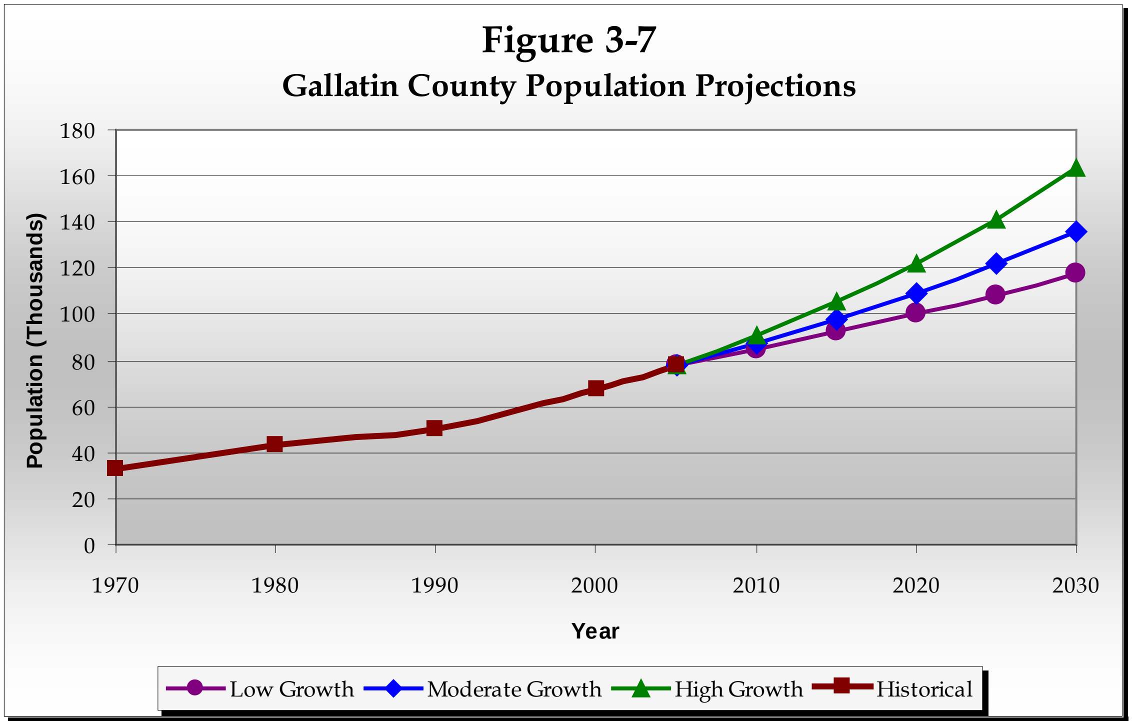


Figure 3-7
Gallatin County Population Projections
Population (Thousands)
180
160
140
120
100
80
60
40
20
0
1970
1980
1990
2000
2010
2020
2030
Year
Low Growth
Moderate Growth
High Growth
Historical

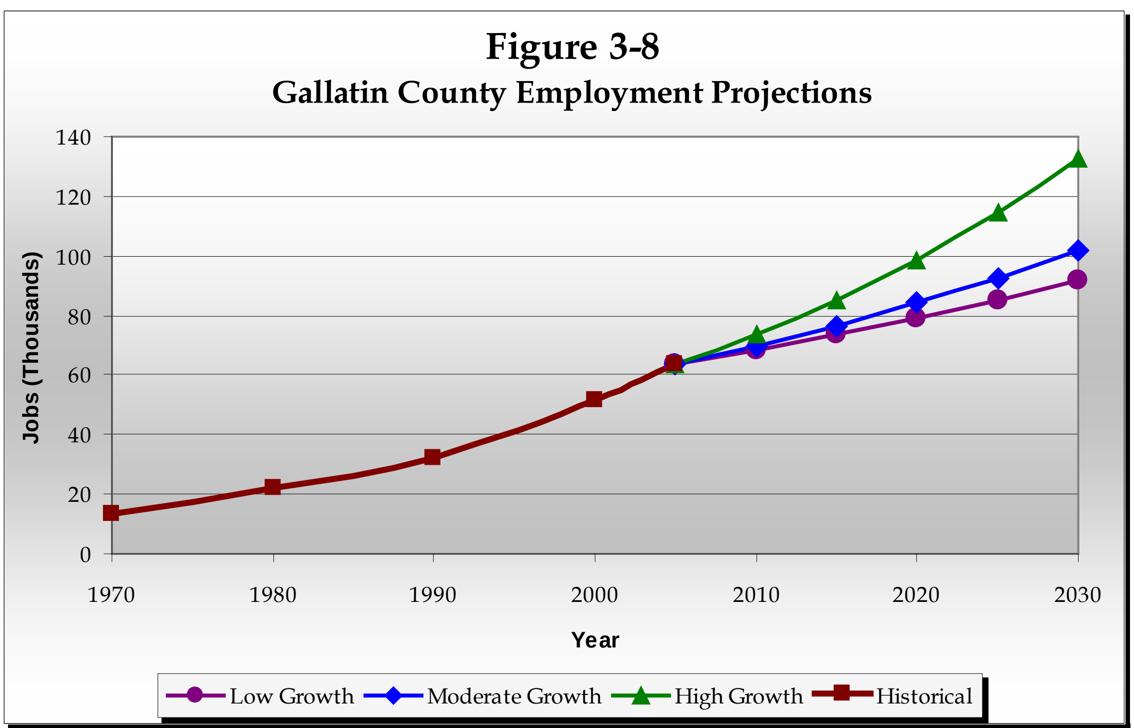


Figure 3-8
Gallatin County Employment Projections
Jobs (Thousands)
140
120
100
80
60
40
20
0
1970
1980
1990
2000
2010
2020
2030
Year
Low Growth
Moderate Growth
High Growth
Historical

3.4 FUTURE DWELLING UNITS

The number of dwelling units is a key component in the traffic model. Dwelling units distribute people throughout the network to given locations. They represent the population and act as a hub for traffic within the network. Having an accurate value for the number of people per dwelling unit helps distribute the traffic more accurately. However, it is often quite difficult to accurately represent the population through dwelling units. This is in part because the number of people per dwelling units varies based on location and can change at any time. The best that can be done is to take an average for the entire network and apply that value to the model.

In the year 2005, the population in Gallatin County was 78,262 people according to the 2005 census. The traffic model developed for the greater Bozeman area uses 32,495 dwelling units for Gallatin County. This works out to be approximately 2.41 people per dwelling unit. A recent road impact fee study for Gallatin County showed that there was expected to be 2.41 people per dwelling unit in the year 2030. The City of Bozeman Water Facility Plan shows that, "in 1990 the average number of people per dwelling unit was 2.5, while in 2000 the average number declined to 2.3 people per dwelling unit." Based on this information, an average of 2.41 people per dwelling unit was used in this plan.

It is expected that the average number of people per dwelling unit for the entire Gallatin County will be slightly higher than that of the city of Bozeman alone. It is also expected that the average number of people per dwelling unit for the study area would more accurately reflect the county wide ratio. Based on a value of 2.41 people per dwelling unit, there will be approximately 56,462 total dwelling units in the year 2030. This works out to be 23,967 additional units compared to 2005 numbers. The results up to the year 2030 can be found in **Table 3-6**. This table represents the estimated projected dwelling units based on 2.41 people per dwelling unit using the previously estimated population from **Table 3-5**.

Table 3-6
Gallatin County Projected Dwelling Units

Year	Population	Dwelling Units*	
		Total	Additional
2005	78,262	32,495	0
2010	87,406	36,291	3,797
2015	97,618	40,531	8,037
2020	109,023	45,267	12,772
2025	121,760	50,555	18,061
2030	135,986	56,462	23,967

*Dwelling unit projection based on 2.41 people per dwelling unit

3.5 FUTURE EMPLOYMENT

Employment numbers are used in the traffic model to help distribute vehicle traffic as accurately as possible. Places with high levels of employment will tend to generate high levels of vehicle traffic. The traffic generated is based in part on the employment type: either retail or non-retail jobs. Non-retail jobs consist of all types of jobs broken out by the NAICS classifications shown in **Figure 3-5** excluding "retail trade."

The "Moderate Growth" scenario presented in **Table 3-5** shows an estimated 101,802 total jobs available in the year 2030. This works out to be 38,423 new jobs between 2005 and 2030. Of the 38,423 new jobs in the year 2030, 12,203 (or 32%) are expected to be retail and 26,220 (or 68%) are expected to be non-retail. A summary of the number of projected additional employment can be found in **Table 3-7** below.

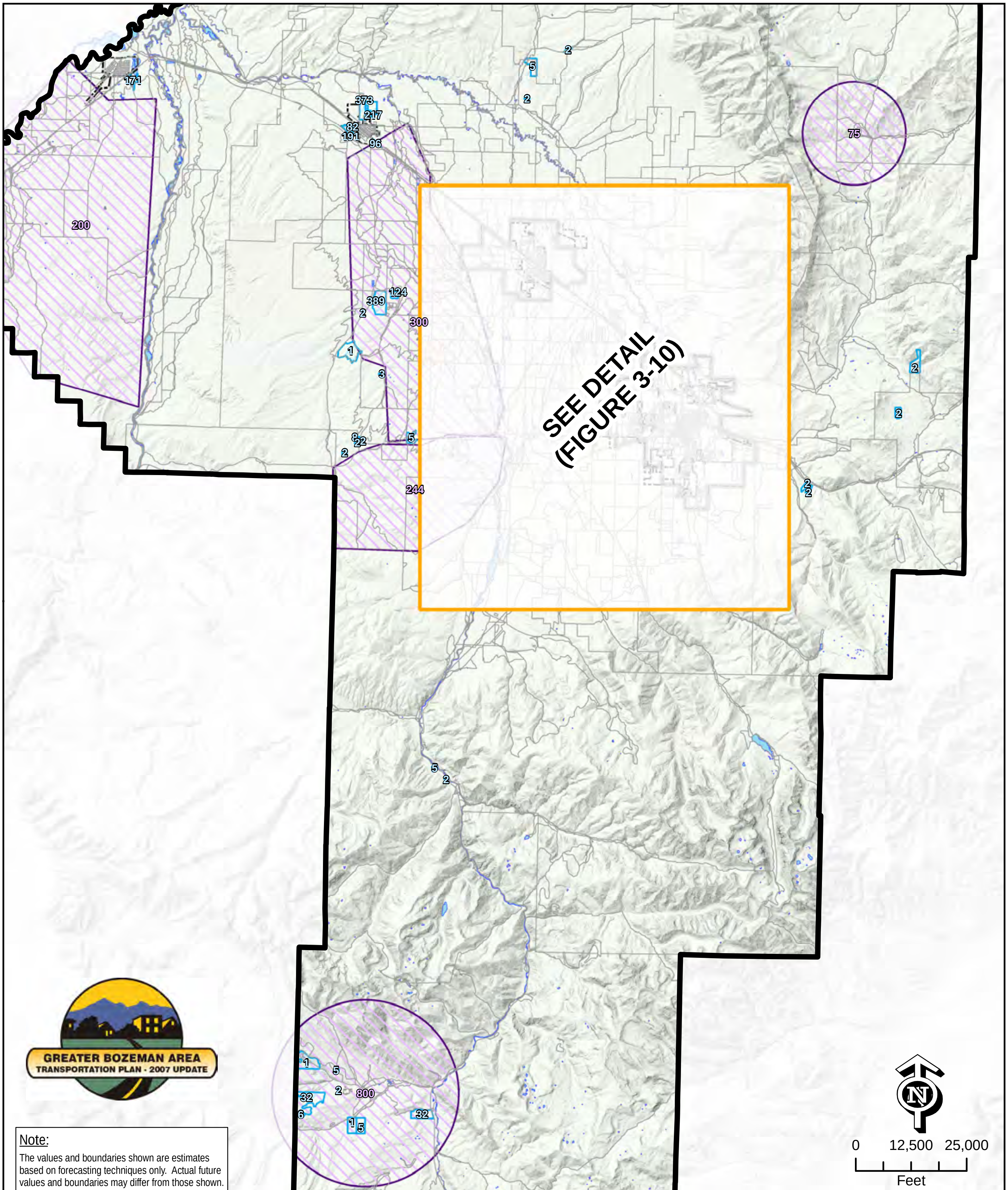
Table 3-7
Gallatin County Projected Additional Employment

Year	Jobs		
	Retail	Non-Retail	Total
2005	0	0	0
2010	2,001	4,300	6,301
2015	4,201	9,027	13,228
2020	6,620	14,224	20,844
2025	9,279	19,938	29,217
2030	12,203	26,220	38,423

3.6 ALLOCATION OF GROWTH

Montana Department of Transportation's modeling of future traveling patterns out to the year 2030 planning horizon required identification of future socioeconomic characteristics within each census tract and census block. County population and employment projections were translated to predictions of increases in housing and employment within Gallatin County. To accomplish this task, a "Land Use Advisory Committee" (LUAC) was formed to discuss and reach consensus on the distribution of future housing and employment growth in the planning area. The committee's membership was comprised of staff from public agencies and utilities familiar with ongoing development trends in Gallatin County. A LUAC meeting was held on August 20th, 2007 to discuss the future development in the planning area.

The committee's work considered recent land use trends, land availability and development capabilities, land use regulations, planned public improvements, and known development proposals. It also included a review of the previous land use assumptions associated with the Belgrade Interchange. **Figures 3-9** and **3-10** show where potential dwelling units are expected to be developed up to the year 2030 in Gallatin County. **Figures 3-11** thru **3-13** show the projected employment values throughout Gallatin County for the year 2030.



Note:
The values and boundaries shown are estimates based on forecasting techniques only. Actual future values and boundaries may differ from those shown.

Legend

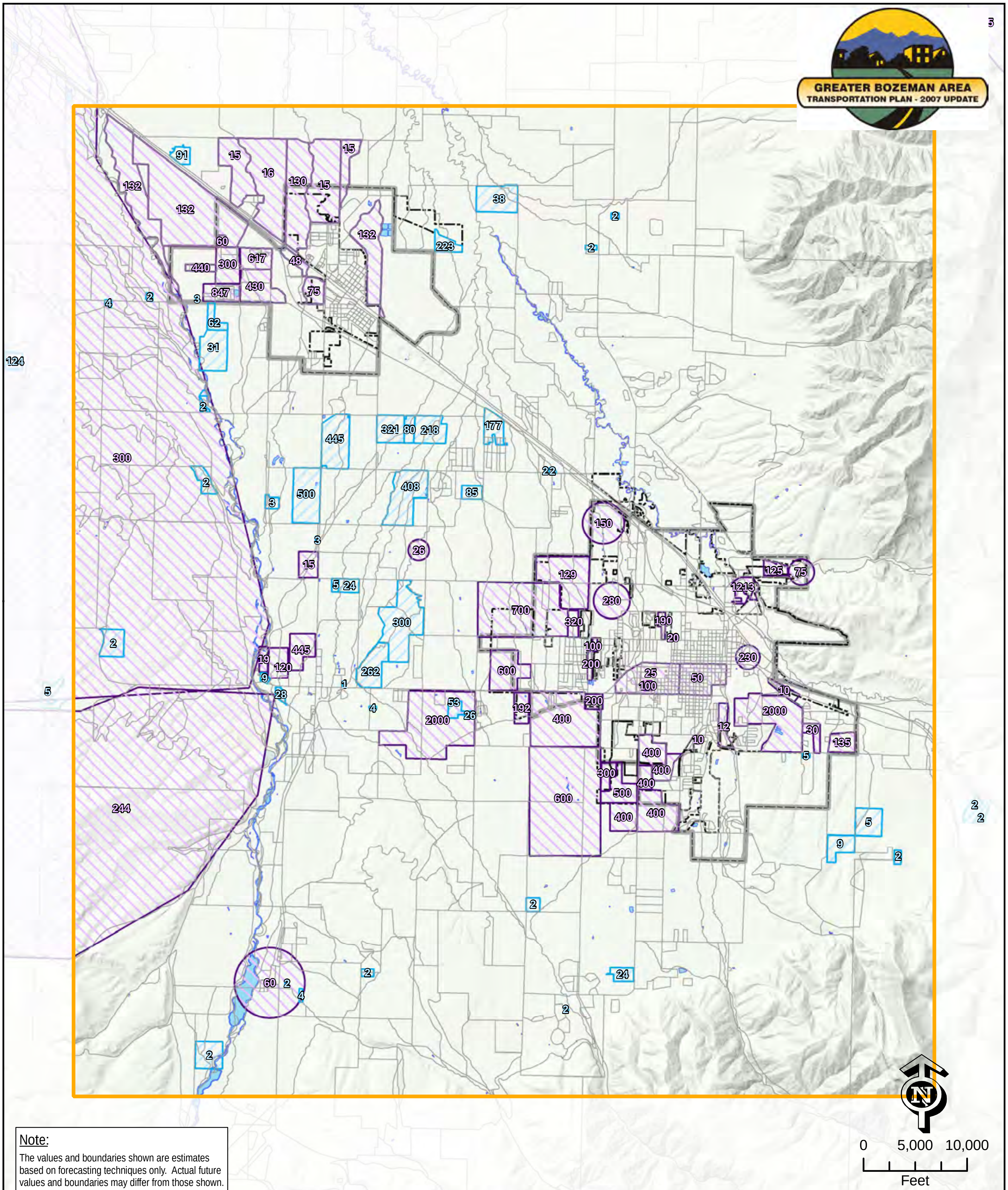
- 86 — Currently Proposed Additional Dwelling Units (as of 10/07)
- 100 — Additional Forecasted Residential Dwelling Units
- Census Block
- County Boundary
- Detail Area
- City Boundary
- Urban Boundary

RPA

Greater Bozeman Area Transportation Plan (2007 Update)

Gallatin County Additional Future (2030) Dwelling Units

Figure 3-9

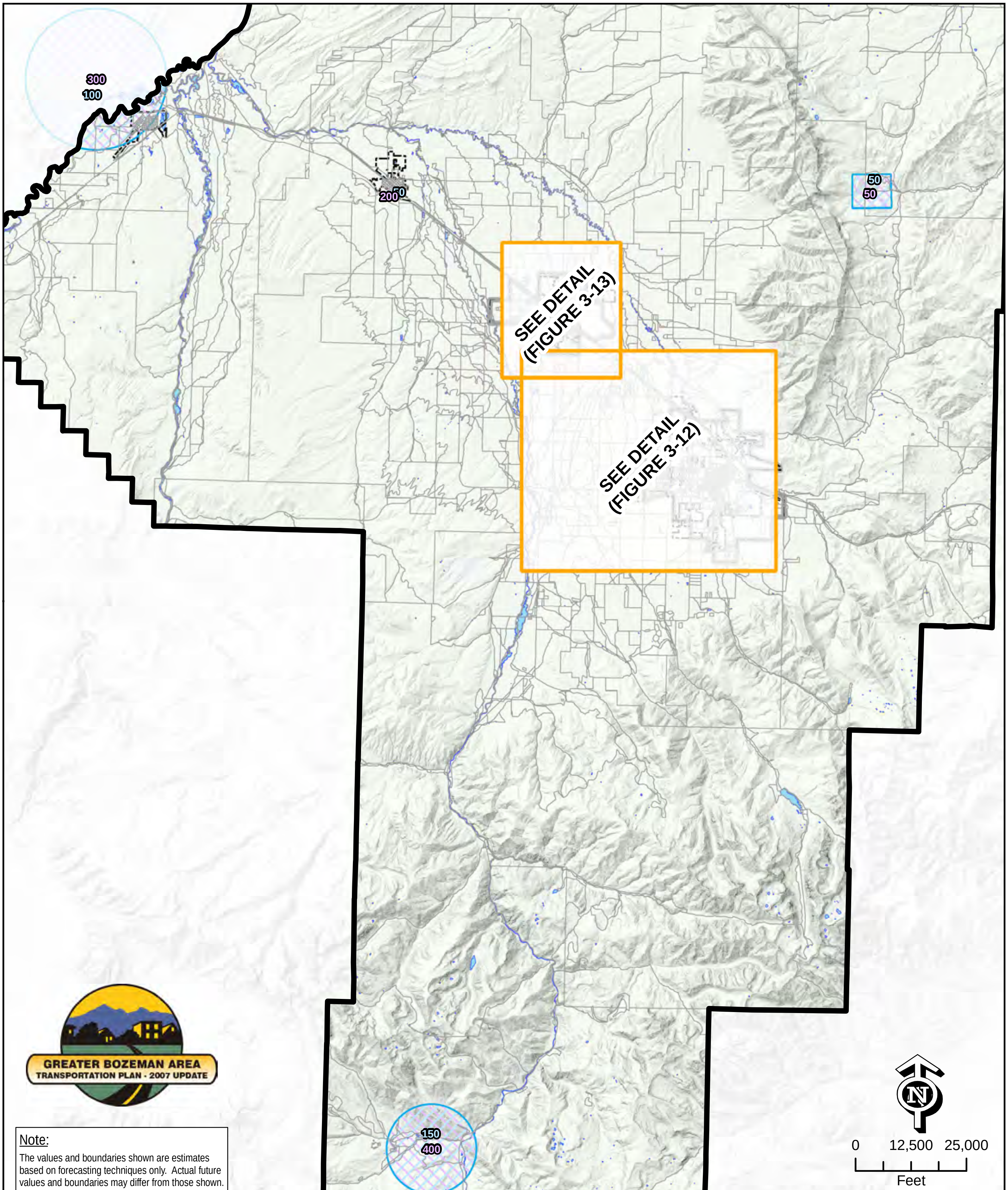


Legend

86	Currently Proposed Additional Dwelling Units (as of 10/07)		County Boundary
			Detail Area
100	Additional Forecasted Residential Dwelling Units		City Boundary
	Census Block		Urban Boundary

Greater Bozeman Area Transportation Plan (2007 Update)

Gallatin County Additional Future (2030) Dwelling Units
Figure 3-10



Note:
The values and boundaries shown are estimates based on forecasting techniques only. Actual future values and boundaries may differ from those shown.

Legend

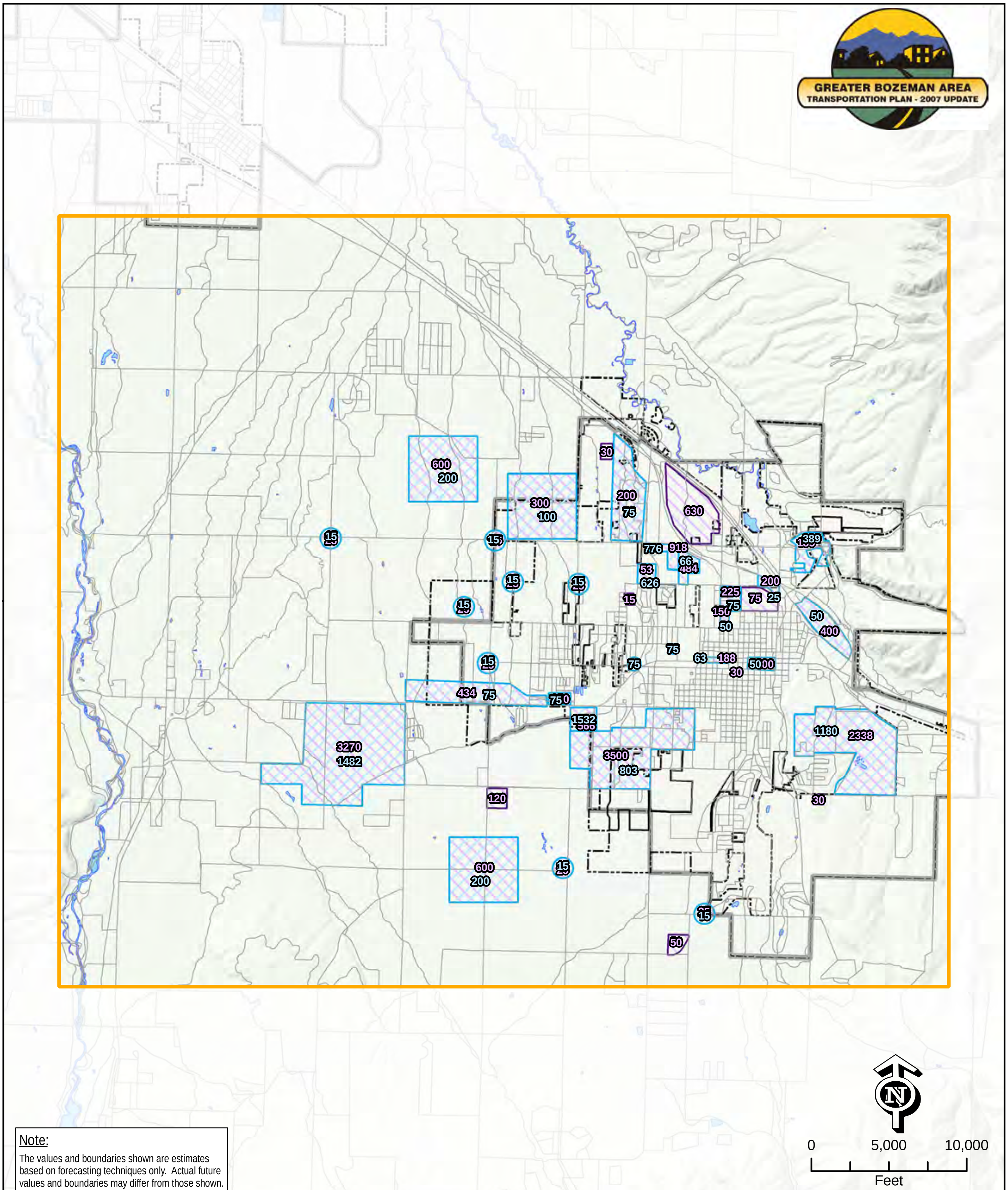
86	Additional Forecasted Retail Jobs		County Boundary
			Detail Area
100	Additional Forecasted Non-Retail Jobs		City Boundary
	Census Block		Urban Boundary

RPA

Greater Bozeman Area Transportation Plan (2007 Update)

Gallatin County Additional Future (2030) Employment

Figure 3-11



Legend

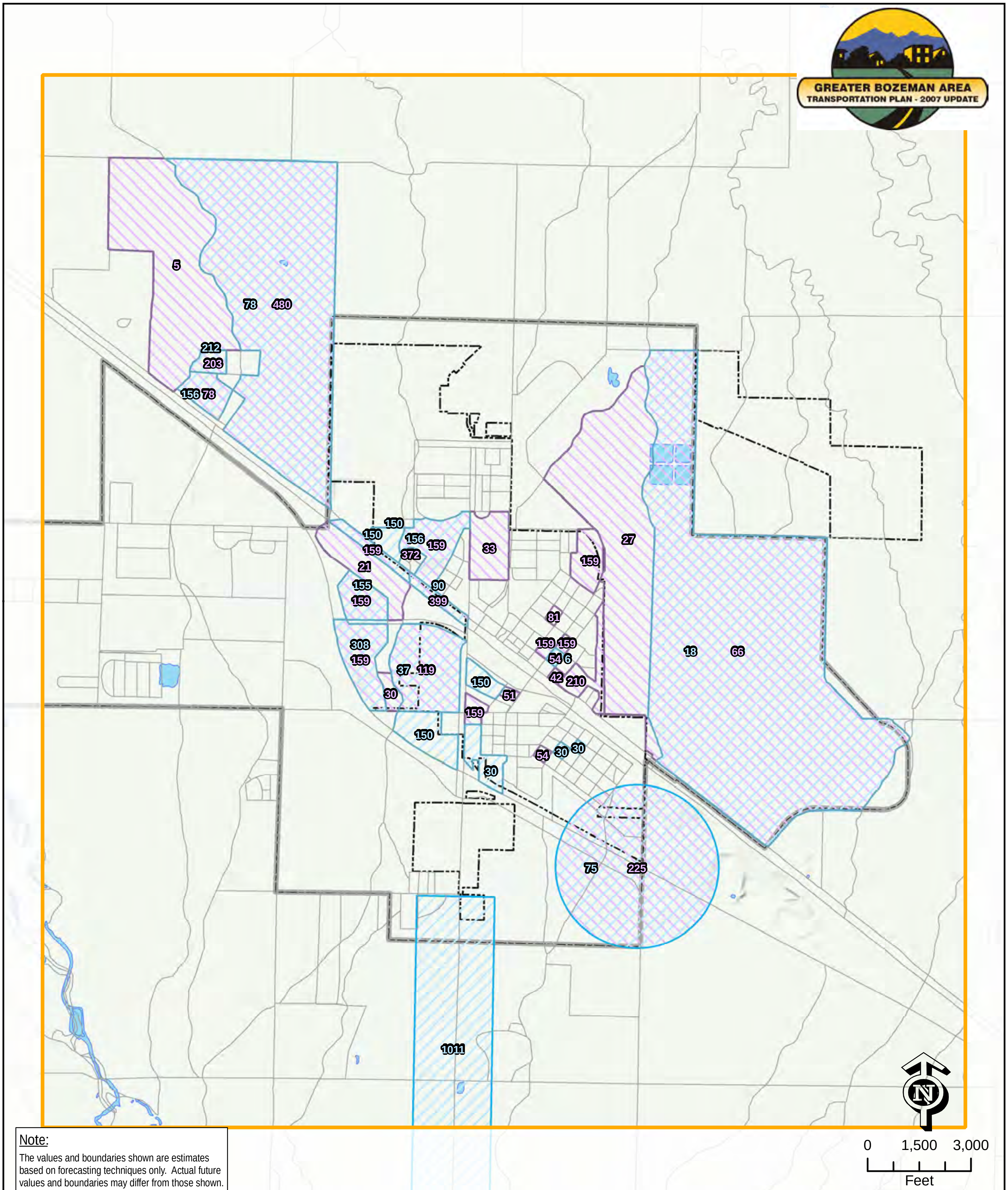
86 Additional Forecasted Retail Jobs	County Boundary
100 Additional Forecasted Non-Retail Jobs	Detail Area
	City Boundary
Census Block	Urban Boundary

RPA

Greater Bozeman Area Transportation Plan (2007 Update)

Gallatin County Additional Future (2030) Employment

Figure 3-12



Note:
The values and boundaries shown are estimates based on forecasting techniques only. Actual future values and boundaries may differ from those shown.

Legend

86 Additional Forecasted Retail Jobs	County Boundary
	Detail Area
100 Additional Forecasted Non-Retail Jobs	City Boundary
Census Block	Urban Boundary

RPA

Greater Bozeman Area Transportation Plan (2007 Update)

Gallatin County Additional Future (2030) Employment
Figure 3-13

3.7 Traffic Model Development

All of the characteristics of the various areas of the greater Bozeman area combine to create the traffic patterns present in the community today. To build a model to represent this condition, the population information was collected from the 2000 census, and employment information was gathered from the Montana Department of Labor and Industry, second quarter of 2006, and was carefully scrutinized by local agency planners and MDT modeling staff.

The roadway network / centerline information was provided by the Gallatin County GIS office. This information was supplemented by input from staff at the City of Bozeman, Gallatin County, and the Montana Department of Transportation who have substantial local knowledge and were able to increase the accuracy of the base model.

The GIS files, population census information, and employment information are readily available. The *TransCAD* software is designed to use this information as input data. *TransCAD* has been developed by the Caliper Corporation of Newton, Massachusetts, and version 4.0 was used as the transportation modeling software for this project. *TransCAD* performs a normal modeling process of generating, distributing and assigning traffic in order to generate traffic volumes. These traffic volumes are then compared to actual ground counts and adjustments are made to "calibrate", or ensure the accuracy of, the model. This is further explained below:

Trip Generation - Trip Generation consists of applying nationally developed trip rates to land use quantities by the type of land use in the area. The trip generation step actually consists of two individual steps: trip production and trip attraction. Trip production and trip attraction helps to "explain" why the trip is made. Trip production is based on relating trips to various household characteristics. Trip attraction considers activities that might attract trip makers, such as offices, shopping centers, schools, hospitals and other households. The number of productions and attractions in the area is determined and is then used in the distribution phase.

Trip Distribution - Trip distribution is the process in which a trip from one area is connected with a trip from another area. These trips are referred to as trip exchanges.

Mode Split - Mode choice is the process by which the amount of travel will be made by each available mode of transportation. There are two major types: automobile and transit. The automobile mode is generally split into drive alone and shared ride modes. For the Bozeman travel demand model, there were no "mode split" assignments (i.e. all trips are assumed to be automobile mode).

Trip Assignment - Once the trip distribution element is completed, the trip assignment tags those trips to the Major Street Network (MSN). The variable that influence this are travel time, length, and capacity.

Due to the inherent characteristics of a traffic model, it is easy to add a road segment, or "link", where none exists now or widen an existing road and see what affect these changes will have on the transportation system. Additional housing and employment centers can be added to the system to model future conditions, and moved to different parts of the model area to see what affect different growth scenarios have on the transportation system. Thus the land use changes anticipated between now and 2030 can be added to the transportation system, and the needed additions to the transportation system can then be identified. Additionally, different scenarios for how the Greater Bozeman area may grow between now and 2030 can be examined to determine the need for additional infrastructure depending upon which one most accurately represents actual growth.

Also necessary in the development of a transportation model is the establishment of the modeling area. The modeling area is, by necessity, much larger than the Study Area. Traffic generated from outlying communities or areas contributes to the traffic load within the Study Area, and is therefore important to the accuracy of the model. Additionally, it is desirable to have a large model area for use in future projects.

The future year model was developed specifically for the year 2030 planning horizon. The 2030 model is used in this document to evaluate future traffic volumes, since 2030 is the horizon year for this document. The information contained earlier in this Chapter was used to determine the additions and changes to the traffic volumes in 2030.

The modeling area was subdivided by using census tracts and census blocks, as previously described in this chapter. Census blocks are typically small in the downtown and existing neighborhood areas, and grow geographically larger in the less densely developed areas. The census blocks & census tracts were used to divide the population and employment growth that is anticipated to occur between now and 2030.

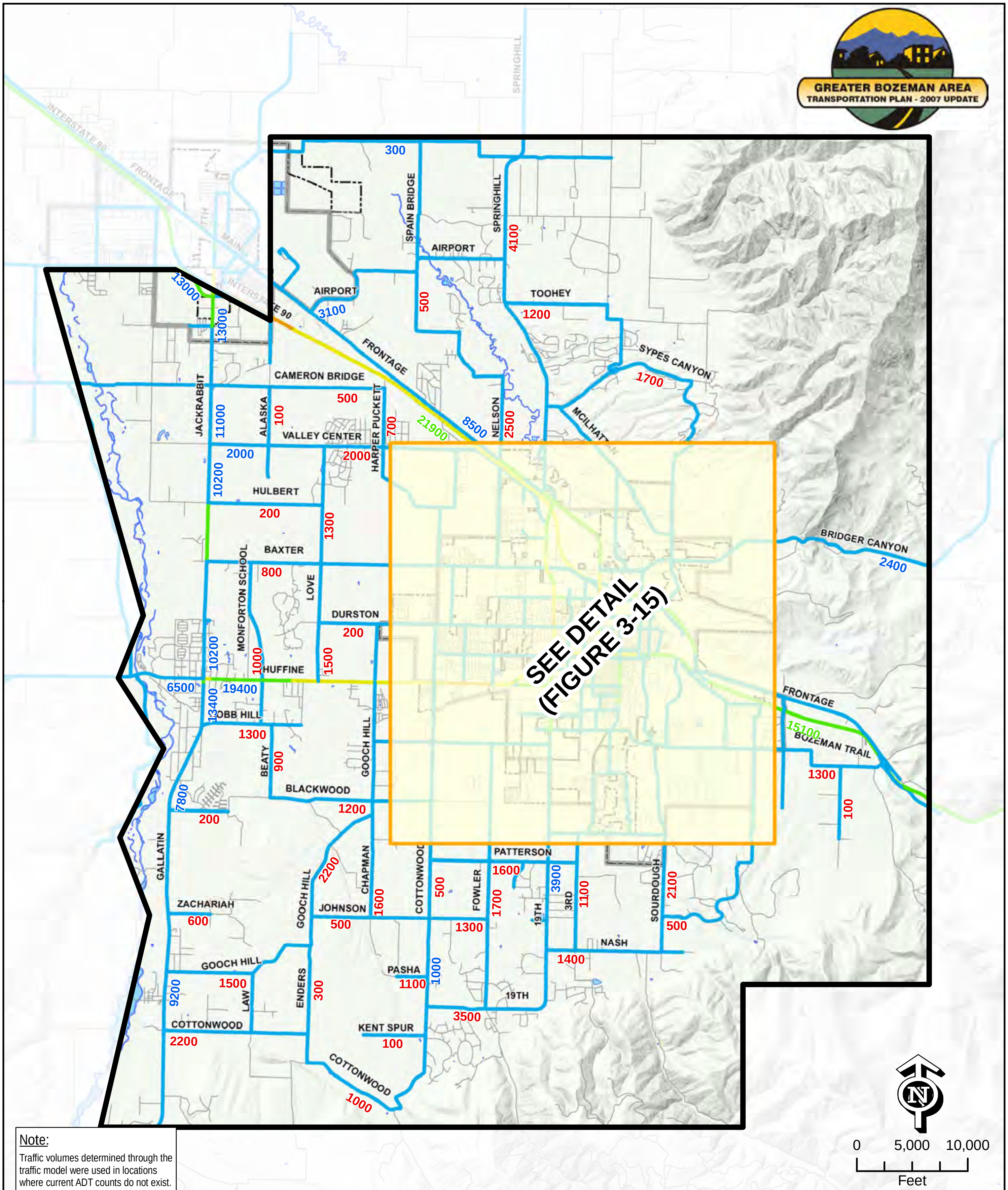
Built into the traffic model are assumptions about traffic characteristics. The model assumes that traffic characteristics in the future will be similar to those seen today. Changing factors such as fuel costs, technological advances, and other unknown issues may affect the amount and type of traffic on the road network in the future. The model also assumes that the socio-economic information contained earlier in this chapter will be realized in the year 2030. While this may be a conservative assumption, it does give an indication of potential problem areas within the transportation system that may need to be addressed in the future. The future 2030 model is a useful planning tool to help predict how traffic might behave in the future.

3.8 TRAFFIC VOLUME PROJECTIONS

The traffic model was used to produce traffic forecasts for the planning horizon year of 2030. For comparison purpose, traffic model results for the calibration year of 2005 are presented herein on **Figure 3-14** and **Figure 3-15**. Year 2030 traffic volume projections are presented in **Figure 3-16** and **Figure 3-17.** These projections indicate that the traffic volumes on some of the major corridors will increase significantly over the next 25 years.

In addition to traffic volumes, the model was used to determine volume to capacity (v/c) ratios. **Figure 3-18** and **Figure 3-19** show the v/c ratios for the calibration year of 2005; future 2030 v/c ratios are shown on **Figure 3-20** and **Figure 3-21**. A discussion of v/c ratios can be found in **Chapter 4**.

It is important to recognize that the volumes shown on **Figure 3-16** and **Figure 3-17** and v/c ratios shown on **Figure 3-20** and **Figure 3-21** are based on the "Existing plus Committed" roadway network. In other words, these are the volumes and v/c ratios if no changes to the transportation system are made other than those currently committed to. Similar graphics are presented in **Chapter 9** that show future values based on a "recommended" transportation system network.



Note:
Traffic volumes determined through the traffic model were used in locations where current ADT counts do not exist.

Legend

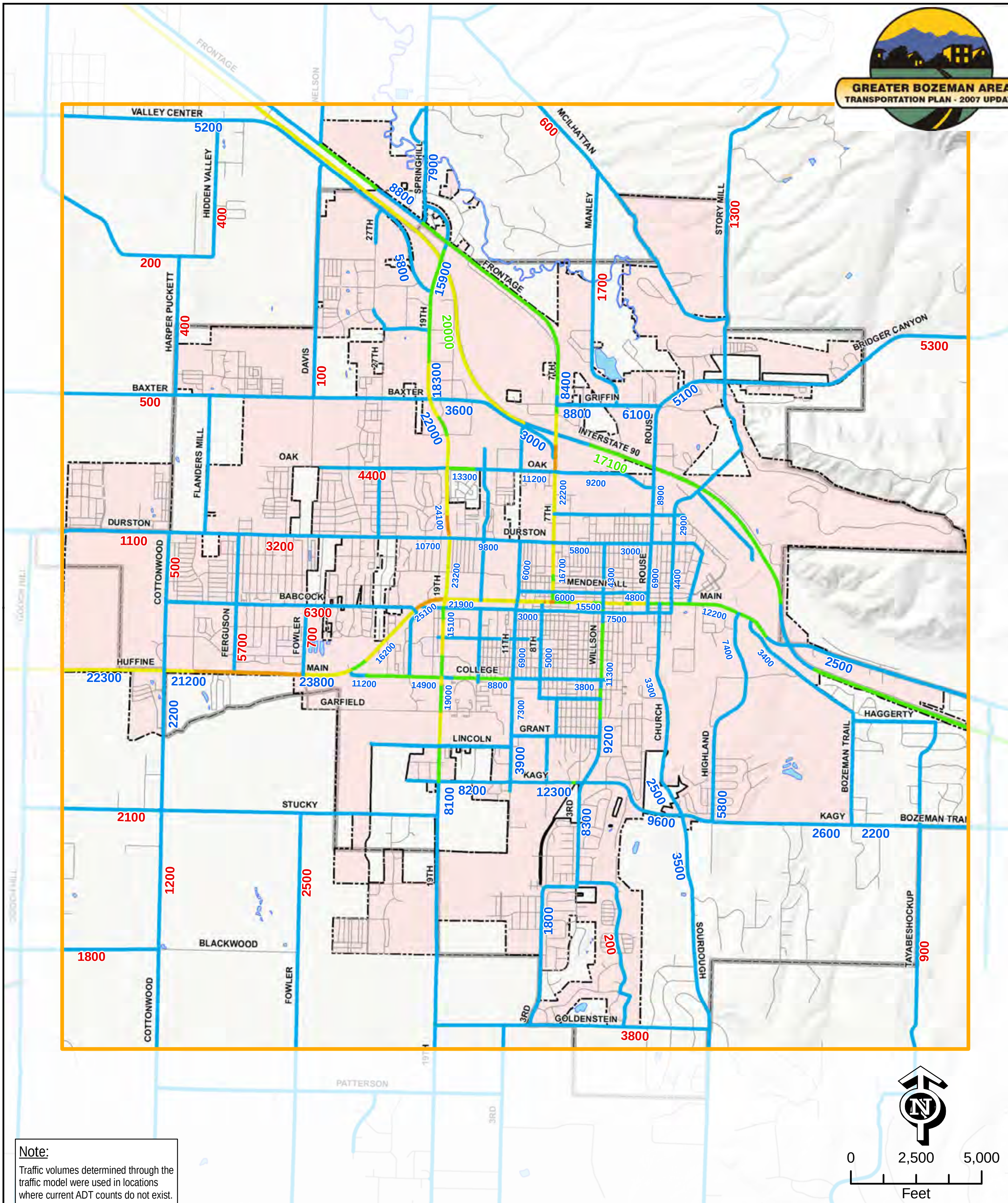
- > 12,000
- 12,000 - 18,000
- 18,000 - 24,000
- 24,000 - 35,000
- > 35,000
- 1200 2005 Average Daily Traffic (ADT)
- 1200 2004 Average Daily Traffic (ADT)
- 1200 2005 Traffic Model Volume*
- Study Area Boundary
- Detail Area
- City Boundary
- Urban Boundary

RPA

Greater Bozeman Area Transportation Plan (2007 Update)

Existing (2005) ADT Traffic Volumes

Figure 3-14



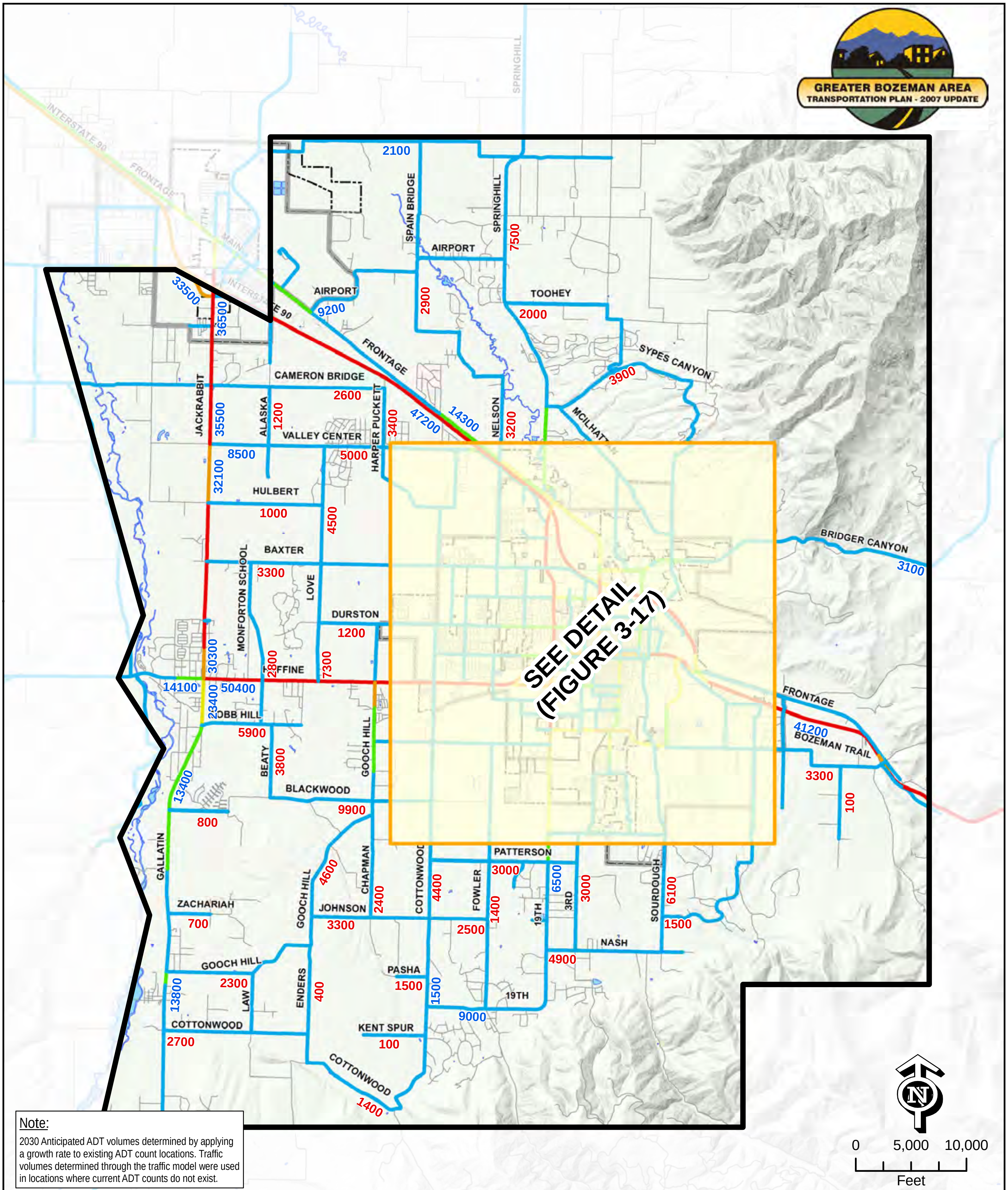
Legend

(blue line)	< 12,000	(orange outline)	Detail Area
(green line)	12,000 - 18,000	(dashed outline)	City Boundary
(yellow line)	18,000 - 24,000	(grey outline)	Urban Boundary
(orange line)	24,000 - 35,000	1200 (blue)	2005 Average Daily Traffic (ADT)
(red line)	> 35,000	1200 (green)	2004 Average Daily Traffic (ADT)
		1200 (red)	2005 Traffic Model Volume*

RPA

Greater Bozeman Area Transportation Plan (2007 Update)

Existing (2005) ADT Traffic Volumes Figure 3-15



Note:
2030 Anticipated ADT volumes determined by applying a growth rate to existing ADT count locations. Traffic volumes determined through the traffic model were used in locations where current ADT counts do not exist.

Legend

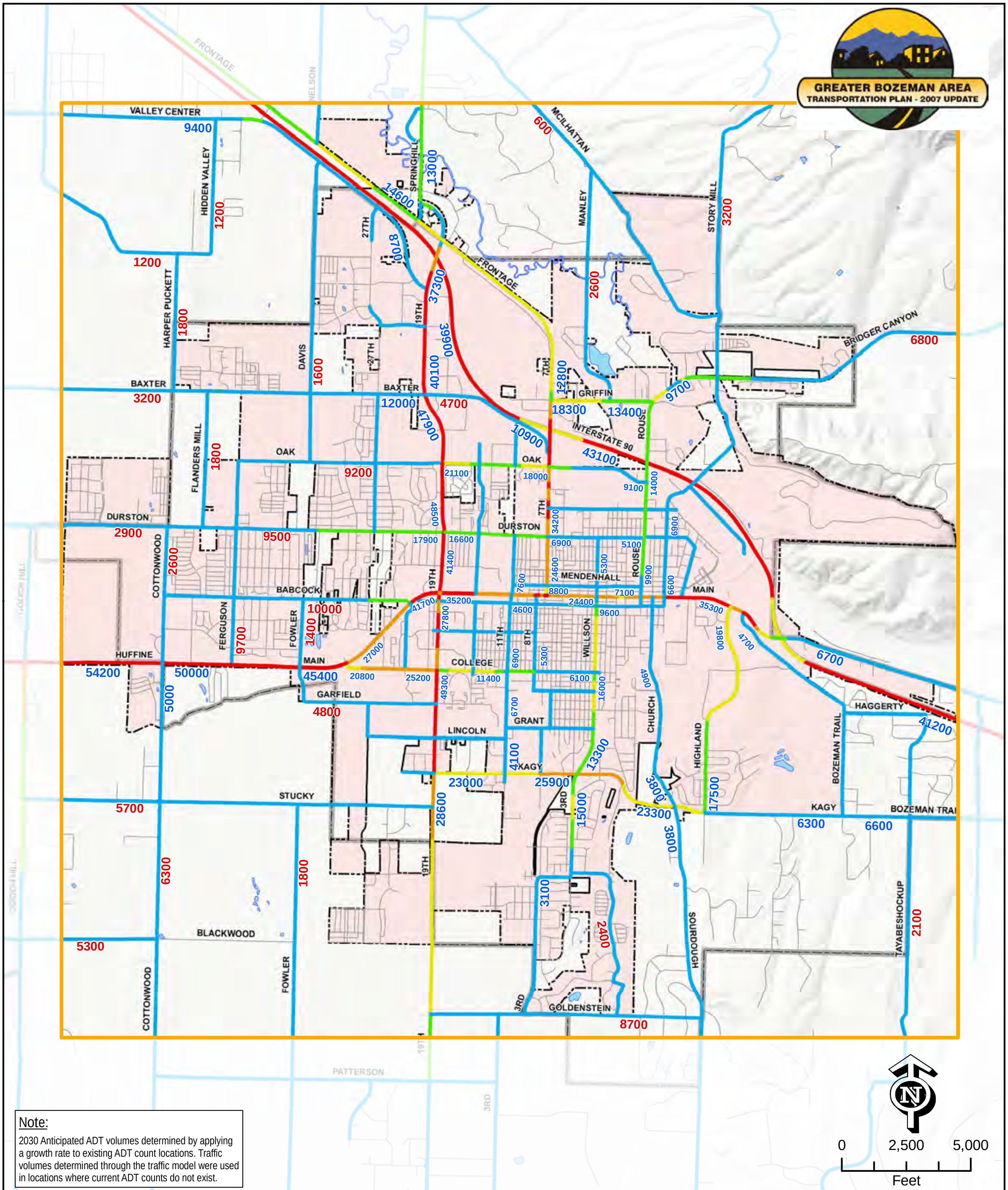
- < 12,000
- 12,000 - 18,000
- 18,000 - 24,000
- 24,000 - 35,000
- > 35,000
- 1200 2030 Anticipated Average Daily Traffic (ADT)*
- 1200 2030 Model Traffic Volume*
- Study Area Boundary
- Detail Area
- City Boundary
- Urban Boundary

RPA

Greater Bozeman Area Transportation Plan (2007 Update)

Future (2030) ADT Traffic Volumes

Figure 3-16



Note:
2030 Anticipated ADT volumes determined by applying a growth rate to existing ADT count locations. Traffic volumes determined through the traffic model were used in locations where current ADT counts do not exist.

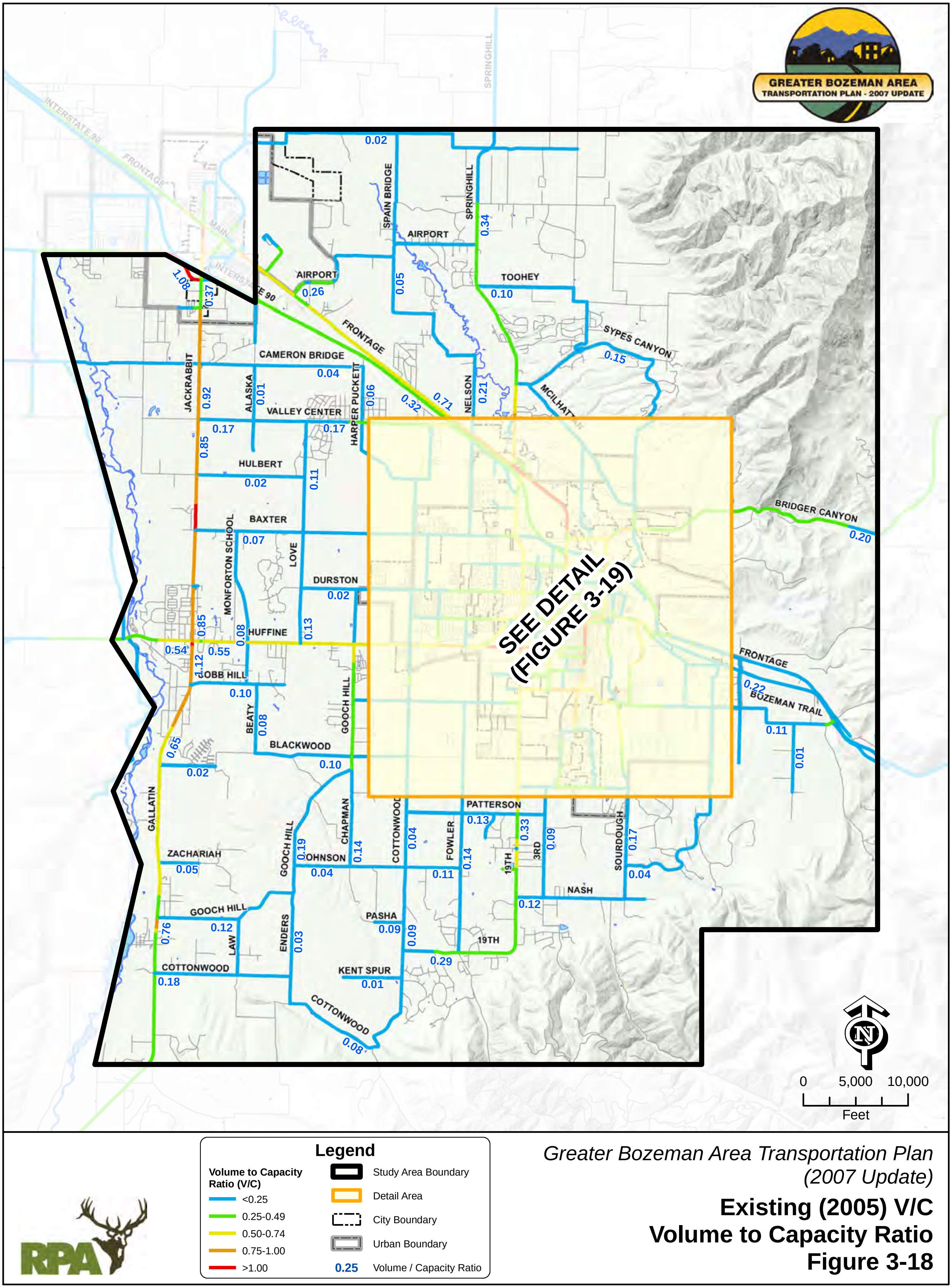
Legend

Blue	< 12,000	Orange box	Detail Area
Green	12,000 - 18,000	Dashed line	City Boundary
Yellow	18,000 - 24,000	Grey line	Urban Boundary
Orange	24,000 - 35,000	1200 (blue)	2030 Anticipated Average Daily Traffic (ADT)*
Red	> 35,000	1200 (red)	2030 Traffic Model Volume*

RPA

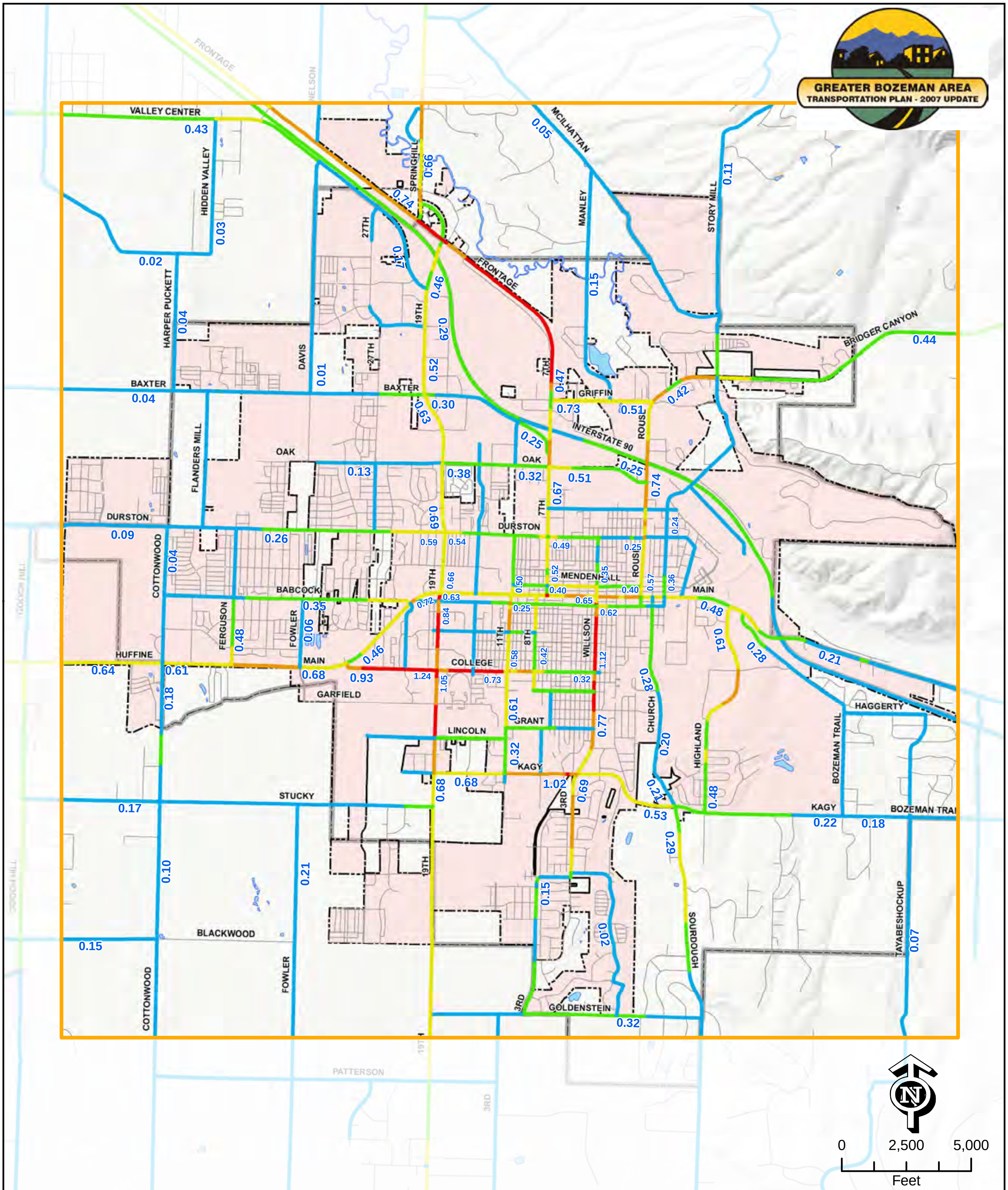
Greater Bozeman Area Transportation Plan (2007 Update)

Future (2030) ADT Traffic Volumes
Figure 3-17



Greater Bozeman Area Transportation Plan (2007 Update)

Existing (2005) V/C
Volume to Capacity Ratio
Figure 3-18



Legend

Volume to Capacity Ratio (V/C)

- <0.25
- 0.25-0.49
- 0.50-0.74
- 0.75-1.00
- >1.00

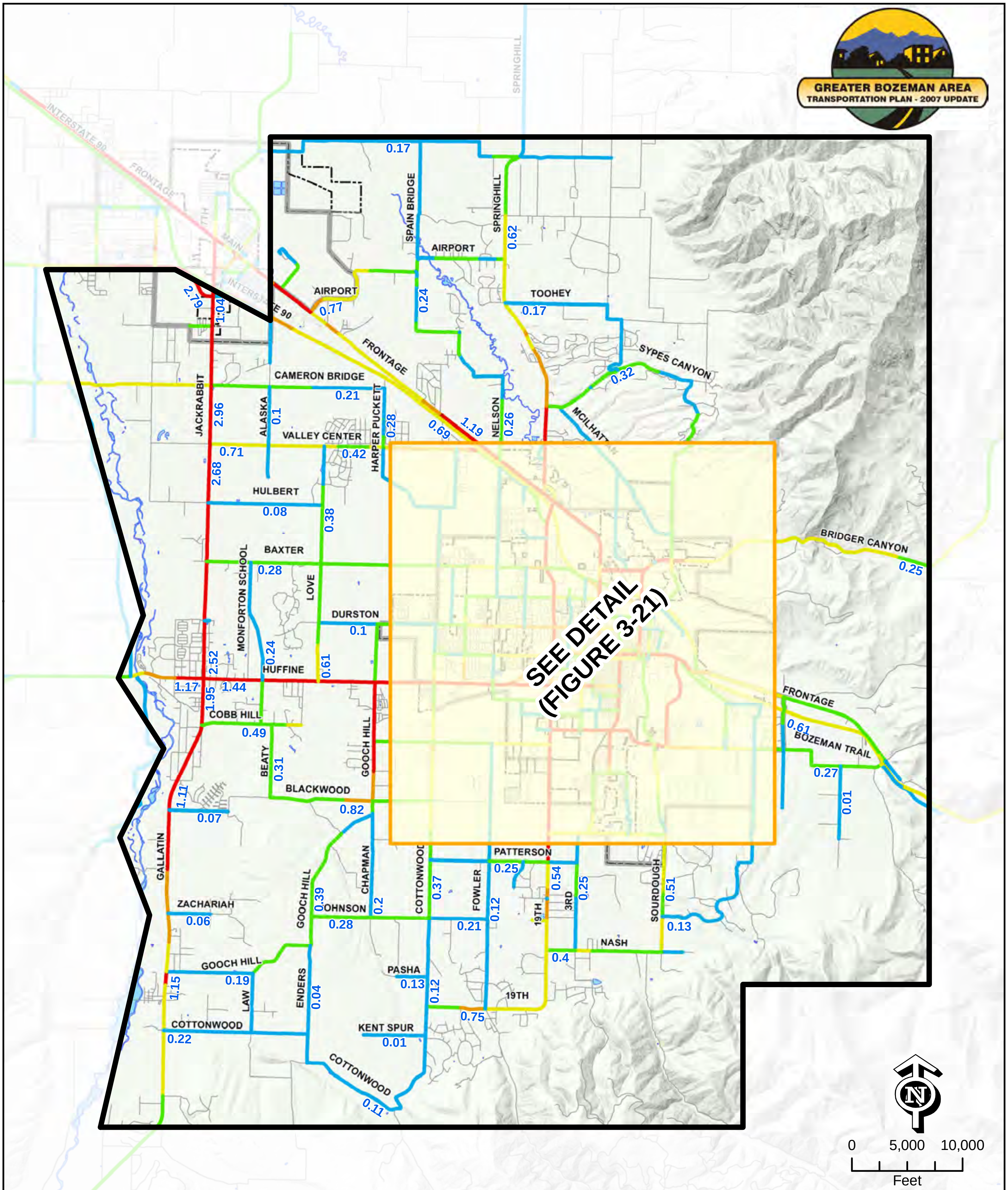
- Detail Area
- City Boundary
- Urban Boundary
- 0.25 Volume / Capacity Ratio

RPA

Greater Bozeman Area Transportation Plan (2007 Update)

Existing (2005) V/C Volume to Capacity Ratio

Figure 3-19

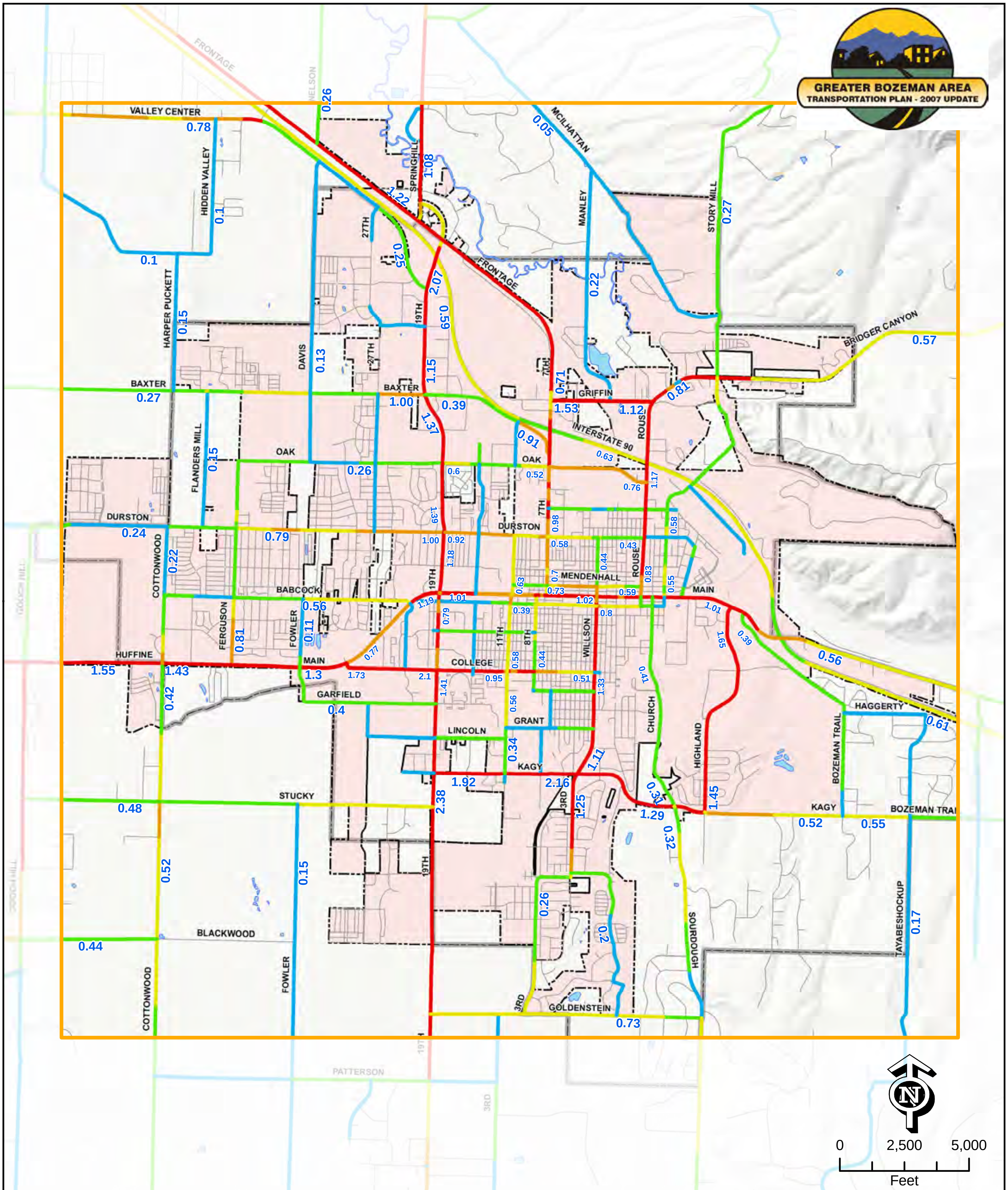


Legend

Volume to Capacity Ratio (V/C)	
<0.25	Study Area Boundary
0.25-0.49	Detail Area
0.50-0.74	City Boundary
0.75-1.00	Urban Boundary
>1.00	0.25 Volume / Capacity Ratio

Greater Bozeman Area Transportation Plan (2007 Update)

Future (2030) V/C Volume to Capacity Ratio Figure 3-20



Legend

Volume to Capacity Ratio (V/C)

- <0.25
- 0.25-0.49
- 0.50-0.74
- 0.75-1.00
- >1.00

- Detail Area
- City Boundary
- Urban Boundary
- **0.25** Volume / Capacity Ratio

Greater Bozeman Area Transportation Plan (2007 Update)

Future (2030) V/C Volume to Capacity Ratio Figure 3-21

3.9 Network Alternatives Test Run Analysis

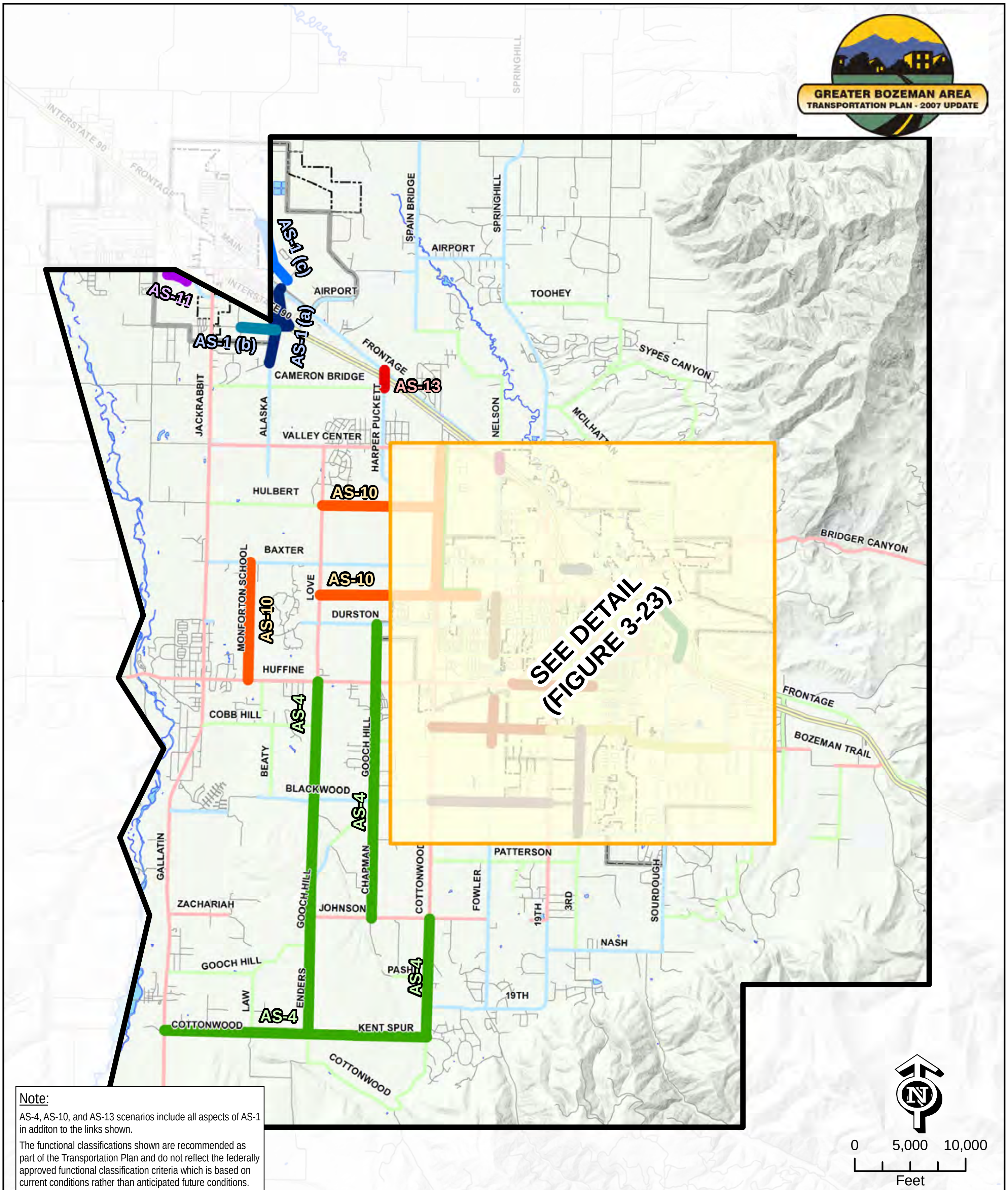
Thirteen (13) scenarios were developed for model alternative test run analysis. Each of the 13 scenarios that were developed involve roadway capacity additions in areas where transportation needs presently exist, or in areas where future investment may be needed as a result of expected population/employment growth. Most scenarios are localized, creating new links or expanding existing facilities in a particular study subarea, with investment effects impacting only a small portion of the study area network, i.e., larger system-wide impacts would not be expected. Because all scenarios involve roadway capacity additions, with the exception of *Alternative Scenario (AS-3) – Access Management*, scenario analysis is focused on how traffic volume and travel times are shifted on key facilities throughout the area of investment (i.e., no multimodal, land use, or other demand management investment options to reduce the number of trips or traffic volume were directly modeled).

The alternatives presented in this section are for modeling purposes only and do not represent actual project recommendations at this time. The analysis of these alternatives was made to give a theoretical idea of how certain network modifications made to the transportation system affect the overall network and surrounding area. Should projects arise in the future along these corridors, design alternatives to those discussed in this section will need to be analyzed to determine the appropriate configuration of the roadways.

To complete the scenario analysis, the 2030 Existing plus Committed (E+C) network was compared to 2030 scenario results for each alternative. The 2030 E+C model run consisted of the 2005 base travel model network with the addition of one committed project, a widening on South 19th street, and 2030 socio-economic projections. For each of the 13 alternatives, link-level model output (in GIS format) generated by MDT for the entire model domain was clipped to the Bozeman study area only. Individual links on key roadways were then selected and extracted into a new GIS layer to focus analysis; this was done for each of the 13 scenarios individually. Corresponding link-level data was grouped by roadway facility, and converted to *Excel* platform for calculation of performance measures which included:

- Link-level percent-difference in AADT between 2030 E+C and 2030 Scenario,
- Link-level percent-difference travel time between 2030 E+C and 2030 Scenario,
- Average AADT by roadway facility,
- Average travel time by roadway facility,
- Volume-weighted percent-difference AADT by roadway facility, and
- Volume-weighted percent-difference travel time by roadway facility.

Percent AADT and travel time differences were first calculated for each roadway link, weighted by link traffic volume, and averaged over the length of the roadway. For models as large as the Bozeman travel model being used for the plan update, fluctuations in traffic conditions are often seen at a very refined (link) level with oscillations between positive and negative increases occurring over a small area. In order to normalize this effect and get a sense for overall performance at the facility level, percentage differences were weighted by traffic volume (to provide greater weight to links with the greatest volume and least weight to links with the least volume) and averaged over the facility.



Note:

AS-4, AS-10, and AS-13 scenarios include all aspects of AS-1 in additon to the links shown.

The functional classifications shown are recommended as part of the Transportation Plan and do not reflect the federally approved functional classification criteria which is based on current conditions rather than anticipated future conditions.

Legend

- Interstate
- Principal Arterial
- Minor Arterial
- Collector
- Local
- Alternative Scenario*
- Study Area Boundary
- Detail Area
- City Boundary
- Urban Boundary

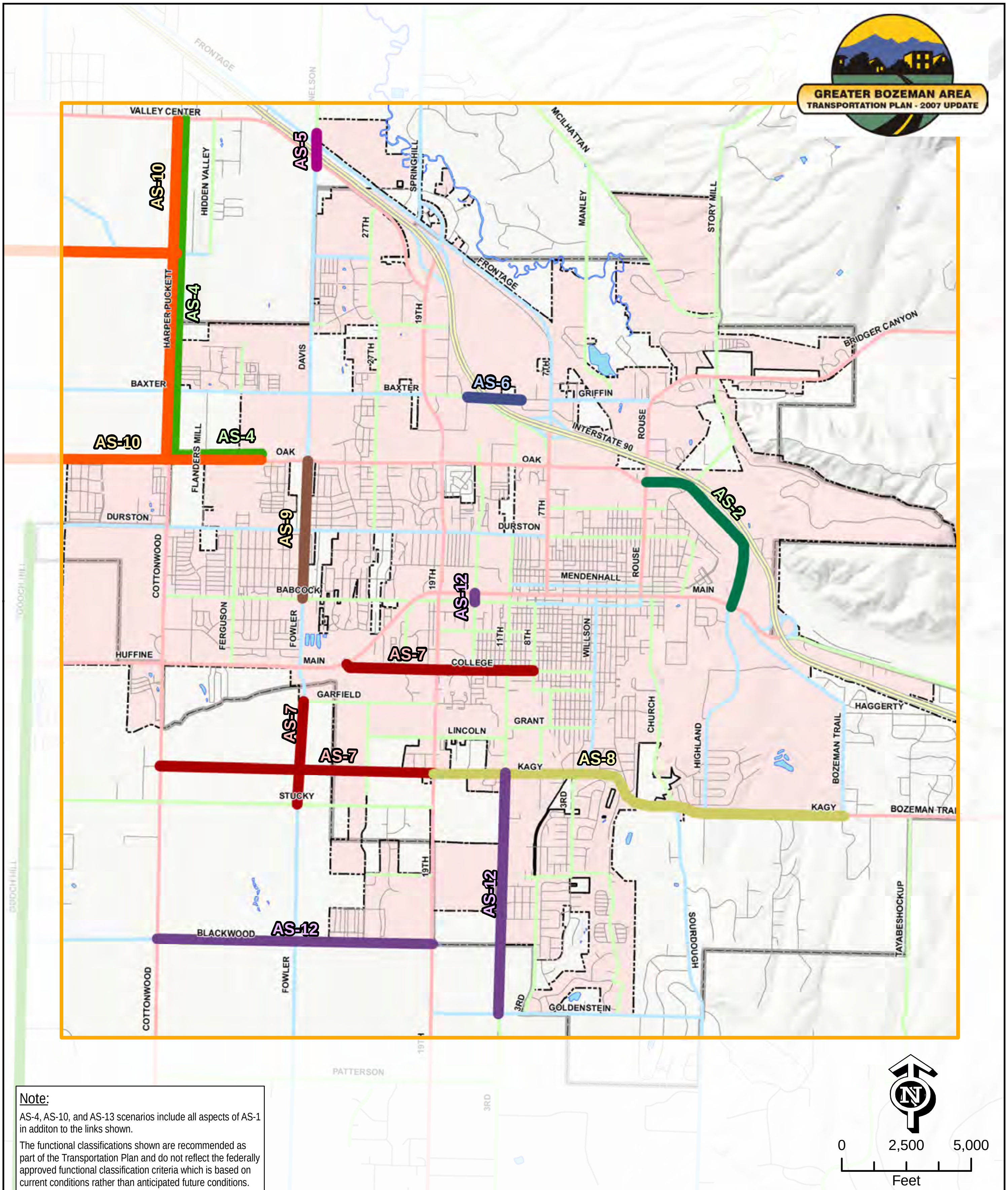
*The colors shown are for designation of modeling alternatives and do not represent any sort of classification.

RPA

Greater Bozeman Area Transportation Plan (2007 Update)

Travel Demand Model Alternative Scenarios

Figure 3-22



Note:

AS-4, AS-10, and AS-13 scenarios include all aspects of AS-1 in additon to the links shown.

The functional classifications shown are recommended as part of the Transportation Plan and do not reflect the federally approved functional classification criteria which is based on current conditions rather than anticipated future conditions.

Greater Bozeman Area Transportation Plan (2007 Update)

Travel Demand Model Alternative Scenarios

Figure 3-23

Legend

- Interstate
- Principal Arterial
- Minor Arterial
- Collector
- Local
- Detail Area
- City Boundary
- Urban Boundary
- Alternative Scenario*

*The colors shown are for designation of modeling alternatives and do not represent any sort of classification.

RPA

Alternative Scenario 1 – East Belgrade Interchange

The northwest portion of the Bozeman study area shows the highest expected growth in population by 2030, in particular towards Belgrade. Between 2005 and 2030, the north-south principal arterials Jackrabbit and Love both show greater than 200% increase in traffic volume, with east-west facilities between Cameron Bridge and Huffine also showing greater than 200% increase. I-90 west shows a greater than 50% increase in volume closer to the city, with increasing growth in volume towards Belgrade (greater than 200% increase outside of the study area towards Belgrade). New interstate access points must serve a regional purpose in accordance with Federal Highway Administration requirements. The purpose of the proposed East Belgrade Interchange is to facilitate greater intermodal connectivity with the Gallatin Field Airport, not to accommodate local traffic. In addition to serving a regional need, the East Belgrade Interchange project is intended to accommodate the projected volume increase in the north-west portion of the study area. Travel demand modeling completed for this analysis includes the following:

- Interchange footprint with a connection to Alaska Road (to the south) and the Gallatin Airport entrance (to the north),
- Connection to Northern Pacific Avenue and also a connection to Frank Road,
- North Dry Creek Road Bypass which connects to the airport road entrance, and
- Extension of Love Lane from its terminus at the south to connect to Cameron Bridge Road.

Scenario analysis results indicate:

- Alaska Road, Cameron Bridge, and Love Lane all experience an increase in traffic volume between the 2030 E+C and 2030 AS-1, as indicated in **Table 3-8**, as trips shift from parallel routes to access I-90 at the new interchange. While Alaska Road experiences a slight increase in travel time of 1.24% due to the volume increase, Cameron Bridge experiences a much greater increase in average weighted travel time of 1081%, from an average travel time of 15 minutes to 51 minutes. It is recommended that an additional capacity connection between the new northern terminus of Love Lane and the new interchange be tested, with the intent of the new capacity connection to draw some of the additional traffic off of Cameron Bridge. Note that Valley Center, which runs parallel to Cameron Bridge, shows a drop in traffic volume of 28% with a corresponding decrease in travel time of 46%. A possible upgrade of Valley Center from a 2-lane collector to a minor arterial could also be tested to divert a portion of trips off of Cameron Bridge, while still providing a direct connection to Alaska and the new interchange.
- Overall, the average weighted travel time on Love Lane between Huffine and Cameron Bridge drops by almost 100%, despite the 22% increase in traffic volume, as a result of the additional capacity being added at its northern terminus (i.e., additional volume that is shifted to the upgraded facility is not enough to cause total volume to exceed available new capacity, therefore volume/capacity ratios decrease between the 2030 E+C and 2030 AS-1, and travel times decrease).

- Key parallel facility, Jackrabbit, benefits from a 14% decrease in volume and 7% decrease in travel time, and Harper Puckett benefits from a 26% decrease in volume and 50% decrease in travel time.
- Both Frontage Road and I-90 show a decrease in traffic volume and travel time with Frontage decreasing in volume and travel time by 21% and 25%, respectively, and I-90 decreasing in volume and travel time by 8% and 3% respectively. This is likely a result of the new interchange facilitating additional trip routing between I-90 and the City of Bozeman onto upgraded, non-interstate (principal arterial) facilities, namely Alaska to Cameron Bridge to Love.

Table 3-8
Alternative Scenario 1 - East Belgrade Interchange

Roadway	Termini	AADT % Change	Travel Time % Change
Alaska	Alaska southern termini /I-90	198.45	1.24
Baxter	Jackrabbit/Harper Puckett	4.17	14.96
Cameron Bridge	Thorpe/Harper Puckett	41.99	1081.39
Frontage	Belgrade Interchange/Springhill	-21.37	-25.4
Harper Puckett	Baxter/Cameron Bridge	-26.01	-50.48
Hulbert	Jackrabbit/Love	-5.67	-0.34
I-90	Gallatin Field/Springhill	-7.8	-2.94
Jackrabbit	Huffine/Amsterdam	-14.09	-6.85
Love	Huffine/Cameron Bridge	22.47	-97.86
Valley Center	Jackrabbit/Harper Puckett	-28.44	-46.09

Alternative Scenario 2 – Northeast Arterial Link

The purpose of this model scenario is to assess the traffic related impacts of creating an arterial link in the northeast portion of the City of Bozeman. This scenario includes the following:

- Extend Highland Boulevard from its current terminus at Main Street north to connect with Cedar Street. This extension is envisioned as a minor arterial link.
- Extend Oak Street east of Rouse Avenue to connect with Cedar Street. This extension is also envisioned as a minor arterial link.
- For purposes of continuity in the traffic model, upgrade Cedar Street to a minor arterial link.

These three modifications are intended to provide a new important connection to reduce traffic along Main Street, Rouse Avenue and within the Northeast Neighborhood.

Scenario analysis results indicate:

- Main Street, between 19th and Haggerty, benefits from a 3% decrease in AADT, and a 7% decrease in travel time. Rouse also benefits from a 5% decrease in AADT and a 5% decrease in travel time.
- Almost all roadways evaluated in the northeast neighborhood see a benefit as indicated in **Table 3-9** below. Note Highland experiences a slight increase in AADT of 2% and travel time of 0.5% due to the new capacity connection causing a shift in trips from parallel collectors, Church and Bozeman Trail, to the upgraded, minor arterial Highland.
- This scenario provides a good example of dispersion of traffic due to well-made capacity connections in an area of expected growth; in this case with the growth occurring in the portion of the City of Bozeman bounded by Kagy, Highland, I-90 and Bozeman Trail, where redevelopment is already occurring to support increased residential development. Traffic is able to be dispersed due to the creation of a gridded system, with several key north-south facilities able to provide comparable level of service and access to I-90; therefore, no disproportionate shift of traffic to one facility over another.

Table 3-9

Alternative Scenario 2 - Northeast Arterial Links

Roadway	Termini	AADT % Change	Travel Time % Change
7th	I-90/Main	0.11	-1.77
Babcock	19th/Wallace	-7.96	-2.23
Bozeman Trail	Kagy/Haggerty	-8.68	-15.1
Broadway	Main/Avocado	-23.57	-11.29
Church	Sourdough/Babcock	-8.98	-40.18
Durston	19th/Avocado	-2.14	-3.33
Highland	Kagy/Cedar	1.55	0.46
Main	19th/Haggerty	-3.3	-6.61
Oak	19th/Rouse	18.8	0
Peach	7th/Rouse	-19.09	-0.7
Rouse	Griffin/Peach	-4.6	-4.97
Sourdough	Kagy/Church	-2.86	-12.08
Tamarack	19th/Wallace	-12.16	-16.57
Wallace	L/Babcock	-23.67	-61.33

Alternative Scenario 3 – Access Management Scenario

This scenario involves modeling existing access management plans for Jackrabbit and Huffine. The purpose of this scenario is to define what access management principles can accomplish in providing excess capacity and congestion relief along existing corridors, potentially delaying major capacity upgrades.

A 5% increase in capacity was modeled for both Jackrabbit and Huffine with turn prohibitions implemented to local roads without signalized intersections (reference May 27, 2008, Access Management memo). This provides a "surrogate" modeling approach to show the benefit of reducing conflict points between vehicles entering/exiting a roadway and channeling vehicle traffic in a manner that supports smoother traffic flow and increased travel speeds.

Scenario analysis results indicate:

- Huffine benefits from an 11% decrease in traffic volume and a 35% decrease in travel time, while Jackrabbit sees a 6% increase in volume and a corresponding 6% increase in travel time. While it is not unusual to expect a volume increase under this scenario as a result of added capacity improving the function of a facility (thereby pulling more trips to it), an overall decrease in travel time should be expected due to the addition of turn prohibitions that mimic reduced conflict points.
- As noted in the Access Management modeling memo, when reviewing the network along the two subject corridors for network detail, it was found that the centroid for traffic analysis zone (TAZ) 9595 is located inside the loop ramp in the southwest quadrant of the interchange at Interstate 90 and Jackrabbit Lane. Since no land use activity is located inside this loop ramp, it was recommended that the centroid be moved to more accurately represent the center of activity and loading of trips onto the network.
- Because there may be an issue with loading of trips in this area, it is recommended that the centroid connector issue be addressed, and that the scenario be re-modeled in the future. It may be beneficial to also model this scenario with the inclusion of the East Belgrade Interchange so that the additional trips drawn to the area as a result of the improved facility can directly access I-90 in another location of close proximity.

Table 3-10

Alternative Scenario 3 - Access Management Scenario

Roadway	Termini	AADT % Change	Travel Time % Change
Alaska	Alaska southern termini/I-90	-5.28	-0.13
Baxter	Jackrabbit/Harper Puckett	-1.23	-3.26
Cameron Bridge	Thorpe/Harper Puckett	33.53	953.48
Durston	Love/Cottonwood	0.46	24.81
Huffine	Zoot/Fowler	-10.87	-34.94
Hulbert	Jackrabbit/Love	-14.46	-1.74
Jackrabbit	Huffine/I-90	5.85	6.23
Love	Huffine/Valley Center	-3.75	-11.12
Valley Center	Jackrabbit/Hidden Valley	2.64	18.99

Alternative Scenario 4 – Arterial Connections / Cross Regional Grid System

This scenario involves modifying and/or widening existing roads, and constructing key new roadway segments for facilities that support critical cross-region movement. Upgrades would be to principal arterials only (four-lane and/or five-lane cross sections). This will serve to create a strong grid arterial system. The focus for this would be on the western and southern portions of the study area where there are greatest increases in traffic volumes as a result of expected long-term population and employment growth.

Recommended modeling assignments build off of existing key principal arterial corridors (e.g., Jackrabbit/Gallatin between I-90 and Cottonwood, 19th between Nash and I-90, Cottonwood between Johnson and Oak). Modeling included the following upgrades:

- **Upgrade 1 – North/South Connection**
  - Extend existing principal arterial, Love Lane, south to connect to Gooch Hill/Johnson
  - Upgrade Gooch Hill/Enders south to Cottonwood from Minor Arterial to Principal Arterial
  - Include all aspects of Alternative Scenario 1 – East Belgrade Interchange

- **Upgrade 2 – East/West Connection**
  - Upgrade existing minor arterial, Cottonwood, between Gallatin and Enders to Principal Arterial
  - New principal arterial capacity connecting Cottonwood/Enders to Kent Spur
  - Upgrade Kent Spur from minor to principal arterial

- **Upgrade 3 – North South/Connection**
  - Upgrade Cottonwood/Kent Spur north to Johnson from minor arterial to principal arterial.
  - Connect Cottonwood between Oak and Harper Puckett – principal arterial
  - Extension of Cottonwood Road from its current terminus to Valley Center Road (as a principal arterial).

- **Upgrade 4 – North South Connection**
  - Upgrade Gooch Hill and Chapman between Johnson and Durston from minor to principal arterial

Scenario analysis results indicate:

- All key north-south, newly upgraded principal arterial facilities – Jackrabbit / Gallatin, Love / Gooch Hill, Cottonwood / Harper Puckett, and north 19th experience significant travel time benefits, as indicated in **Table 3-11**. Similar to AS2, but on a larger scale, traffic is able to be evenly dispersed due to the creation of a connected system, with several key north-south facilities able to provide comparable level of service and access to I-90; therefore, no disproportionate shift of traffic to one facility over another.

- I-90 and Frontage between the new East Belgrade Interchange and 19th also show traffic improvements with 19th showing a 4% decrease in traffic volume and a 3% decrease in travel time, and Frontage Road showing a 19% decrease in volume and 17% decrease in travel time.
- Similar to the other alternatives where the East Belgrade Interchange in modeled, Alaska sees a significant increase in volume of 219% as trips are shifted to the facility to access I-90 at the new location, and a corresponding increase in travel time of 4%. Cameron Bridge experiences deterioration in level of service of 85% increase in volume and greater than 2500% increase in travel time (from an average travel time of 2 minutes to 23 minutes) as trips are shifted to the area. It is recommended that additional improvements be tested in the area to relieve the induced traffic created on Cameron Bridge, e.g., an additional capacity connection between the new northern terminus of Love Lane and the new interchange, or an upgrade of Valley Center from a 2-lane collector to a minor arterial facility. Valley Center shows a 22% drop in volume and 39% drop in travel time and can likely accommodate shift in additional volume to the facility if it is upgraded. There is an active Environmental Assessment (EA) for Valley Center that calls for the roadway to be widened and turn lanes to be added.
- Harper Puckett shows an increase in traffic volume of 58% and greater than 2500% increase in travel time (from an average travel time of 2 minutes to 52 minutes), also due to the significant shift in trips to the area. The improvements suggested above, may also serve to alleviate the increase in volume and travel time on Harper Puckett if they reduce the volume increase (bottleneck which is likely occurring) on Cameron Bridge.
- Key east-west facilities extending between the upgraded north-south principal arterials show both traffic improvements and deterioration, with the majority showing improvement. Durston shows a 17% increase in volume and 9% increase in travel time, while Huffine shows a 6% decrease in volume and 20% decrease in travel time, Main with a 6% decrease in volume and 14% decrease in travel time, and Johnson a 26% and 79% decrease in volume and travel time, respectively. Oak shows a 93% increase in volume, but 90% decrease in travel time as the addition of new capacity causes trips and volume to shift to the upgraded facility; however this volume increase is not enough to exceed available (new) capacity allowing the volume/capacity ratio to drop and average travel times to decrease.
- In general, significant volume and travel time reductions are seen on the entire western side of the study area as a result of the interconnected principal arterial system created in an area of expected population and employment growth.

Table 3-11
Alternative Scenario 4 - Arterial Connections / Cross Regional Grid System

Roadway	Termini	AADT % Change	Travel Time % Change
19th	Valley Center/Main	-4.2	-2.58
I-90	East Belgrade Interchange/19th	-10.17	-5.34
Alaska	Alaska southern termini/I-90	218.68	4.08
Cameron Bridge	Jackrabbit/Harper Puckett	84.79	2784.17
Cottonwood	Kent Spur/Harper Puckett	39.98	-66.39
Durston	Love/19th	17.47	8.59
Frontage	East Belgrade Interchange/19th	-19.38	-16.64
Gallatin	Cottonwood/Jackrabbit	-2.3	-14.07
Gooch Hill/Enders	Cottonwood-Kent Spur/Love	-10.76	-48.22
Harper Puckett	Valley Center/Baxter	57.89	2843.66
Huffine	Jackrabbit/Main	-5.78	-20.35
Jackrabbit	Huffine/I-90	-16.07	-6.98
Love	Gooch Hill/Cameron Bridge	42.67	-97.78
Main	Fowler/19th	-6.34	-14.33
Oak	Cottonwood/19th	92.87	-89.67
Valley Center	Jackrabbit/19th	-22.08	-39.37

Alternative Scenario 5 – Interstate 90 Overpass at Davis / Nelson Alignment

The scenario is created to assess the benefits of providing a grade separated overpass of I-90 and the existing railroad tracks along the north-south alignment of Fowler/Davis and Nelson roads. This is not envisioned as an interchange; however it may serve to reduce traffic along the Frontage Road entering Bozeman, North 19th Avenue, and Valley Center Road.

Scenario analysis results indicate:

- Frontage Road entering Bozeman experiences a 7% decrease in AADT and 10% decrease in travel time. North 7th experiences a 3% decrease in AADT and 12% decrease in travel time.
- North 19th and Valley Center both experience an increase in traffic volume and travel time, with North 19th seeing a 15% increase in AADT and 12% increase in travel time, and Valley Center experiencing an 18% increase in AADT and greater than 300% increase in travel time (from an average travel time of 3.3 minutes to 10.2 minutes).
- Davis is impacted by a 76% increase in traffic volume, but a 67% decrease in travel time, indicating that the increased capacity is enough to accommodate the shift in traffic volume (volume/capacity ratio drops allowing travel times to decrease).
- The intended goal to reduce traffic along the Frontage Road was addressed as a portion of trips are shifted from accessing Frontage Road at Springhill, to enter Bozeman. Instead, trips are shifted to the new capacity connection at Davis/Nelson

to enter northeast Bozeman from Davis and North 19th. This shift in trips, however, causes the increase in traffic volume on these two facilities. Baxter also sees an increase in AADT of 15% and travel time of 56% as a result of a large number of trips shifting to the area.

- Recommend testing additional improvements to Valley Center and/or North 19th if 1-90 Overpass is constructed at Davis/Nelson.

Table 3-12
Alternative Scenario 5 - Interstate 90 Overpass at Davis / Nelson Alignment

Roadway	Termini	AADT % Change	Travel Time % Change
North 19th	Valley Center/Oak	15.09	11.84
7th	Frontage/Oak	-3.01	-12.03
Baxter	Harper Puckett/7th	14.72	55.66
Davis	Baxter/Nelson	76.47	-66.51
Frontage	Sacajawea Peak/7th	-7.39	-9.61
Hidden Valley	Valley Center/Harper Puckett	-10.8	-6.13
Oak	New Holland/7th	-1.18	-9.9
Valley Center	Harper Puckett/19th	18.78	304.42

Alternative Scenario 6 – Interstate 90 Overpass at Baxter / Mandeville Alignment

The scenario is created to assess the benefits of providing a grade separated overpass of Interstate 90 along the west-east alignment of Baxter/Mandeville Lane. This is not envisioned as an interchange; however it may serve to reduce traffic along the Frontage Road entering Bozeman, North 7th Avenue, and Griffin Drive.

Scenario analysis results indicate:

- North 7th experiences a 5% decrease in AADT, and a 19% decrease in travel time.
- Frontage Road entering Bozeman benefits from a 5% decrease in AADT and 14% decrease in travel time.
- Griffin experiences a 4% increase in AADT and 9% increase in travel time resulting from its proximity to the new capacity connection at Baxter/Mandeville, which causes additional trips to load onto Griffin heading to/from Baxter. For the same reason (proximity to new capacity connection), Mandeville sees a 233% increase in traffic volume, but a 56% decrease in travel time.

Table 3-13
Alternative Scenario 6 - Interstate 90 Overpass at Baxter / Mandeville Alignment

Roadway	Termini	AADT % Change	Travel Time % Change
7th	Oak/Frontage	-5.43	-19.21
Baxter	Davis/Mandeville	9.08	-2.14
Davis	Baxter/Valley Center	0.51	2.27
Frontage	Nelson/7th	-5.13	-13.83
Griffin	Mandeville/Rouse	4.27	8.51
Mandeville	Baxter/Griffin	232.57	-55.7
Oak	New Holland/Rouse	0.92	0.01
Rouse	Oak/Griffin	-3.84	-20.02

Alternative Scenario 7 – Southwest Grid Modifications

The scenario will expand and strengthen the southwest grid in an existing and forecasted growth area. It includes the following:

- College Street upgrade to a five-lane principal arterial between Main Street and S. 19th Ave.
- College Street upgrade to a three-lane minor arterial between S. 8th Ave. and S. 19th Ave.
- Extending Kagy Boulevard from S. 19th Avenue to Cottonwood near the Stucky Road intersection (as a three-lane principal arterial)
- Completing the Fowler Lane connection from Garfield Street south to Stucky (as a minor arterial).

Scenario analysis results indicate:

- Parallel facilities to the new Kagy Boulevard capacity extension, Babcock and Stucky, show significant travel time benefits as trips shift to the new capacity; Babcock sees a 4% decrease in AADT and 10% decrease in travel time, Stucky sees a 62% decrease in AADT and almost 100% decrease in travel time.
- Overall, Kagy experiences a 48% increase in AADT as a result of trips shifting to the upgraded and expanded facility, but only a slight 3% increase in travel time.
- College Avenue between Cottonwood and 11th benefits from a 5% decrease in AADT and a 27% decrease in travel time.
- Extension of Fowler lane from Stucky to Garfield Street is causing an increase in traffic volume on Fowler of 41% and a significant increase in travel time of 359%. While you would expect an increase in volume on the facility as trips are shifted to the new capacity, the increase in travel time may not warrant the new capacity addition, in particular as the parallel facilities Cottonwood and 19th are not showing significant traffic improvements as trips are shifted from these facilities to the new capacity; Cottonwood shows a 4% increase in travel time and 19th shows a 5% increase in travel time.

Table 3-14
Alternative Scenario 7 - Southwest Grid Modifications

Roadway	Termini	AADT % Change	Travel Time % Change
19th	Babcock/Patterson	-0.97	4.64
Babcock	Cottonwood/11th	-3.66	-10.1
College	Cottonwood/11th	-5.15	-27.42
Cottonwood	Patterson/Babcock	0.17	3.73
Fowler	Patterson/Babcock	40.98	359.43
Huffine	Cottonwood/11th	-2.24	-11.13
Kagy	Cottonwood/7th	48.34	3.03
Stucky	Cottonwood/19th	-62.53	-98.5

Alternative Scenario 8 – Kagy Boulevard Expansion

This scenario involves expanding the existing Kagy Boulevard from its current two-lane configuration (with left-turn bays) to a widened five-lane principal arterial. This would create a high capacity principal arterial corridor.

Scenario analysis results indicate:

- Kagy Boulevard benefits from a decrease in travel time of 4%, despite a slight increase in AADT of 1%, with the AADT increase expected due to the improvement of the facility. Adjacent Bozeman Trail also benefits from a 5% decrease in AADT and 2% decrease in travel time.
- Other impacts in the area of improvement are minimal/negligible (see **Table 3-15** below), with the most significant change occurring on Sourdough which shows a 16% decrease in AADT and 36% decrease in travel time.

Table 3-15
Alternative Scenario 8 - Kagy Boulevard Expansion

Roadway	Termini	AADT % Change	Travel Time % Change
19th	Goldenstein/Main	4.38	8.46
3rd	Goldenstein/Westridge	0.09	-2.14
Babcock	19th/Church	-0.63	1.43
Bozeman Trail	Haggerty/Tayabeshockup	-4.53	-1.56
Church	Main/Sourdough	-0.58	-1.15
Highland	Bozeman Trail/Main	-0.01	0
Kagy	19th/Tayabeshockup	1.07	-4.07
Main	19th/Haggerty	0.8	3.43
Sourdough	Goldenstein/Church	-16.06	-35.97
Willson	Bozeman Trail/Main	-1.13	-0.92

Alternative Scenario 9 – Fowler Lane Extension

This scenario involves completing the Fowler Lane corridor north of Main Street, specifically between Babcock and Oak Street, in hopes of providing additional north-south travel mobility. This is envisioned as a minor arterial facility.

Scenario analysis results indicate:

- Fowler experiences a significant increase of 285% AADT due to the shift in trips to the newly upgraded north-south arterial facility, but a 72% decrease in travel time; indicating that the increase in additional capacity between Babcock and Oak is able to accommodate the shift in travel to the upgraded corridor (i.e., volume/capacity ratio is reduced allowing travel times to decrease).
- Adjacent Davis Street, at the north end of Fowler, benefits from a 12% decrease in AADT and a 35% decrease in travel time.
- Parallel facility, Cottonwood, benefits from a 5% decrease in volume and 14% decrease in travel time, as trips are shifted to Fowler; however parallel 19th shows in a increase in volume and travel time of 6% and 8%, respectively.
- Surrounding key facilities show largely improved travel conditions as indicated in **Table 3-16** below.

Table 3-16

Alternative Scenario 9 - Fowler Lane Extension

Roadway	Termini	AADT % Change	Travel Time % Change
19th	Babcock/Valley Center	5.98	7.84
Babcock	19th/Cottonwood	-0.98	-42.69
Cottonwood	Huffine/Durston	-4.57	-13.93
Davis	Valley Center/Baxter	-11.89	-34.71
Durston	Cottonwood/19th	15.4	7.93
Fowler	Huffine/Davis	284.7	-72.01
Huffine	Cottonwood/Main	-4.78	-18.73
Main	Huffine/19th	-8.4	-17.76
Oak	Fowler/19th	-12.54	-50.1
Valley Center	Hidden Valley/19th	-7.52	-14.78

Alternative Scenario 10 – Northwest Grid Modifications

As with AS 1 – East Belgrade Interchange, the northwest grid system modification have been developed to address the growth occurring in the north-west portion of the study area. This scenario has been modeled to complete the principal arterial system in the "triangle" area.

This model scenario includes the following:

- All aspects of AS 1 - East Belgrade Interchange.
- Extension of Oak Street from its current western terminus all the way to the west to intersect Love Lane (as a principal arterial).
- Extension of Love Lane to the north to connect with Cameron Bridge Road, as a principal arterial.
- Extension of Cottonwood Road from its current terminus to Valley Center Road (as a principal arterial).
- Re-classification of Monforton School Road to a collector with attributes adjusted accordingly.
- Extension of Hulbert Road from its eastern terminus to the east to connect with an extended Harper Puckett Road (as a collector).

Scenario analysis results indicate:

- Similar to AS 1, traffic is being pulled onto Alaska, Cameron Bridge, and Love Lane to access the new interchange. Each of these roadways experiences an increase in traffic volume with Alaska seeing a 217% increase, Cameron Bridge a 45% increase, and Love Lane a 25% increase in AADT. Note that despite the volume increase on Love, average travel time drops by almost 100% from 28 minutes to less than 1 minute.
- Huffine experiences a 6% decrease in AADT and 21% decrease in travel time, and Valley Center shows a 30% decrease in AADT and 60% decrease in travel time.
- Jackrabbit, between Huffine and Amsterdam, also shows travel benefits, with a 14% decrease in AADT and 6% decrease in travel time.
- There is a significant shift in traffic from Hidden Valley Road (66% decrease in AADT and 13% decrease in travel time), a collector street, to Harper Puckett/Cottonwood, due to the Cottonwood extension as a higher functional class principal arterial.
- Oak shows a 31% increase in volume, but a 120% decrease in travel time. This is a result of new capacity connections causing a shift in traffic volume to the upgraded facility. The volume increase is not enough, however, to exceed available (new) capacity allowing average travel times to decrease. Similarly, Harper Puckett shows an 11% increase in AADT, but a 41% decrease in travel time.
- In general, grid modifications in connection with the new interchange appear to support reductions in traffic volume and travel times on key facilities in the north-west portion of the study area as traffic is dispersed on to a completed grid system to the south and west of the new interchange. Some locations (e.g., Cameron Bridge and the southern portion of Cottonwood at Huffine) are showing more localized, but fairly significant increases in travel time, however, and may require additional analysis.

Table 3-17
Alternative Scenario 10 - Northwest Grid Modifications

Roadway	Termini	AADT % Change	Travel Time % Change
Alaska	Alaska southern termini/I-90	217.45	3.61
Baxter	Jackrabbit/19th	-23.88	54.62
Cameron Bridge	Thorpe/Harper Puckett	44.9	1177.57
Cottonwood	Huffine/Valley Center	47.34	583.19
Durston	Love/19th	8.73	4.41
Harper Puckett	Cameron Bridge/Hulbert	11	-41.47
Hidden Valley	Valley Center/Hulbert	-65.85	-12.63
Huffine	Jackrabbit/Main	-5.77	-21.13
Jackrabbit	Huffine/Frank	-13.99	-5.74
Love	Huffine/Cameron Bridge	25.31	-97.94
Oak	Love/19th	31.01	-119.59
Valley Center	Jackrabbit/Harper Puckett	-30.47	-60.35

Alternative Scenario 11 – Amsterdam On-Ramp

This scenario added an interchange on-ramp from Amsterdam Road onto Interstate 90 to reduce congestion at Amsterdam Road and Jackrabbit Lane (just south of Belgrade).

Scenario analysis results indicate:

- A reduction in 25% AADT and 89% travel time on Amsterdam, and a reduction of 1.32% AADT and 1.89% travel time on Jackrabbit.
- Impacts in the surrounding area are minimal. Reference **Table 3-18** below.

Table 3-18
Alternative Scenario 11 - Amsterdam On-Ramp

Roadway	Termini	AADT % Change	Travel Time % Change
Alaska	Cameron Bridge/I-90	-1.3	0
Amsterdam	Jackrabbit/	-25.01	-88.93
Cameron Bridge	Thorpe/Alaska	0.58	6.43
Jackrabbit	Hulbert/Amsterdam	-1.32	-1.89
Frank	Thorpe/Jackrabbit	-1.26	-7.23
Thorpe	Cameron Bridge/	-3.99	-3.05

Alternative Scenario 12 – Southern Grid Modifications

The southern grid modifications include the following:

- Extend 11th Ave. from Kagy Boulevard to Goldenstein (as a collector).
- Extend 15th Ave. from Main Street to Babcock (as a collector).
- Extend Blackwood Road from S. 19th Ave. west to Cottonwood Road (as a minor arterial).

Scenario analysis results indicate:

- 11th Street AADT increases 16% with a slight 1.24% increase in travel time. 15th Street AADT increases by 111% with a 17% increase in travel time. These increases are a result of the new capacity connections causing a shift in trips and traffic volume to the expanded facilities, with most significant volume increases occurring on links immediately adjacent to new capacity. The fairly large travel time increase on 15th is likely because the capacity addition is very short in length; trips are shifted to the newly connected facility causing volume to increase, but the slight capacity addition is not enough to accommodate this increase, therefore volume/capacity ratio increases and travel time increases.
- 19th and Wilson/3rd, both of which run parallel to the upgraded 11th and 15th street facilities, experience a reduction in AADT and travel time due to the shift in trips to 11th and 15th.
- Cottonwood benefits from a significant decrease in AADT of 27% and travel time decrease of 54%, as new capacity connections on Blackwood and 11th create more direct access to downtown Bozeman.
- Kagy Boulevard shows a 4% decrease in AADT and less than 1% decrease in travel time.
- Patterson and Stucky, which run parallel to the Blackwood extension, see significant benefit due to the grid modifications in the area which allow traffic to more evenly disperse onto other facilities. Patterson shows a 14% decrease in AADT and 43% decrease in travel time and Stucky shows a 9% decrease in AADT and 48% decrease in travel time.
- Sourdough benefits from a 25% decrease in AADT and 52% decrease in travel time.
- In general, grid modifications appear to support reductions in traffic volume and travel times on key facilities in the southern portion of the study area as traffic is dispersed on to a completed grid system.

Table 3-19
Alternative Scenario 12 - Southern Grid Modifications

Roadway	Termini	AADT % Change	Travel Time % Change
11th	Goldenstein/Durston	15.93	1.24
15th	College/Durston	111.53	16.95
19th	Cottonwood/Durston	-0.57	-1.82
3rd	Goldenstein/Kagy	-21.56	-4.96
College	19th/Willson	-0.19	1.89
Cottonwood	19th/Stucky	-26.95	-53.54
Durston	19th/Rouse	-26.95	0.13
Goldenstein	19th/Sourdough	-13.74	-18.02
Kagy	19th/Sourdough	-4.07	-0.63
Patterson	Cottonwood/19th	-14.37	-42.88
Sourdough	Goldenstein/Kagy	-24.5	-51.94
Stucky	Cottonwood/19th	-8.7	-48.3
Willson	Kagy/Peach	-3.74	-2.2

Alternative Scenario 13 – Interstate 90 Interchange (Harper Puckett Road)

The purpose of AS-13 is to model the effects of a future interchange approximately half way between the proposed East Belgrade interchange and the 19th Avenue interchange. This scenario includes all aspects of AS-1 as well.

It should be noted that the Federal Highway Administration requires that new interstate access points must serve a regional purpose. At this time this scenario would not serve a regional need and as such would not meet Federal Highway Administration requirements.

Scenario analysis results indicate:

- Similar to AS 1 and AS 10, traffic is being pulled onto Alaska, Cameron Bridge, and Love Lane, to access the new East Belgrade interchange. Each of these roadways experiences an increase in traffic volume with Alaska seeing a 170% increase, Cameron Bridge a 103% increase, and Love Lane a 24% increase in AADT. Note that Cameron Bridge is seeing a much greater increase in AADT compared to Alternatives 1 and 10 because of the additional interchange directly to the north of the roadway, causing even more trips and traffic volume to shift to this facility. The very significant increase in travel time on Cameron Bridge resulting from this shift in traffic volume (average-weighted travel time increase greater than 4500%; or in absolute terms, an increase in average travel time from 9-87 minutes), may preclude this as an alternative to consider, unless additional improvements are made in the area.
- Most roadways in the area are experiencing a general increase in AADT and travel time as a significant number of trips shift to access I-90 at one of the two proposed

interchanges. I-90 does show improvement, with a 13% decrease in AADT and 32% decrease in travel time, as a result of some traffic shifting off of the interstate onto the arterial system to access the City of Bozeman. Jackrabbit also sees a decrease in 15% AADT and 6% travel time, similar to AS 1 and AS 10.

- There is no apparent benefit to this scenario over Alternative 1 which includes only the East Belgrade Interchange (with the exception of greater travel benefits on I-90 in the area of improvement). This is possibly because the proposed interchanges are located too closely together, drawing too much traffic into the north west portion of the study area to access I-90 in the same general location.

Table 3-20

Alternative Scenario 13 - Interstate 90 Interchange (Harper Puckett Road)

Roadway	Termini	AADT % Change	Travel Time % Change
19th	Goldenstein/Main	4.38	8.46
3rd	Goldenstein/Westridge	0.09	-2.14
Babcock	19th/Church	-0.63	1.43
Bozeman Trail	Haggerty/Tayabeshockup	-4.53	-1.56
Church	Main/Sourdough	-0.58	-1.15
Highland	Bozeman Trail/Main	-0.01	0
Kagy	19th/Tayabeshockup	1.07	-4.07
Main	19th/Haggerty	0.8	3.43
Sourdough	Goldenstein/Church	-16.06	-35.97
Willson	Bozeman Trail/Main	-1.13	-0.92

3.10 Traffic Model Development Conclusions

The alternative scenarios modeled, and described above, are reflective of major street network (MSN) projects that may or may not have considerable value to the transportation conditions in the community. Some of the alternative scenarios modeled will be carried forward later in the Plan in the form of specific recommendations. These are primarily found in **Chapter 5**. A few of the scenarios do not appear to have substantial value, so will not be considered further. Ultimately, the recommended projects defined in **Chapter 5** will transform into what is known as the community's "Recommended Major Street Network". This network is shown graphically in **Chapter 9**, along with travel demand model volume outputs. The "Recommended Major Street Network" is the future transportation system network that the community should be planning towards as land use changes occur over the planning horizon (year 2030).

4.1 Introduction

This chapter identifies areas of the transportation system that do not meet the typical industry standards of traffic engineering and transportation planning, and also the expectations and/or perceptions of the community. In general, it is important to identify issues and problems before a series of mitigation strategies can be developed. The identification of "problems" is the result of intensive data collection, analysis, field observation, and public input. Over the development of this Transportation Plan Update, these tools have been used to assess all of the collected data to develop an understanding of the "problems" with the existing transportation system. This becomes a necessary step and forms the basis for developing mitigation strategies. The development of mitigation (i.e. preliminary recommendations) will be the follow-up step to plan for correction of the identified deficiencies. Identified deficiencies may fall into one or more of the following categories:

- Intersection levels of service
- Signal warrant analysis
- Corridor levels of service
- Safety (i.e. crash analyses)
- Pedestrian facilities
- Bicycle facilities
- Transit system

Each of these areas is expanded upon in this chapter.

4.2 Intersection Levels of Service (Motorized)

Urban road systems are ultimately controlled by the function of the major intersections. Intersection failure directly reduces the number of vehicles that can be accommodated during the peak hours that have the highest demand and the total daily capacity of a corridor. As a result of this strong impact on corridor function, intersection improvements can be a very cost-effective means of increasing a corridor's traffic volume capacity. In some circumstances, corridor expansion projects may be able to be delayed with correct intersection improvements. Due to the significant portion of total expense for road construction projects used for project design, construction, mobilization, and adjacent area rehabilitation, a careful analysis must be made of the expected service life from intersection-only improvements. If adequate design life can be achieved with only improvements to the intersection, then a corridor expansion may not be the most efficient solution. With that in mind, it is important to determine how well the major intersections are functioning by determining their Level of Service (LOS).

LOS is a qualitative measure developed by the transportation profession to quantify driver perception for such elements as travel time, number of stops, total amount of stopped delay, and impediments caused by other vehicles. It provides a scale that is intended to match the perception by motorists of the operation of the intersection. LOS provides a means for identifying intersections that are experiencing operational difficulties, as well as providing a scale to compare intersections with each other. The LOS scale represents the full range of operating conditions. The scale is based on the ability of an intersection or street segment to accommodate the amount of traffic using it. The scale ranges from "A" which indicates little, if any, vehicle delay, to "F" which indicates significant vehicle delay and traffic congestion. The LOS analysis was conducted according to the procedures outlined in the Transportation Research Board's ***Highway Capacity Manual – Special Report 209*** using the *Highway Capacity Software, version 4.1c*.

Of the 74 intersections that were studied as part of this project (41 signalized intersections and 33 unsignalized intersections), 22 had a level of service of D, E or F during the AM or PM peak hours of the day (6 signalized intersections as shown in **Table 4-1** and 16 unsignalized intersections as shown in **Table 4-2**).

It should be noted that the LOS shown in the following tables for the intersections along Rouse Avenue may not be identical to those shown in the recently published *Rouse Avenue Environmental Assessment*. Variations to the LOS at these intersections may be the result of variations in the peak hour factor, type of analysis software, the amount of truck traffic observed, construction activities in the area, or the time of year and day of the week that the intersection traffic counts were made.

Table 4-1
Existing (2007) Level of Service for Signalized Intersections

Intersection	AM Peak Hour					PM Peak Hour				
	EB	WB	NB	SB	INT	EB	WB	NB	SB	INT
Huffine Lane & Ferguson Road	B	B	-	C	**B**	F	B	-	C	**D**
Kagy Boulevard & South Willson Avenue	C	E	D	C	**D**	D	D	C	D	**D**
Main Street & South 19th Avenue	D	E	C	D	**D**	D	C	C	C	**D**
North 7th Avenue & Durston Road	D	D	C	D	**D**	B	B	D	C	**C**
North 7th Avenue & Oak Street	D	D	C	C	**C**	E	D	C	C	**D**
West College Street & South 19th Avenue	F	D	D	D	**D**	D	F	F	E	**F**

Table 4-2
Existing (2007) Level of Service for Unsignalized Intersections

Unsignalized Intersection	AM	PM	Unsignalized Intersection	AM	PM
8th Avenue & College Street	C	D	Jackrabbit Lane & Baxter Lane	C	D
College Street & Willson Avenue	E	F	Jackrabbit Lane & Durston Road	C	D
East Main Street & Haggerty Lane	C	E	Jackrabbit Lane & Ramshorn Drive	D	C
Frontage Road & Valley Center Road	C	E	Jackrabbit Lane & Forkhorn Trail	E	E
Highland Boulevard & Ellis Street	C	E	Jackrabbit Lane & Shedhorn Trail	C	E
Highland Boulevard & Kagy Boulevard	E	C	Kagy Boulevard & Sourdough Road	F	F
Jackrabbit Lane & Cameron Bridge Road	D	F	South 11th Avenue & College Street	D	F
Jackrabbit Lane & Hulbert Road	C	D	South 11th Avenue & Kagy Boulevard	D	F

Note that for the unsignalized intersections, it is more relevant to present operational characteristics of each individual turning movement associated with the individual intersection legs. This data is reflected in **Table 4-3** for all of the unsignalized intersections studied as part of this Transportation Plan.

Table 4-3
Existing (2007) Level of Service for Unsignalized Intersections
(Individual Turning Movements)

Unsignalized Intersection	AM Peak Hour			PM Peak Hour		
	Delay	LOS	V/C	Delay	LOS	V/C
Frontage Road & Nelson Road	17.2	C	-	18.3	C	-
Eastbound Left/Thru	7.8	A	0.02	9.3	A	0.02
Westbound Left/Thru/Right	17.2	C	0.2	18.3	C	0.16
Frontage Road & Valley Center Road	15.7	C	-	35.3	E	-
Westbound Left	9.1	A	0.06	8.5	A	0.14
Northbound Left/Right	15.7	C	0.33	35.3	E	0.59
Highland Boulevard & Ellis Street	20.75	C	-	31.15	E	-
Eastbound Left	24.1	C	0.09	43.7	E	0.52
Eastbound Thru/Right	20.4	C	0.01	14.9	B	0.02
Westbound Left/Thru/Right	17.6	C	0.18	21	C	0.35
Northbound Left	8.5	A	0	8.1	A	0
Southbound Left	8.1	A	0.05	8.6	A	0.02
Highland Boulevard & Kagy Boulevard	42.3	E	-	18.85	C	-
Eastbound Left	9.1	A	0.25	8	A	0.2
Westbound Left/Thru/Right	7.4	A	0	7.6	A	0
Northbound Left/Thru/Right	66.8	F	0.17	23.5	C	0.03
Southbound Left/Thru/Right	17.8	C	0.56	14.2	B	0.51
Main Street & Haggerty Lane	21.2	C	-	39.9	E	-
Westbound Left	8.4	A	0.06	9.7	A	0.04
Northbound Left/Right	21.2	C	0.32	39.9	E	0.67
Bozeman Trail Road & Haggerty Lane	9	A	-	8.7	A	-
Westbound Left/Right	9	A	0.07	8.7	A	0.05
Southbound Left/Thru/Right	7.3	A	0	7.3	A	0.03
Kagy Boulevard & Bozeman Trail Road	10.1	B	-	10.6	B	-
Eastbound Left/Thru/Right	7.6	A	0.01	7.4	A	0.02
Westbound Left/Thru/Right	7.3	A	0	7.5	A	0
Northbound Left/Thru/Right	10.7	B	0.04	10.7	B	0.01
Southbound Left/Thru/Right	9.5	A	0.06	10.5	B	0.1
Kagy Boulevard & Church Avenue	120.5	F	-	67.9	F	-
Eastbound Left	8.9	A	0.02	8.1	A	0.03
Westbound Left	8	A	0.02	8.8	A	0.06
Northbound Left/Thru/Right	210.9	F	1.29	81.5	F	0.75
Southbound Left/Thru/Right	30.1	D	0.42	54.3	F	0.77

Unsignalized Intersection	AM Peak Hour			PM Peak Hour		
	Delay	LOS	V/C	Delay	LOS	V/C
Main Street & I-90 Off-Ramp	16.5	C	-	12.3	B	-
Southbound Left/Thru	16.7	C	0.26	23.4	C	0.14
Southbound Right	16.5	C	0.63	10	A	0.17
Main Street & I-90 On-Ramp	10.5	B	-	10.7	B	-
Eastbound Left	8.2	A	0.15	8.6	A	0.28
Southbound Left/Right	10.5	B	0.21	10.7	B	0.15
Story Mill & Bridger Canyon	12.85	B	-	15.4	C	-
Eastbound Left/Thru/Right	7.9	A	0.06	7.9	A	0.11
Westbound Left/Thru/Right	7.5	A	0	7.7	A	0
Northbound Left/Thru/Right	14.6	B	0.09	18.6	C	0.21
Southbound Left/Thru/Right	11.1	B	0.17	12.2	B	0.2
N. Rouse Avenue & Peach Street	20.4	C	-	28.6	C	-
Eastbound Left/Thru/Right	25	C	0.34	35.9	E	0.45
Westbound Left/Thru/Right	15.4	C	0.2	21.3	C	0.41
Northbound Left/Thru/Right	8.3	A	0.02	8.4	A	0.04
Southbound Left/Thru/Right	8.2	A	0.08	8.3	A	0.07
11th Avenue & College Street	33.25	D	-	67.52	F	-
Eastbound Left/Thru/Right	39.12	E	-	67.92	F	-
Westbound Left/Thru/Right	35.69	E	-	83.5	F	-
Northbound Left/Thru/Right	21.01	C	-	67.91	F	-
Southbound Left/Thru/Right	32.14	D	-	46.12	E	-
College Street & Willson Avenue	44.6	E	-	74.5	F	-
Eastbound Left/Thru/Right	46.4	E	0.57	100.5	F	0.94
Westbound Left/Thru/Right	42.8	E	0.43	48.5	E	0.51
Northbound Left/Thru/Right	8.4	A	0.12	9	A	0.12
Southbound Left/Thru/Right	8.6	A	0.03	8.4	A	0.03
Kagy Boulevard & 11th Avenue	26.85	D	-	92.95	F	-
Eastbound Left	9.2	A	0.1	9.6	A	0.05
Westbound Left	8.6	A	0.01	8.6	A	0
Northbound Left	38.6	E	0.02	57.8	F	0.14
Northbound Thru/Right	11.7	B	0.01	19.5	C	0.1
Southbound Left	52.9	F	0.42	261.2	F	1.28
Southbound Thru/Right	15.6	C	0.13	16.9	C	0.25
19th Avenue & Goldenstein Road	10.9	B	-	11.1	B	-
Westbound Left/Right	10.9	B	0.13	11.1	B	0.11
Southbound Left/Thru	8	A	0.03	7.7	A	0.06
Jackrabbit Lane & Cameron Bridge Road	29.75	D	-	54	F	-
Eastbound Left/Thru/Right	38.1	E	0.66	72.3	F	0.63
Westbound Left/Thru/Right	21.4	C	0.12	35.7	E	0.2
Northbound Left	9.3	A	0.02	8.7	A	0.11
Southbound Left	8.1	A	0.01	9.7	A	0.02
Jackrabbit Lane & Hulbert	22.6	C	-	34.6	D	-

Unsignalized Intersection	AM Peak Hour			PM Peak Hour		
	Delay	LOS	V/C	Delay	LOS	V/C
Eastbound Left/Thru/Right	20.2	C	0.12	38.9	E	0.18
Westbound Left/Thru/Right	25	C	0.04	30.3	D	0.1
Northbound Left/Thru/Right	9.3	A	0	8.3	A	0
Southbound Left/Thru/Right	8.2	A	0.01	9.8	A	0.01
Jackrabbit Lane & Baxter Lane	23	C	-	34.95	D	-
Eastbound Left/Thru/Right	29.5	D	0.05	42.1	E	0.11
Westbound Left/Thru/Right	16.5	C	0.07	27.8	D	0.09
Northbound Left/Thru/Right	9.3	A	0	8.2	A	0
Southbound Left/Thru/Right	8.1	A	0.01	10	B	0.02
Jackrabbit Lane & Durston Road	23.15	C	-	29.45	D	-
Eastbound Left/Thru/Right	26.2	D	0.02	38	E	0.04
Westbound Left/Thru/Right	20.1	C	0.02	20.9	C	0.06
Northbound Left/Thru/Right	9.3	A	0	8.3	A	0
Southbound Left/Thru/Right	8.1	A	0.01	13	B	0
Jackrabbit Lane & Ramshorn Drive	28.9	D	-	22.3	C	-
Eastbound Left/Thru/Right	27.5	D	0.02	22.2	C	0.01
Westbound Left/Thru/Right	30.3	D	0.1	22.4	C	0.21
Northbound Left/Thru/Right	9.6	A	0	8.4	A	0
Southbound Left/Thru/Right	8	A	0.01	10.1	B	0.01
Jackrabbit Lane & Forkhorn Trail	40.7	E	-	38.25	E	-
Eastbound Left/Thru/Right	35.1	E	0.38	53.3	F	0.55
Westbound Left/Thru/Right	46.3	E	0.11	23.2	C	0.2
Northbound Left/Thru/Right	10.1	B	0.06	8.3	A	0.03
Southbound Left/Thru/Right	8.1	A	0.02	9.7	A	0.01
Jackrabbit Lane & Shedhorn Trail	19.7	C	-	49.15	E	-
Eastbound Left/Thru/Right	20.8	C	0.16	62.4	F	0.56
Westbound Left/Thru/Right	18.6	C	0.08	35.9	E	0.36
Northbound Left/Thru/Right	9.5	A	0.03	8.6	A	0.02
Southbound Left/Thru/Right	8.1	A	0.01	9.5	A	0.01
Jackrabbit Lane & Spanish Peak	17.8	C	-	24.9	C	-
Westbound Left/Right	17.8	C	0.05	24.9	C	0.23
Southbound Left/Thru	8.5	A	0.03	9.3	A	0.02
Huffine Lane & Monforton School Road	14.2	B	-	24.2	C	-
Eastbound Left	9.4	A	0.02	11.6	B	0.01
Southbound Left/Right	14.2	B	0.05	24.2	C	0.16
Huffine Lane & Love Lane	17.7	C	-	20.4	C	-
Eastbound Left	9.1	A	0.03	10.7	B	0.08
Southbound Left/Right	17.7	C	0.36	20.4	C	0.29
Huffine Lane & Gooch Hill Road	14.75	B	-	15.75	C	-
Eastbound Left	9.1	A	0	9.4	A	0.02
Westbound Left	9.6	A	0.05	10.3	B	0.14
Northbound Left/Thru	23.5	C	0.19	27.5	D	0.09

Unsignalized Intersection	AM Peak Hour			PM Peak Hour		
	Delay	LOS	V/C	Delay	LOS	V/C
Northbound Right	13.1	B	0.25	12.1	B	0.13
Southbound Left/Thru/Right	14	B	0.03	16.7	C	0.02
Valley Center Road & Harper Pucket	10.35	B	-	11.05	B	-
Eastbound Left/Thru/Right	7.4	A	0	7.7	A	0
Westbound Left/Thru/Right	7.7	A	0	7.5	A	0
Northbound Left/Thru/Right	10.1	B	0.01	11.1	B	0.03
Southbound Left/Thru/Right	10.6	B	0.05	11	B	0.02
College Street & 8th Avenue	17.31	C	-	25.6	D	-
Eastbound Left/Thru/Right	14.63	B	-	30.49	D	-
Westbound Left/Thru/Right	21.4	C	-	22.33	C	-
Northbound Left/Thru/Right	12.54	B	-	27.91	D	-
Southbound Left/Thru/Right	16.25	C	-	18.61	C	-
U.S. 191 & Gooch Hill	11.4	B	-	15.1	C	-
Westbound Left/Right	11.4	B	0.06	15.1	C	0.08
Southbound Left	7.7	A	0.01	8.6	A	0.02
U.S. 191 & Mill Street	15.9	C	-	19.85	C	-
Eastbound Left/Thru/Right	17.8	C	0.19	23.6	C	0.23
Westbound Left/Thru/Right	14	B	0.05	16.1	C	0.2
Northbound Left/Thru	8.1	A	0.01	7.8	A	0.02
Southbound Left/Thru	8.1	A	0.04	8.6	A	0.04
U.S. 191 & Cottonwood Road	12	B	-	18.85	C	-
Eastbound Left/Thru/Right	12.7	B	0.02	22.9	C	0.22
Westbound Left/Thru/Right	11.3	B	0.08	14.8	B	0.13
Northbound Left/Thru/Right	8	A	0	7.8	A	0
Southbound Left/Thru/Right	7.5	A	0.02	8.8	A	0.04

Signalized Intersections

- **Huffine Lane & Ferguson Road** – This intersection experiences poor LOS during the PM peak hour. The eastbound left-turn movement has a LOS of F and is the main cause for the intersection to fail. This intersection lacks a protected eastbound left-turn movement but does have a designated turn lane.

- **Kagy Boulevard & South Willson Avenue** – This intersection has a poor LOS for both the AM and PM peak hours. The westbound leg of the intersection has the lowest LOS during both peak hours. This intersection has protected left-turn phasing and dedicated left-turn lanes at all legs of the intersection.

- **Main Street & South 19th** – This intersection has a LOS of D for the AM and PM peak hours. Problems with this intersection are caused by the heavy amounts of traffic that pass through it. Additional lanes will be added to this intersection in the near future to accommodate additional traffic.

- **North 7th Avenue & Durston Road** – This intersection has a LOS of D during the AM peak hour. The signal timing and phasing of this intersection are not optimized to properly handle the amount of traffic passing through.

- **North 7th Avenue & Oak Street** – This intersection has a poor LOS during the PM peak hour. This failure is due to poor performance on the eastbound and westbound legs of the intersection. This intersection has designated and protected phasing for the left-turn movements at each leg.

- **West College Street & South 19th Avenue** – This intersection experiences poor LOS during the AM and PM peak hours. Every leg of the intersection during the AM and PM peak hours has a LOS of D or lower. This intersection is not equipped to handle the high amounts of traffic passing through. Additional lanes will be added to this intersection in the near future to accommodate additional traffic.

Unsignalized Intersections

The unsignalized intersections experiencing a LOS of D or lower for the AM or PM peak hours fail generally due to the inability of traffic on the minor approach to enter the intersection. High traffic volumes on the major approach make turning movements from the minor approach difficult. A signal warrant analysis was conducted for each of the unsignalized intersections that have a LOS of D or lower for either the AM or PM peak hours. The signal warrant analysis is found in the next section.

4.3 Signal Warrant Analysis (Motorized)

A signal warrant analysis was conducted to determine if any of the existing unsignalized intersections with unacceptable Levels of Service (LOS) met signal warrants. The subject intersections are listed in **Table 4-2** in the previous section.

According to the 2003 Edition of the *Manual on Uniform Traffic Control Devices (MUTCD)*, there are eight (8) signal warrants that must be analyzed for the installation of a traffic control signal. The MUTCD states that a traffic signal should not be installed unless one or more warrants are satisfied.

The eight (8) signal warrants that must be analyzed are as follows:

1. **Eight-Hour Vehicular Volume**
This warrant is intended for application at locations where a large volume of intersection traffic is the principal reason to consider the installation of a traffic signal (Condition A) or where the traffic volume on the major street is so heavy that traffic on the minor street experiences excessive delay or conflict in entering or crossing the major street (Condition B) during any eight (8) hours of an average day. The criteria for Warrant 1 may be met if either Condition A or Condition B is met. The combination of Condition A and B are not required. This warrant was not analyzed due to insufficient project data.

2. FOUR- HOUR VEHICULAR VOLUME

This warrant is intended for locations where the volume of intersecting traffic is the principal reason to consider installing a traffic control signal. This warrant requires that the combination of the major-street traffic (total of both approaches) and the higher-volume minor-street traffic (one direction only) reach the designated minimum volume during any four (4) hours of an average day. This warrant was based upon a combination of AM and PM peak hour volumes to account for the four-hour period. This warrant was met for six (6) of the intersections analyzed as shown in **Table 4-4**.

3. PEAK HOUR

This warrant is intended for use at a location where during any one (1) hour of an average day, the minor-street traffic suffers undue delay when entering or crossing the major street. This warrant also requires that the combination of the major-street traffic (total of both approaches) and the higher-volume minor-street traffic (one direction only) reach the designated minimum volume. The peak hour warrant was conducted assuming that this peak hour would fall within the peak periods. This warrant was met for twelve (12) of the intersections analyzed as shown in **Table 4-4**.

4. PEDESTRIAN VOLUME

The Pedestrian Volume signal warrant is intended for application where the traffic volume on a major street is so heavy that pedestrians experience excessive delay in crossing the major street. This warrant was not analyzed due to insufficient project data.

5. SCHOOL CROSSING

This warrant addresses the unique characteristics that a nearby school may have on the roadways. It requires that the major roadway be unsafe to cross and that there are no other feasible crossings in the area. This warrant was not analyzed due to insufficient project data.

6. COORDINATED SIGNAL SYSTEM

Progressive movement in a coordinated signal system sometimes necessitates installing traffic control signals at intersections where they would not otherwise be needed in order to maintain proper platooning of vehicles. This warrant was not met for any of the intersections under consideration.

7. CRASH EXPERIENCE

The Crash Experience signal warrant conditions are intended for application where the severity and frequency of crashes are the principal reasons to consider installing a traffic control signal. This warrant was not analyzed due to insufficient project data.

8. ROADWAY NETWORK

This warrant is intended for locations where the installation of a traffic signal may encourage concentration and organization of traffic flow on a roadway network. This warrant was not met for any of the intersections under consideration.

Table 4-4 shows which warrants are met for each intersection under existing traffic conditions.

Ideally, before considering a signal for traffic control at an intersection, it is desirable to meet more than one signal warrant. All of the intersections identified that meet one warrant (i.e. the Peak Hour warrant) will be further evaluated to determine if less restrictive traffic controls, or possible geometric modifications, will benefit the operational characteristics of the intersection. Intersections meeting two or three signal warrants are ideal candidates for signalization, but must be analyzed carefully to consider the major street traffic movements and volumes.

Table 4-4
Signal Warrant Analysis (Existing Unsignalized Intersections)

Intersection	LOS		Signal Warrant			
	AM	PM	#2	#3	#6	#8
Frontage Road & Valley Center Road	C	E	X	X		
Highland Boulevard & Ellis Street	C	E				
Highland Boulevard & Kagy Boulevard	E	C				
East Main Street & Haggerty Lane	C	E				
Kagy Boulevard & Sourdough Road	F	F		X		
South 11th Avenue & College Street	D	F	X	X		
College Street & Willson Avenue	E	F		X		
South 11th Avenue & Kagy Boulevard	D	F		X		
Jackrabbit Lane & Cameron Bridge Road	D	F	X	X		
Jackrabbit Lane & Hulbert Road	C	D				
Jackrabbit Lane & Baxter Lane	C	D				
Jackrabbit Lane & Durston Road	C	D				
Jackrabbit Lane & Ramshorn Drive	D	C				
Jackrabbit Lane & Forkhorn Trail	E	E		X		
Jackrabbit Lane & Shedhorn Trail	C	E		X		
8th Avenue & College Street	C	D		X		

Based upon the preliminary signal warrant analysis for this planning project, the following intersections appear to meet one or more traffic signal warrants and could be considered for traffic signal control going forward based on traffic volumes alone:

- Frontage Road & Valley Center Road
- Kagy Boulevard & Sourdough Road
- South 11th Avenue & College Street
- College Street & Willson Avenue
- South 11th Avenue & Kagy Boulevard
- Jackrabbit Lane & Cameron Bridge Road
- Jackrabbit Lane & Forkhorn Trail
- Jackrabbit Lane & Shedhorn Trail
- 8th Avenue & College Street

While the previously mentioned intersections may meet one or more traffic signal warrants, it may not be appropriate in every case to install a traffic signal. Alternatives to traffic signals, such as roundabouts, reduced access, revised intersection geometrics, etc, may be analyzed as other potential traffic control measures. **Chapter 9** provides a discussion on conceptual roundabout design while **Chapter 8** discusses roundabouts and other traffic calming measures.

In order to determine the optimal intersection control strategy, the overall design of the intersection must be considered. Some general objectives for good intersection design that should be considered are:

- Provide adequate sight distance
- Minimize points of conflict
- Simplify conflict areas
- Limit conflict frequency
- Minimize the severity of conflicts
- Minimize delay
- Provide acceptable capacity

4.4 Corridor Volumes, Capacity and Levels of Service (Motorized)

The corridors shown on **Figure 2-5** and **Figure 2-6** in **Chapter 2** were evaluated for volume to capacity (v/c) ratios under existing traffic conditions (year 2005 due to calibrated travel demand model) and future year traffic projections (year 2030). These variables are shown on **Figure 3-15** and **Figure 3-16** (existing year 2005 v/c ratios) and **Figure 3-17** and **Figure 3-18** (projected year 2030 v/c ratios) located in **Chapter 3**. The preparation and analysis of these figures assisted in determining potential capacity deficiencies under the future traffic conditions.

Roadway capacity is of critical importance when looking at the growth of a community. As traffic volume increases, the vehicle flow deteriorates. When traffic volumes approach and exceed the available capacity, the road begins to "fail". For this reason it is important to look at the size and configuration of the current roadways and determine if these roads need to be expanded to accommodate the existing or future traffic needs. The capacity of a road is a function of a number of factors including intersection function, land use adjacent to the road, access and intersection spacing, road alignment and grade, speed, turning movements, vehicle fleet mix, adequate road design, land use controls, street network management, and good planning and maintenance. Proper use of all of these tools will increase the number of vehicles that a specific lane segment may carry. However, the number of lanes is the primary factor in evaluating road capacity since any lane configuration has an upper volume limit regardless of how carefully it has been designed.

The size of a roadway is based upon the anticipated traffic demand. It is desirable to size the arterial network to comfortably accommodate the traffic demand that is anticipated to occur 20 years from the time it is constructed. The selection of a 20-year design period represents a desire to receive the most benefit from an individual construction project's service life within reasonable planning limits. The design, bidding, mobilization, and repair to affected adjacent properties can consume a significant portion of an individual project's budget. Frequent projects to make minor adjustments to a roadway can therefore be prohibitively expensive. As roadway capacity generally is provided in large increments, a long term horizon is necessary. The collector and local street network are often sized to meet the local needs of the adjacent properties.

There are two measurements of a street's capacity, Annual Average Daily Traffic (AADT) and Peak Hour. AADT measures the average number of vehicles a given street carries over a 24- hour period. Since traffic does not usually flow continuously at the maximum rate, AADT is not a statement of maximum capacity. Peak Hour measures the number of vehicles that a street can physically accommodate during the busiest hour of the day. It is therefore more of a maximum traffic flow rate measurement than AADT. When the Peak Hour is exceeded, the traveling public will often perceive the street as "broken" even though the street's AADT is within the expected volume. Therefore, it is important to consider both elements during design of corridors and intersections.

Street size of the roadway and the required right-of-way is a function of the land use that will occur along the street corridor. These uses will dictate the vehicular traffic characteristics, travel by pedestrians and bicyclists, and need for on-street parking. The right-of-way required should always be based upon the ultimate facility size.

The actual amount of traffic that can be handled by a roadway is dependent upon the presence of parking, number of driveways and intersections, intersection traffic control, and roadway alignment. The data presented in **Table 4-5** and **Table 4-6** indicates the approximate volumes that can be accommodated by a particular roadway. As indicated in the differences between the two tables, the actual traffic that a road can handle will vary based upon a variety of elements including: road grade; alignment; pavement condition; number of intersections and driveways; the amount of turning movements; and the vehicle fleet mix.

Roadway capacities can be increased under "ideal management conditions" (**Column 2** in **Table 4-5**) that take into account such factors as limiting direct access points to a facility, adequate roadway geometrics and improvements to sight distance. By implementing these control features, vehicles can be expected to operate under an improved Level of Service and potentially safer operating conditions.

Table 4-5
Approximate Volumes for Planning of Future Roadway Improvements

Road Segment	Volumes[1]	Volumes[2]
Two Lane Road	Up to 12,000 VPD	Up to 15,000 VPD*
Three Lane Road	Up to 18,000 VPD	Up to 22,500 VPD*
Four Lane Road	Up to 24,000 VPD	Up to 30,000 VPD*
Five Lane Road	Up to 35,000 VPD	Up to 43,750 VPD*

[1]Historical management conditions
[2]Ideal management conditions
*Additional volumes may be obtained in some locations with adequate road design, access control, and other capacity enhancing methods.

Table 4-5 shows capacity levels which are appropriate for planning purposes in developing areas within the study area. In newly developing areas, there are opportunities to achieve additional lane capacity improvements. The careful, appropriate, and consistent use of the capacity guidelines listed above can provide for long-term cost savings and help maintain roads at a scale comfortable to the community.

Two important factors to consider in achieving additional capacity are peak hour demand and access control. Traffic volumes shown in **Table 4-5** are 24-hour averages; however, traffic is not smoothly distributed during the day. The major street network shows significant peaks of demand, especially the work "rush" hour. These limited times create the greatest periods of stress on the transportation system. By concentrating large volumes in a brief period of time, a road's short-term capacity may be exceeded and a road user's perception of congestion is strongly influenced. The use of pedestrian and bicycle programs as discussed in **Chapter 6** and TDM measures can help to smooth out the peaks and thereby extend the adequate service life of a specific road configuration. The Transportation Plan strongly recommends the pursuit of such measures as low-cost means of meeting a portion of expected transportation demand.

Each time a roadway is intersected by a driveway or another street it raises the potential for conflicts between transportation users. The resulting conflicts can substantially reduce the roadway's ability to carry traffic if conflicts occur frequently. This basic principle is the design basis for the interstate highway system, which carefully restricts access to designated entrance and exit points. Arterial streets are intended to serve the longest trip distances in an urbanized area and the highest traffic volume corridors. Access control is therefore very important on the higher volume elements of a community's transportation system. Collector streets, and especially local streets, do provide higher levels of immediate property access required for transportation users to enter and exit the roadway network. In order to achieve volumes in excess of that shown in **Column 4** of **Table 4-5**, access controls should be put in place by the appropriate governing body. It is strongly recommended that access control standards appropriate to each classification of street be incorporated into the subdivision and zoning regulations of the City of Bozeman. Follow up monitoring of the effects of access control will aid in future transportation planning efforts.

Using the traffic model developed for this project, it was possible to project the traffic volumes on all major roads within the study area. These roads were analyzed for the current year (2005), and future year (2030) conditions to determine if the roads have an adequate number of lanes for the traffic volume. **Figure 3-16** and **Figure 3-17** presented in **Chapter 3** show the projected traffic volumes for the planning year horizon of year 2030 within the study area. The best tool generated by the traffic model for comparing the current traffic volumes to the existing number of travel lanes on the major corridors is the volume to capacity ratio (v/c ratio). By definition, the "v/c ratio" is the result of the flow rate of a roadway lane divided by the capacity of the roadway lane. **Table 4-6** shows "v/c ratios" and their corresponding roadway corridor "Level of Service" designations.

Table 4-6
V/C Ratios & LOS Designations

V/C Ratio	Description	Corridor LOS
< 0.59	Well Under Capacity	LOS A and B
> 0.60 – 0.79	Under Capacity	LOS C
> 0.80 – 0.99	Nearing Capacity	LOS D
> 1.00 – 1.19	At Capacity	LOS E
> 1.20	Over Capacity	LOS F

An examination of the "v/c ratios" computed by the traffic model, and as shown graphically on **Figures 3-18 thru 3-21**, shows the facilities that either over capacity or are at or nearing capacity, and consequently are roadways that may be currently undersized:

<u>Roadways at or above capacity for existing (2005) conditions</u>

- **Amsterdam Road** – Jackrabbit Lane to the study area boundary
- **Jackrabbit Lane** – Baxter Lane to 0.5 miles north
- **Gallatin Road** – Huffine Lane to 0.12 miles south
- **College Street** – Main Street to 11th Avenue
- **19th Avenue** – Lincoln Street to Main Street
- **North 7th Avenue** –Griffin Drive to Frontage Road
- **Frontage Road** – North 7th Avenue to Springhill Road
- **Willson Avenue** – Garfield to Main Street

<u>Roadways at or above capacity for future (2030) conditions</u>

- **Amsterdam Road** – Jackrabbit Lane to the study area boundary
- **Jackrabbit Lane** – Huffine Lane to the study area boundary
- **Gallatin Road** – Huffine Lane to Axtell Anceney Road
- **Huffine Lane** – Jackrabbit Lane to Main Street
- **Norris Road** – Jackrabbit Lane to Zoot Way
- **Gooch Hill Road** – Huffine Lane to Blackwood Road
- **College Street** – Main Street to 8th Avenue
- **Main Street** – Babcock Street to 15th Avenue and 8th Avenue to Interstate 90
- **19th Avenue** – Patterson Road to Interstate 90
- **North 7th Avenue** – Aspen Street to Frontage Road
- **Frontage Road** – North 7th Avenue to Sacajawea Peak Drive and Airport Road to study area boundary
- **Springhill Road** – 19th Avenue to Sypes Canyon Road
- **Willson Avenue** – Main Street to Kagy Boulevard
- **South 3rd Street** – Kagy Boulevard to Henderson Street
- **Kagy Boulevard** – 19th Street to Highland Boulevard
- **Highland Boulevard** – Kagy Street to Main Street
- **Rouse Avenue** – Lamme Street to Griffin Drive
- **Bridger Drive** – Griffin Drive to Bucks Run Court
- **Griffin Drive** – Rouse Avenue to North 7th Avenue
- **Durston Road** – 19th Avenue to 25th Avenue and Hanson Lane to Yellowstone Avenue

4.4.1 Speed-Density-Flow Relationship

The following section discusses the relationship between speed, density, and flow rate as defined by the *Highway Capacity Manual (HCM) 2000*. These three basic variables can be used to describe traffic on a roadway, and can ultimately be used to determine the LOS and capacity of the facility.

> **Speed** is defined as the average travel speed for purposes of this discussion. The average travel speed is computed by dividing the length of the roadway under consideration by the average travel time of the vehicles traversing it. For capacity analysis, speeds are best measured by observing travel times over a known length of highway. As measures of effectiveness, speed criteria must recognize driver expectations and roadway function.
>
> **Flow rate** is defined as the equivalent hourly rate at which vehicles pass over a given point or section of a lane or roadway during a given time interval of less than one (1) hour. Flow rate represents the demand of a given facility during a specific time period. Congestion can influence demand, and observed volumes sometimes reflect capacity constraints rather than true demand.
>
> **Density** is the number of vehicles occupying a given length of a lane or roadway at a particular instant. Measuring density in the field is difficult; it can, however, be calculated from the average travel speed and flow rate. Density is a critical parameter for uninterrupted-flow facilities because it characterizes the quality of traffic operations. It describes the proximity of vehicles to one another and reflects the freedom to maneuver within the traffic stream.

The equation found below shows the relationship between density, flow rate, and average travel speed:

$$D = \frac{v}{S}$$

where

v = flow rate (veh/h),
S = average travel speed (mi/h), and
D = density (veh/mi).

Figure 4-1 shows a generalized relationship between these three variables (as defined by the above equation). The form of these functions depends on the prevailing traffic and roadway conditions on the segment under study and on its length in determining density. Although these diagrams show continuous curves, it is unlikely that the full range of the functions would appear at any particular location.

From the curves shown in **Figure 4-1**, it can be seen that there are two points at which a zero flow rate is reached: 1) when there are no vehicles on the roadway, and 2) when the density becomes so high that all vehicles must stop.

Between these two points, the dynamics of traffic flow produce a maximizing effect. As flow increases from zero, density also increases, since more vehicles are on the roadway. When this happens, speed declines because of the interaction of vehicles. This decline is negligible at low and medium densities and flow rates. As density increases, these generalized curves suggest that speed decreases significantly before capacity is achieved. **Capacity** is reached when the product of density and speed results in the maximum flow rate. This condition is shown as optimum speed, optimum density, and maximum flow.

Any flow other than capacity can occur under two different conditions, one with a high speed and low density and the other with high density and low speed. LOS A through E are defined on the low-density, high-speed side of the curves, with the maximum-flow boundary of LOS E placed at capacity. LOS F describes oversaturated flow and is represented by the high-density, low-speed part of the functions.

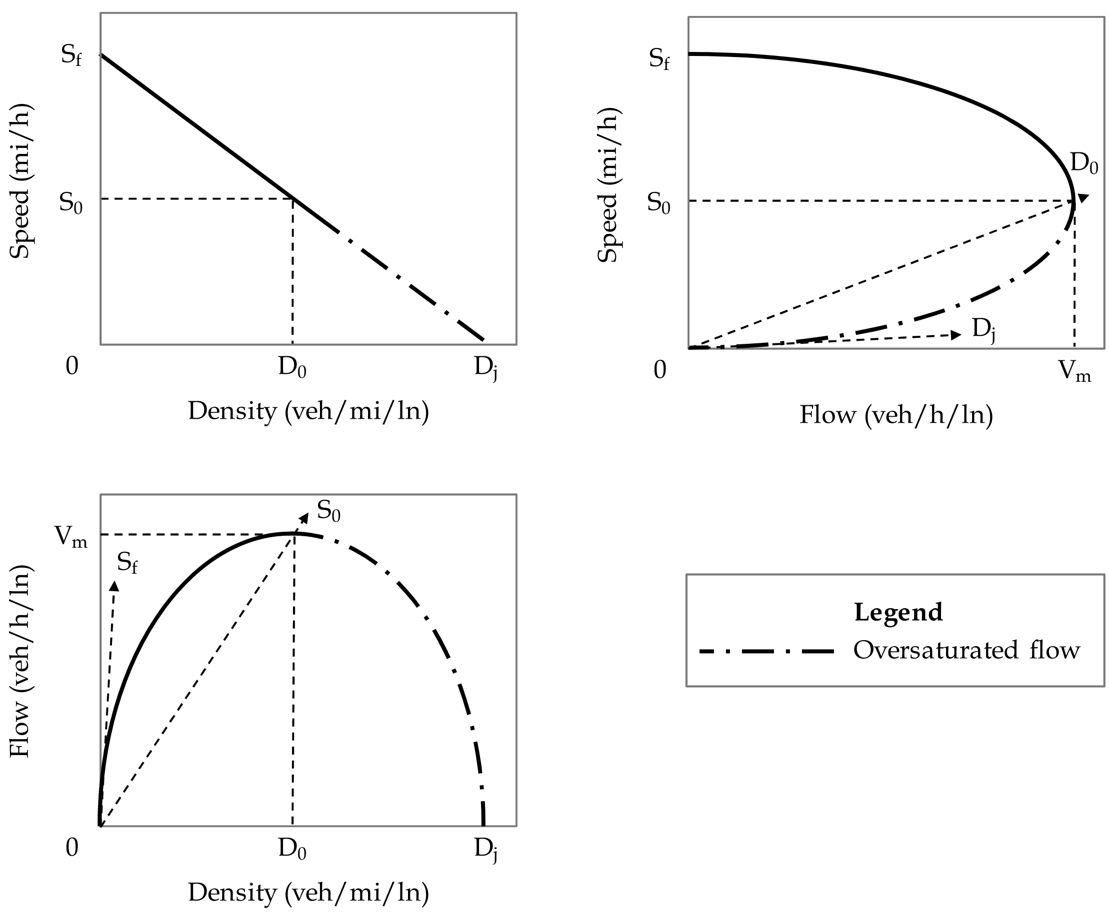


Figure 4-1
Fundamental Relationships between Speed-Density-Flow (May 1990)

4.5 VEHICLE CRASH ANALYSIS (MOTORIZED)

The MDT Traffic and Safety Bureau provided crash information and data for use in this Transportation Plan. The crash information was analyzed to find high crash locations. General crash characteristics were determined along with probable roadway deficiencies and solutions. The crash information covers the three-year time period from January 1st, 2004 to December 31st, 2006. **Section 2.1.5** in **Chapter 2** contains detailed information concerning the crash analysis prepared for this planning project.

Intersections that were identified through the composite rating score method, as described in **Chapter 2**, that warrant further study and may be in need of mitigation to specifically address crash trends. These intersections are as listed below. The locations of these intersections are shown on **Figure 2-11** and **Figure 2-12**.

- 7th Avenue & Oak Street
- 19th Avenue & Baxter Lane
- 18th Avenue & College Street
- 19th Avenue & Durston Road
- 19th Avenue & Oak Street
- Huffine Lane & Ferguson Road
- Huffine Lane & Fowler Road
- Huffine Lane & Jackrabbit Lane
- Jackrabbit Lane & Valley Center Road
- Main Street & 7th Avenue
- Main Street & 15th Avenue
- Main Street & 19th Avenue
- Main Street & College Street
- Willson Avenue & Babcock Street

Note that the fourteen intersections listed above are in alphabetical order, and there is no significance to the order of their listing. The identified intersections will be evaluated further to determine what type of mitigation measures may be possible to reduce specific crash trends (if any) and/or severity. These mitigation measures will be evaluated in the overall context of recommended improvements being evaluated via the *Greater Bozeman Area Transportation Plan – 2007 Update* development. It should be noted that several of the intersections have undergone significant reconstruction during the analysis period of January 1, 2004 to December 31, 2006 including the intersections of 7th Avenue & Oak Street, 19th Avenue & Baxter Lane, 19th Avenue & Durston Road, 19th Avenue & Oak Street, Huffine Lane & Ferguson Road, and Huffine Lane & Fowler Road that are listed above.

4.6 Pedestrian System

4.6.1 Problem Themes

Gallatin County residents within the study area face a largely undeveloped pedestrian system with major challenges including vast distances between homes and services, high vehicle speeds on rural roadways, low density development patterns, and roadways with no pedestrian facilities. See **Figure 2-17** *Study Area Pedestrian Facilities* to see existing pedestrian facilities in the study area.

Bozeman City residents have a much more developed pedestrian system, but there are still many problems that can be corrected. Through the existing conditions analysis and public involvement the main themes of pedestrian problems are summarized below:

- Lack of ADA compatible curb ramps throughout much of the city
- Old, deteriorating sections of sidewalk
- Lack of vegetation maintenance
- Lack of consistent snow removal in winter
- Longstanding gaps in the pedestrian network. See **Figure 2-18** *Bozeman Pedestrian Gaps*.
- Short-term gaps in the pedestrian network in new development areas.
- Difficult crossing locations of major streets.
- Large distances between legal crossings of major streets
- Lack of full integration with transit – sidewalk connections, shelters.

4.6.2 Pedestrian Collision Analysis

Crash data from January 2002 through June 2007 provided by the Bozeman Police Department were analyzed (see **Figure 2-19** and **Figure 2-20**). Fifteen crashes involving a pedestrian were reported in the greater Bozeman study area since 2002, all of which were within the Bozeman city limits. Seven of these crashes were on Main Street, two were on 7th Avenue, two were on Durston/Peach, one on North 19th, one on Mendenhall Street and one on Babcock Street. All reported crashes occurred on minor or principal arterials. These numbers, like the bicycle collision data, are likely underreported. The Bozeman Police Department reported that about half of the time the pedestrian was at fault, crossing mid block (jaywalking), or crossing against the signal. There were also several instances of riding on cars or jumping out into traffic.

4.6.3 Problem Areas

Few smaller, lower traffic streets including local streets and collectors present great difficulty for most pedestrians. Crossings are plentiful and short. Sidewalks are generally present with some needing maintenance. **Table 4-7** shown below focuses on major problems and barriers for pedestrian travel in Bozeman.

Table 4-7
Pedestrian Problem Identification

Street	From	To	Problem Description
Baxter Road	Fowler Avenue	N. 19th Avenue	Most of this roadway has no pedestrian facilities.
Cottonwood Road	Durston Road	Huffine Lane	No pedestrian facilities built.
Durston Road	Valley Drive	Flathead Avenue	No pedestrian facilities – This portion of the road has not been upgraded
Durston Road	Cottonwood Road	Westgate Avenue	No sidewalks on south side of roadway, south side is developed as soccer fields.
Griffin Drive	N. 7th Avenue	N. Rouse Avenue	No pedestrian facilities.
Kagy Boulevard	S. 19th Avenue	S. 11th Avenue	Several sections without pedestrian facilities. No pedestrian connection between housing and University.
Kagy Boulevard	Highland Boulevard	Bozeman Trail Road	No pedestrian facilities currently. The north side will be upgraded with development, but south side has been developed.
N. 7th Ave	Main Street	I-90	Sidewalk system is fragmented and generally of poor quality. Most sidewalks are curb-tight. Crossings occur at major intersections only. Jaywalking is prevalent.
N. Rouse Avenue	E. Lamme Street	Story Mill Road	Roadway is mostly lacking pedestrian facilities.
Oak Street	N. Rouse Avenue	Meagher Avenue	Some small sections near North 7th have no pedestrian facilities. Other problems stem from lack of pedestrian crossings combined with a wide street section.
S. 19th Avenue	W. Babcock Street	Stucky Road	Roadway has no pedestrian facilities.
S. 3rd Avenue / Graf Street	Kagy Boulevard	Teslow Drive	Sole pedestrian facility is a 4 foot paved shoulder with a rumble strip to buffer from traffic. Not adequate to connect large amount of housing to commercial area.
S. Church Avenue	Kagy Boulevard	E. Story Street	Most of route lacks pedestrian facilities. Where sidewalks exist they are poorly maintained and overgrown.
W. Main Street	S. 8th Avenue	Cottonwood Road	Long distances between crossing opportunities. Crossings themselves are very long with 6 or more lanes common for a pedestrian to cross.

4.7 Bicycle System

Bicyclists are a diverse group with widely varying needs and preferences. A solution for some will still leave others unserved. For example, the construction of bike lanes will be a boon to confident cyclists and those that prefer direct routes with few interruptions, however less confident cyclists will not feel comfortable next to vehicle traffic and will prefer a separated pathway or a parallel lower traffic route. Conversely, a shared-use path will encourage less confident cyclists and other recreational users, but if it is the sole bicycle facility confident cyclists will prefer to ride in the unimproved roadway, away from slow moving pedestrians and complicated crossings of roads and driveways. To meet the needs of all cyclists, a balanced approach to solving bicycle facility problems is required.

4.7.1 Problem Themes & Areas

With a few notable exceptions of shared use paths and undercrossings in Gallatin Gateway, Four Corners, and Huffine just east of Four Corners, Gallatin County lacks bicycle facilities. Many of the problems that exist for pedestrians also exist for cyclists. Long distances, high traffic speeds, narrow or non-existent shoulders, rumble strips, road debris, and even recently maintained roads which have been chip sealed become significant obstacles to cyclists.

The City of Bozeman has seen a rapid increase in bicycle facilities in recent years. Many of the east-west arterials to the north side of Main Street have undergone reconstruction with the addition of bicycle lanes including Durston Road, Oak Street, Babcock Street, Baxter Lane, and others. North-south corridors to see reconstruction, many of which are only half built through new development include, Ferguson Avenue, Fowler Avenue, Cottonwood Road, and North 27th Avenue. Shared use path corridors have also been developed and expanded including the North 19th Ave corridor, and the Highland Blvd corridor. In 2002 a series of bicycle routes were installed involving signage only within many of the older neighborhoods in the city.

Through the existing conditions analysis and public involvement the main themes of bicycle problems are summarized below:

- Continuous bike lanes not available on all arterial routes including:
  - North Rouse Avenue
  - Kagy Boulevard
  - Huffine/Main Street
  - North 7th Avenue
  - North & South 19th Avenue
  - Cottonwood Road
  - Davis Lane
  - Willson Avenue
  - College Street
  - South 8th Avenue
  - Valley Center Drive
- Existing bike lane network is fragmented with numerous gaps
- Many unimproved roadways have no shoulder
- Bike lanes and shoulders covered in debris
- Pavement quality including potholes and cracking on many bike routes
- Difficult crossings of major roadways at unsignalized intersections along high desire corridors including:
  - W Garfield St and S 19th Ave
  - W Kagy Blvd and S 11th Ave
  - W Koch St and S 19th Ave
  - W Koch St and S 11th Ave
  - W Lamme St and N 7th Ave
  - W Lamme St and N Rouse Ave
  - W College St and S Willson Ave

- Inadequate bicycle detection at signalized intersections
- If available, bike lanes not adequately plowed in winter;
- Inadequate or no bicycle parking at bicyclists' destination
- No bicycle parking at transit stops
- Lack of wayfinding signage on bicycle routes to major destinations
- Lack of bicycle lanes to Downtown Bozeman (Main Street, Mendenhall Street and Babcock Street)
- Lack of bicycle lanes to Montana State University
- Lack of shoulder bikeways on rural roadways
- Lack of dedicated bicycle facilities along high profile routes such as Bozeman-Belgrade, and Bozeman-Four Corners
- General perception of lack of safety for adults and children.
- General perception of lack of adequate bicycle connections from new residential areas to commercial areas.
- Need for better education for bicyclists and motorists

4.7.2 Bicycle Collision Analysis

Crash data from January 2002 through June 2007 provided by the Bozeman Police Department were analyzed (see Figure 2-15 and Figure 2-16). Since 2002, 83 bicycle/vehicle or bicycle/pedestrian accidents were reported in the greater Bozeman study area with 69 occurring within the Bozeman City limits. This number is actually lower than the actual number of collisions that likely have occurred, as many may have not been reported. In addition, the Police Department reports that accident tracking methods have improved in the last few years causing the years 2002-2005 likely being under represented in the number of collisions. Due to these factors trends between years cannot be ascertained. Data collected from the Bozeman Police Department does show that of the 69 recorded incidents 43 percent of the collisions were the fault of the bicycle, 14 percent were the fault of the vehicle and 42 percent undetermined.

Main reasons for bicycle rider fault involved riding on sidewalk or riding the wrong direction against traffic. Several accidents at night involved no lights or reflectors and in several cases the bicyclist lost control while braking. There were several instances where the bicycle rider ignored stop signs or red signals and swerving into or through traffic. A few cases involved intoxicated bicycle riders. Adequate and properly designed bicycle facilities can encourage proper behavior by cyclists and potentially reduce this category of accidents in the future. With vehicles at fault, there were several cases of opening doors on a rider and several cases of not yielding to the bicycle when turning or in a crosswalk.

Generally, rural crashes are concentrated on higher-order streets such as Huffine Lane, Valley Center Road, and Cameron Bridge Road. Within Bozeman, crashes are likewise clustered along principal arterials such as 7th Avenue, 19th Avenue, and Main Street. In addition, a smaller number of crashes were reported on minor arterials and collector streets as well, including College Street, Garfield Street, and 11th Avenue. One thing nearly all the crash locations have in common is that almost none had dedicated bicycle facilities.

4.8 TRANSIT SYSTEM

4.8.1 Needs Identified in the "Bozeman Area Transportation Coordination Plan"

The following were identified as needs in the *Bozeman Area Transportation Coordination Plan – FY 2009 (utilized as provided, with permission, from Lisa Ballard, P.E., Current Transportation Solutions)*. It is also stated that at this time, adequate resources are not available to meet all the needs identified in the plan.

Service Gaps

- Bus schedules do not facilitate commuter transportation from Bozeman to Belgrade
- Northeast trailer parks
- South of campus
- Business park southwest of campus hosting *RightNow Technologies*, one of the largest employers
- New growth areas in northwest
- Reach, Inc. Work Center
- Hospital – one-way loop
- Northwest Bozeman between Babcock and Durston
- East Main / new library is poorly connected to west side
- Higher service frequency
- Bridger Bowl
- Livingston-Bozeman commuter service
- Evening service
- Weekend service

Information Gaps

- Lack of coordinated communication between the service providers. Streamline and Skyline drivers communicate well. Schedules and web pages have been updated to provide adequate information regarding the other service. Coordination with Angel Line, Madison County, and West Yellowstone has been minimal in the last year.
- Lack of knowledge in the community regarding Streamline.
- Difficulty among some potential users in understanding time tables and planning trips.

Resource Gaps

- There exists no central place of storage and maintenance for vehicles
- There is no set standard for training of drivers and no specific place to train them. Sharing of drivers is thus not possible without universal requirements for training.
- Lack of benches and bus shelters

4.8.2 Additional Identified Needs

Below is a list of additional needs not identified in the *Bozeman Area Transportation Coordination Plan – FY 2009*.

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. Responsibility for these bus bays needs to be determined.
- Determine a standard design for street furniture.

Infrastructure Needs

- **College** (the entire road) – 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 Avenue** – The sidewalk is separated from the road by a ditch, and there are no pedestrian connections to the road, even at driveways.
- **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.

4.9 Equestrian Issues

The planning boundary for the Update includes areas currently and historically used by equine riders and drivers. They and other non-motorized residents have used the unpaved roads as a trail system. If these roads are paved with no shoulder and no trail, and traffic volumes and speeds increase, these roads may become less safe for both motorized and non-motorized users. Future improvements need to take into consideration all of these users.

5.1 Recommended Major Street Network (MSN) Improvements

This Plan includes a variety of recommended major street network improvement projects. These projects are needed to meet the anticipated traffic demands for the year 2030. This section summarizes these projects.

5.1.1 MSN Projects from the 2001 Transportation Plan

A list of recommended major street network (MSN) projects that were recommended as part of the *Greater Bozeman Area Transportation Plan – 2001 Update* and their status as of this plan update are listed in this section. The 2001 update of the Transportation Plan included 40 recommended MSN projects. Of these projects, 4 were completed, 6 are partially completed, and 30 have not been completed. Of the either partially completed or not completed projects from the previous plan, 32 projects have been included in this update of the plan (either as committed or as recommended projects). The various 40 projects recommended from the previous plan and their resultant status is shown below in **Table 5-1**.

Table 5-1
MSN Projects from 2001 Transportation Plan & Status for 2007 Plan

MSN Location No.	Location of Past MSN Project	Past Recommendation	Status for this Plan Update
1	N. 19th Ave. – Baxter Ave. to Springhill Rd.	Widen to a 5-lane urban arterial (includes widening overpass)	Partially Completed, modified and included herein as **MSN-1**
2	S. 19th Ave. – College St. to W. Main St.	Widen to a 5-lane urban arterial.	Not Completed, modified and included herein as **CMSN-1**
3	S. 19th Ave. – Kagy Blvd. to College St.	Widen to 5-lane urban arterial.	Not Completed, modified and included herein as **CMSN-1**
4	Kagy Blvd. – S. 19th Ave. to Willson Ave.	Widen to 3-lane urban arterial.	Not Completed, modified and included herein as **MSN-2**
5	S. 3rd Ave. – Graf to Kagy Blvd.	Widen to 3-lane urban arterial.	Not Completed, modified and included herein as **MSN-3**
6	Rouse Ave. – Main St. to Story Mill Rd.	Widen to 3-lane urban arterial	Not Completed, modified and included herein as **MSN-4**
7	College St. – Main St. to S. 19th Ave.	Widen to 5-lane urban arterial.	Not Completed, modified and included herein as **MSN-5**
8	College St. – S. 19th Ave. to S. 8th Ave.	Widen to 3-lane urban arterial.	Not Completed, modified and included herein as **CMSN-2**
9	Cottonwood Rd. – Stucky Rd. to Valley Center Rd.	Construct 3-lane urban arterial.	Not Completed, modified and included herein as **MSN-6**
10	Fowler/ Davis – Stucky Rd. to Valley Center Rd.	Construct 2-lane urban arterial.	Partially Completed, modified and included herein as **MSN-7**
11	Hulbert – Valley Center Rd. to Cottonwood Rd.	Construct 2-lane urban collector.	Not Completed, modified and included herein as **CMSN-3**
12	Deadman's Gulch / Cattail Street – N. 19th to Cottonwood Rd.	Construct 2-lane urban collector.	Not Completed, modified and included herein as **MSN-8**
13	Kagy/Stucky – S. 19th to Cottonwood Rd.	Construct 2-lane urban arterial.	Not Completed, modified and included herein as **MSN-9**
14	Durston Rd. – N. 19th Ave. to Cottonwood Rd.	Widen to 3-lane urban arterial.	Partially Completed, modified and included herein as **CMSN-4**
15	Oak St. – N. 19th Ave. to Cottonwood Rd.	Construct 3-lane urban arterial.	Partially Completed, modified and included herein as **MSN-10**

MSN Location No.	Location of Past MSN Project	Past Recommendation	Status for this Plan Update
16	Graf – S. 3rd Ave. to S. 19th Ave.	Connect with paved 2-lane urban collector.	Not Completed, modified and included herein as **MSN-11**
17	S. 11th Ave. – Kagy Blvd. to Graf	Connect with 2-lane urban collector.	Not Completed, modified and included herein as **MSN-12**
18	N. 11th Ave. – Durston Rd. to Baxter Lane	Connect with a 2-lane urban collector.	Not Completed, modified and included herein as **MSN-13**
19	N. 15th Ave. – Durston Rd. to Baxter Ln.	Connect with a 2-lane urban collector.	Partially Completed, will now only extend to Tschache Lane
20	N. 27th Ave. – Durston Rd. to Valley Center Rd.	Connect with 2-lane urban collector.	Partially Completed
21	Kagy/Bozeman Trail – Highland Blvd. to I-90	Upgrade to 2-lane rural arterial and realign.	Completed
22	W. Babcock St. – Main St. to Ferguson Rd.	Widen to 3-lane urban collector.	Completed
23	W. Babcock St. – 11th Ave. to 19th Ave.	Upgrade to 2-lane urban collector.	Not Completed, modified and included herein as **MSN-14**
24	Lincoln Rd. – S. 11th Ave. to S. 19th Ave.	Upgrade to 2-lane urban collector.	Completed
25	Sourdough Rd. – Kagy Blvd. to Goldstein Rd.	Upgrade to a 2-lane rural collector.	Completed
26	South Church	Upgrade to 2-lane urban collector.	Not Completed, modified and included herein as **MSN-15**
27	W. Main St. – 7th Ave. to 19th Ave.	Install raised median, landscape median where possible.	Not Completed, modified and included herein as **MSN-16**
28	Frontage Rd. – N. 7th Ave. to Belgrade.	Widen to 3-lane rural arterial, with right turn lanes at major intersections.	Not Completed, modified and included herein as **MSN-17**
29	Springhill Rd. – Frontage Rd. to Sypes Canyon Rd.	Widen to 3-lane rural arterial.	Not Completed, modified and included herein as **MSN-18**
30	Baxter Lane – N. 11th Ave. to 19th Ave.	Upgrade to 2-lane urban collector.	Not Completed, modified and included herein as **CMSN-5**
31	Baxter Lane – N. 19th Ave. to Cottonwood Rd.	Upgrade to 2-lane urban arterial.	Not Completed, modified and included herein as **CMSN-6**
32	Haggerty Ln. – Main St. to Kagy Blvd.	Upgrade to 2-lane urban collector.	Not Completed, modified and included herein as **MSN-19**
33	Airport Interchange	Create a new interstate interchange to serve the airport and connect the interchange to the Frontage Rd. with 2-lane rural arterial.	Not Completed, modified and included herein as **MSN-20**
34	Jackrabbit Ln. – Gallatin Gateway to Four Corners.	Widen to 3-lane rural arterial.	Not Completed, modified and included herein as **MSN-21**
35	Jackrabbit Ln. – Four Corners to I-90	Widen to 3-lane rural arterial with right turn lanes at the major intersections.	Not Completed, modified and included herein as **MSN-22**
36	I-90 Underpass – U.S. 10 to Valley Center Rd.	Upgrade underpass to rural collector standard.	Not Completed
37	Griffin Dr. Railroad Underpass	Construct a railroad underpass.	Not Completed, modified and included herein as **MSN-23**
38	Cedar St.	Upgrade Cedar St. to a 2-lane urban collector standard and connect to Rouse Ave.	Not Completed, modified and included herein as **MSN-24**
39	Ferguson Ave. – Main St. to Valley Center Rd.	Connect with a 2-lane urban collector.	Not Completed, modified and included herein as **MSN-25**
40	Highland Trail Improvements – S. Kagy Blvd.	Construct a trail from Kagy along the Highland Ridge and connects to Goldenstein Rd.	Not Completed

5.1.2 Committed Major Street Network (CMSN) Projects

Committed projects are only listed if the project will affect capacity and/or delay characteristics of a roadway facility and/or intersection. This distinction is necessary since some committed improvement projects, likely to occur within the next five years, are not listed here since they will not have an effect on the traffic model. Committed improvements listed are only considered if they are likely to be constructed within a five-year timeframe (i.e. year 2007 through the year 2012), and a funding source has been identified and is assigned to the specific project.

CMSN-1: **19th Avenue (Babcock Street to Kagy Boulevard):**
This project consists of reconstructing 19th Avenue from the intersection with Babcock Street south to the intersection with Kagy Boulevard to meet 5-lane principal arterial standards. This project comes from the high traffic volumes found on this roadway and the expected growth in the Bozeman area. This segment is approximately 1.25 miles long.

CMSN-2: **College Street (19th Avenue to 8th Avenue):**
This project consists of reconstructing College Street from the intersection with 19th Avenue east to the intersection with 8th Avenue to meet minor arterial standards. This section of West College has already exceeded the volume of traffic it was projected to carry in 2020. Planned improvements to South 19th Avenue and increased development in the South 19th Avenue corridor will only further increase traffic demand on this facility. This facility also lacks bicycle and pedestrian facilities, therefore, this project will improve not only safety and capacity for motorized vehicle but for bicycle and pedestrians as well.

CMSN-3: **Hulbert Road (Love Lane to Jackrabbit Lane):**
Hulbert Road will be paved from the intersection with Love Lane west to the intersection with Jackrabbit Lane. This segment is approximately 2 miles long and is classified as a collector roadway. This project also consists of paving Hulbert Road west from the intersection with Jackrabbit Lane to the Gallatin Heights Major property boundary. This segment is approximately 0.5 miles long and is a local roadway.

CMSN-4: **Durston Road (Fowler Road to Ferguson Road):**
This project consists of constructing a new roadway between Fowler Road and Ferguson Road. It is apparent from recent development activity that the areas served by this minor arterial roadway may cause the predicted volumes to be exceeded along this corridor. This project will improve the safety and capacity for motorized vehicles as well as bicycles and pedestrians.

CMSN-5: **Baxter Lane (7th Avenue to 19th Avenue):**
This project consists of reconstructing Baxter Lane from the intersection with 19th Avenue east to the intersection with 7th Avenue to meet minor arterial standards. Baxter Lane is positioned to become a major commercial route due

to zoning on the south side of the road from 19th Avenue to 7th Avenue. By 2020 it has been projected that this roadway will carry more than double the vehicles per day than what it currently carries. This project will improve the safety and capacity for motorized vehicles as well as bicycles and pedestrians.

CMSN-6: **Baxter Lane (19th Avenue to Harper Puckett Road):**
This project consists of reconstructing Baxter Lane from the intersection with Harper Puckett Road east to the intersection with 19th Avenue to meet minor arterial standards. Continued development in the northwest quadrant of the City insures that this improvement will be needed. This project will improve the capacity and safety of this corridor.

CMSN-7: **Baxter Lane (Harper Puckett Road to Jackrabbit Lane):**
Baxter Lane will be paved from the intersection with Harper Puckett Road west to the intersection with Jackrabbit Lane. This segment of Baxter lane is classified as a minor arterial roadway.

CMSN-8: **Harper Pucket Road:**
Harper Pucket Road will be paved from the intersection with Cameron Bridge Road south to the approximately 0.5 miles south of Valley Center Road. This segment is approximately 1.5 miles long and is classified as a minor arterial roadway.

CMSN-9: **Durston Road:**
Durston Road will be extended approximately one mile from the current western termination point through Black Bull Run Subdivision and Middle Creek Parklands Subdivision to intersect with Jackrabbit Lane. Durston Road will also be paved from the current western end of asphalt location at the Bozeman City limits to the end of its extension. This segment of Durston Road is classified as a minor arterial roadway.

CMSN-10: **Valley Center Road:**
This project consists of paving Valley Center Road from the intersection with Jackrabbit Lane west to the Gallatin Heights Major property boundary. This segment is approximately 0.5 miles long and is a local roadway.

CMSN-11: **Cameron Bridge Road:**
Cameron Bridge Road will be paved from the intersection with Jackrabbit Lane east to the intersection with Harper Puckett Road. This segment is approximately 3 miles long and is classified as a collector roadway.

CMSN-12: **Monforton School Road:**
Monforton School Road will be abandoned at the campus of Monforton School via a new cul-de-sac, and a new road will be re-routed to line up across from Cobb Hill Road at Huffine Lane. It is recommended herein that the relocated Monforton School Road be changed to a collector road functional classification (see **Figure 9-1**).

CMSN-13: **Spain Bridge Road:**
Spain Bridge Road will be paved from the intersection with Penwell Bridge Road south to the intersection with Airport Road. This segment is approximately 2 miles long and is classified as a minor arterial roadway.

CMSN-14: **Penwell Bridge Road:**
This project consists of paving a one mile stretch of Penwell Bridge Road east from the intersection with Dry Creek Road. Another stretch of Penwell Bridge Road will also be paved from the intersection with Spain Bridge Road to East Gallatin River. Penwell Bridge Road is a local roadway.

CMSN-15: **Tayabeshockup Road:**
Tayabeshockup Road will be paved south from the intersection with Bozeman Trail Road. This segment is approximately 2 miles long and is classified as a collector roadway.

CMSN-16: **Valley Center Drive:**
This project consists of upgrading Valley Center Drive from the intersection with Jackrabbit Lane to the intersection with Love Lane to a two-lane urban arterial standard. This section will consist of one travel lane in each direction, 6-foot shoulders on each side, curb and gutter, turn-lanes at major intersections, and sidewalks. This project is approximately 2 miles long.

5.1.3 Recommended Major Street Network (MSN) Projects

During the preparation of this Plan, a number of MSN projects were identified. Estimated project costs are included for each recommended project. These costs are "planning level" estimates and do not include possible right of way, utility, traffic management, or other heavily variable costs.

The following list of MSN projects are **not** in any particular order with respect to priority:

MSN-1: **N. 19th Avenue (Interstate 90 to Springhill Road)**
This project consists of widening N. 19th Avenue from Interstate 90 to the intersection with Springhill Road to a 5-lane urban arterial standard. This project includes widening the I-90 overpass along N. 19th Avenue. This roadway is currently a principal arterial roadway south of I-90 and a minor arterial roadway north of I-90. This project serves as a long-term need that will be necessary to accommodate future development patterns in the region and serve north-south traffic flow. It is expected that a minimum of two travel lanes in each direction, bike lanes on each side, curb and gutter, boulevard, sidewalk, and raised median will be required.
Estimated Cost: $9,500,000

MSN-2: **Kagy Boulevard (S. 19th Avenue to Willson Avenue)**
This project consists of widening Kagy Boulevard from the intersection with S. 19th Avenue to the intersection with Willson Avenue to a three-lane urban

arterial. This includes one travel lane in each direction, bike lanes on each side, curb and gutter, boulevard, sidewalks, and a raised median. This project serves as a long-term need that will be necessary to accommodate future development patterns in the region and serve east-west traffic flow around the southern portions of the city. Currently this section of Kagy Boulevard is a two-lane roadway with few left-turn bays.
Estimated Cost: $4,700,000

MSN-3: **S. 3rd Avenue (Graf Street to Kagy Boulevard)**
This project consists of widening S. 3rd Avenue from the intersection with Graf Street to the intersection with Kagy Boulevard to a three-lane urban arterial roadway. This includes one travel lane in each direction, bike lanes on each side, curb and gutter, sidewalks, and a raised median. This project serves to accommodate development in the region and serve north-south traffic flow around the southern portions of the city.
Estimated Cost: $3,300,000

MSN-4: **Rouse Avenue (Main Street to Story Mill Road)**
This project consists of widening Rouse Avenue from the intersection with Main Street to the intersection with Story Mill Road to a three-lane urban arterial. This includes one travel lane in each direction, bike lanes on each side, curb and gutter, boulevard, sidewalks, and a raised median. This project serves to accommodate increasing traffic volumes along Rouse Avenue and serve traffic flow around the northern portions of the city. Currently Rouse Avenue is a two-lane roadway with few left-turn bays. An Environmental Assessment (EA) has been prepared for this recommended project that identifies specific constraints and known design issues.
Estimated Cost: $10,000,000

MSN-5: **College Street (Main Street to 19th Avenue):**
This project consists of reconstructing College Street from the intersection with Main Street east to the intersection with 19th Avenue to a five-lane urban arterial roadway. It is expected that a minimum of two travel lanes in each direction, bike lanes on each side, curb and gutter, boulevard, sidewalk , and a raised median will be required. This section of West College has exceeded the volume of traffic it was projected to carry. During peak hours, traffic is backed up from 19th Avenue to Huffine Lane and beyond. This project will improve the safety and capacity for motorized vehicles as well as bicycles and pedestrians.
Estimated Cost: $3,300,000

MSN-6: **Cottonwood Road / Harper Puckett Road (Stucky Road to Valley Center)**
This project consists of widening Cottonwood Road from the intersection with Stucky Road north to its current termini and constructing an extension to Cottonwood Road from its current northern termini to Baxter Lane. It is also recommended that Harper Puckett Road be widened from the intersection with Baxter Lane north to the intersection with Hidden Valley Road and that

an extension be constructed north to intersect with Valley Center Road. This project should be constructed to a five-lane urban arterial standard. This includes two travel lanes in each direction, bike lanes on each side, curb and gutter, boulevard, sidewalks, and a raised median. This project is necessitated by the future development patterns in the region and will serve north-south traffic flow around the western edge of the city.
Estimated Cost: $24,300,000

MSN-7: **<u>Fowler/Davis Road (Stucky Road to Valley Center Road)</u>**
This project consists of upgrading Fowler Road and Davis Road from the intersection with Stucky Road to the intersection with Valley Center Road to a three-lane urban arterial standard. This includes one travel lane in each direction, bike lanes on each side, curb and gutter, boulevard, sidewalks, and a raised median. New links will have to be constructed along this corridor between Oak Street and Babcock Street and between Garfield Street and Stucky Road. This project is necessitated by the future development patterns in the region and will serve north-south traffic flow around the western portion of the city.
Estimated Cost: $21,100,000

MSN-8: **<u>Deadman's Gulch / Cattail Street (27th Avenue to Cottonwood Road)</u>**
This project consists of upgrading Cattail Street from the intersection with 27th Avenue west to its current termini point to a two-lane urban collector roadway. A new link between the current western termini point of Cattail Street and Cottonwood Road should be created to two-lane collector standards complete with one travel lane in each direction, bike lanes on each side, curb and gutter, boulevard, parking, and sidewalks. This project is necessitated by the future development patterns in the region and will serve east-west traffic flow around the northern portion of the city.
Estimated Cost: $4,100,000

MSN-9: **<u>Stucky Road (S. 19th Avenue to Gooch Hill Road)</u>**
This project consists of upgrading Stucky road from the intersection with S. 19th Avenue west to the intersection with Gooch Hill Road to a two-lane urban collector roadway. This includes one travel lane in each direction, bike lanes on each side, curb and gutter, boulevard, parking, and sidewalks. This project is necessitated by the future development patterns in the region and will serve east-west traffic flow around the southern edge of the city.
Estimated Cost: $8,400,000

MSN-10: **<u>Oak Street (Fowler Lane to Cottonwood Road)</u>**
This project consists of constructing a new link along Oak Street from the intersection with Fowler Lane west to Cottonwood Road. This section should be built to a five-lane urban arterial standard and should include two travel lanes in each direction, bike lanes on each side, curb and gutter, boulevard, sidewalks, and a raised median. This project is necessitated by the future

development patterns in the region and will serve east-west traffic flow around the northwestern portion of the city.
Estimated Cost: $4,900,000

MSN-11: **Graf Street:**
Graf Street is to be extended from its current western termini to connect to 19th Avenue. This extension would be approximately 0.6 miles long and should be built to meet two-lane collector standards. This extension is an important connection for public safety purposes, allowing fire service to meet their response time requirements in areas where they currently cannot.
Estimated Cost: $1,800,000

MSN-12: **S. 11th Avenue (Kagy Boulevard to Graf Street extension)**
This project would connect S. 11th Avenue between Kagy Boulevard and the future extension of Graf Street as described in **MSN-11**. This roadway should be built to a two-lane urban collector standard which should include one travel lane in each direction, bike lanes on each side, curb and gutter, boulevard, parking, and sidewalks. A new link between Opportunity Way and the Graf Street extension would need to be constructed under this project. This project will serve to create a north-south link for the southern portion of the city.
Estimated Cost: $2,000,000

MSN-13: **N. 11th Avenue (Durston Road to Baxter Lane)**
This project consists of upgrading N. 11th Avenue from the intersection with Durston Road to the intersection with Baxter Lane. A new link between Durston Road and Oak Street would need to be constructed under this project. This roadway should be built to a two-lane urban collector standard which should include one travel lane in each direction, bike lanes on each side, curb and gutter, boulevard, parking, and sidewalks. This project will serve to create an additional north-south link along the north-central part of the city.
Estimated Cost: $2,300,000

MSN-14: **W. Babcock Street (11th Avenue to 19th Avenue)**
W. Babcock Street should be upgraded to a two-lane urban collector standard between the intersection with 11th Avenue and the intersection with 19th Avenue. This would include one travel lane in each direction, bike lanes on each side, curb and gutter, boulevards, parking, and sidewalks.
Estimated Cost: $1,400,000

MSN-15: **Church Street (Main Street to Kagy Boulevard):**
This project consists of reconstructing Church Street from the intersection with Main Street south to the intersection with Kagy Boulevard to a two-lane urban collector standard. This would include one travel lane in each direction, bike lanes on each side, curb and gutter, boulevards, parking, and sidewalks. The need for this project comes from increased traffic due to

growth in the South Bozeman area as well as the county area south of Bozeman. This project will improve the safety and capacity for motorized vehicles as well as bicycles and pedestrians.
Estimated Cost: $4,300,000

MSN-16: **<u>W. Main Street (7th Avenue to 19th Avenue)</u>**
This project consists of installing a raised or landscaped median at appropriate locations along W. Main Street between the intersection with 7th Avenue and the intersection with 19th Avenue. This project will help to increase traffic flow via access control and improve safety along this corridor.
Estimated Cost: $600,000

MSN-17: **<u>Frontage Road (N. 7th Avenue to Belgrade)</u>**
The Frontage Road between N. 7th Avenue to Belgrade should be upgraded to a three-lane rural arterial roadway. This includes one travel lane in each direction and a two-way center turn lane. This project is necessitated by the future development patterns in the region and will serve as a link between the Belgrade and Bozeman areas. Roadway shoulders should be included to facilitate bicycle travel.
Estimated Cost: $21,100,000

MSN-18: **<u>Springhill Road (Frontage Road to Sypes Canyon Road)</u>**
Springhill Road from the intersection with the Frontage Road to the intersection with Sypes Canyon Road should be widened to a three-lane rural arterial roadway. This includes one travel lane in each direction and a two-way center turn lane. This project is necessitated by the development on the western side of the city and north of the interstate. This project will serve to provide a north-south connection along the northwest side of the city.
Estimated Cost: $4,400,000

MSN-19: **<u>Bozeman Trail/Haggerty Lane (Main Street to Kagy Boulevard)</u>**
Bozeman Trail should be upgraded to a two-lane urban collector roadway from the intersection with Kagy Boulevard north to the intersection with Haggerty Lane. Haggerty Lane should also be upgraded to a two-lane urban collector roadway from the intersection with Bozeman Trail northwest to the intersection with Main Street. A two-lane urban collector roadway includes one travel lane in each direction, bike lanes on each side, curb and gutter, boulevard, parking, and sidewalks. This project is necessitated by the future development in the region and will serve as a north-south link along the southeastern portion of the city.
Estimated Cost: $5,000,000

MSN-20: **<u>East Belgrade Interchange</u>**
This project consists of constructing a new I-90 interchange to serve the airport and Belgrade areas. A northern interchange connection is to be made to connect with the Frontage Road. A southern connection to the interchange should be made to connect to Alaska Road. The interchange connections

should be constructed to two-lane rural arterial standards complete with one travel lane in each direction. This project is necessitated by the future development in the region and the need for more adequate connection to the airport. Non-motorized facilities should be developed in association with this project as this interchange will serve important cross connectivity north and south of Interstate 90.
Estimated Cost: $34,400,000

MSN-21: **<u>Gallatin Road (Gallatin Gateway to Four Corners)</u>**
It is recommended that Gallatin Road be widened to a three-lane rural arterial between Gallatin Gateway and Four Corners complete with one travel lane in each direction and a two-way center turn lane. This project is necessitated by the development in the region and the increasing traffic volumes along this corridor. This project will serve as a vital north-south link for the area and will increase the overall safety of the roadway.
Estimated Cost: $12,300,000

MSN-22: **<u>Jackrabbit Lane (Four Corners to Frank Road)</u>**
It is recommended that Jackrabbit Lane be widened to a five-lane arterial between Four Corners and Frank Road, complete with two travel lanes in each direction and a two-way center turn lane or raised median. This project is necessitated by the development in the region and the increasing traffic volumes along this corridor. This project will serve as a vital north-south link for the area and will increase the overall safety of the roadway.
Estimated Cost: $29,200,000

MSN-23: **<u>Griffin Drive Railroad Underpass</u>**
This project consists of constructing a railroad underpass along Griffin Drive. The railroad crossing separates the northeastern portion of the city and creates a problem for emergency vehicle access and traffic congestion when the train blocks the current at-grade crossings.
Estimated Cost: $7,800,000

MSN-24: **<u>Cedar Street / Oak Street</u>**
This project consists of upgrading Cedar Street to a three-lane urban arterial. An eastern extension of Oak Street from its intersection with Rouse Avenue to connect to Cedar Street and a southern extension of Cedar Street connecting to Main Street at the intersection with Highland Boulevard should also be constructed under this project. This project would also require two grade separated railroad crossings. A three-lane urban arterial includes one travel lane in each direction, bike lanes on each side, curb and gutter, boulevard, sidewalks, and a raised median. This project in necessitated by the future development patterns in the region and will serve to access development area on the eastern side of the city and relieve neighborhood "cut-thru" traffic issues in the northeast neighborhood area.
Estimated Cost: $13,700,000

MSN-25: **Ferguson Avenue (Durston Road to Valley Center Road)**

This project consists of extending Ferguson Avenue from its current northern termini point north to intersect with Valley Center Road. This roadway should be constructed to a two-lane urban collector standard which includes one travel lane in each direction, bike lanes on each side, curb and gutter, boulevard, parking, and sidewalks. This project is necessitated by the future development patterns in the region and will serve north-west traffic flow around the western portion of the city.

Estimated Cost: $7,800,000

MSN-26: **Highland Boulevard (Main Street to Kagy Boulevard)**

This project consists of widening Highland Boulevard from the intersection with Main Street to the intersection with Ellis Street to a five-lane urban arterial standard, and from the intersection with Ellis Street south to the intersection with Kagy Boulevard to a three-lane urban arterial standard. This roadway is currently a minor arterial roadway with one travel lane in each direction. This project serves as a long-term need that will be necessary to accommodate future development patterns in the region and serve north-south traffic flow. It is expected that a minimum of two travel lanes in each direction from Main Street to Ellis Street, one travel lane in each direction from Ellis Street to Kagy Boulevard, bike lanes on each side, curb and gutter, boulevard, sidewalk, and a raised median will be required.

Estimated Cost: $7,600,000

MSN-27: **Kagy Boulevard (Highland Avenue to Bozeman Trail)**

This project consists of widening Kagy Boulevard from the intersection with Highland Avenue to the intersection with Bozeman Trail to a three-lane urban arterial standard complete with one travel lane in each direction, bike lanes on each side, curb and gutter, boulevard, sidewalk, and a raised median. This roadway is a two-lane roadway and is classified as a principal arterial. This project serves as a long-term need that will be necessary to accommodate future development patterns in the region and serve east-west traffic flow.

Estimated Cost: $4,600,000

MSN-28: **Stucky Road / Elk Lane Extension**

This project consists of constructing an extension of Stucky Road west from the intersection with Gooch Hill Road to the future intersection of Elk Lane and Love Lane. This segment should be constructed to a two-lane collector standard complete with one travel lane in each direction, bike lanes on each side, curb and gutter, boulevard, parking, and sidewalks. This project is necessitated by the future development patterns in the region and will serve east-west traffic flow around the southwestern edge of the city.

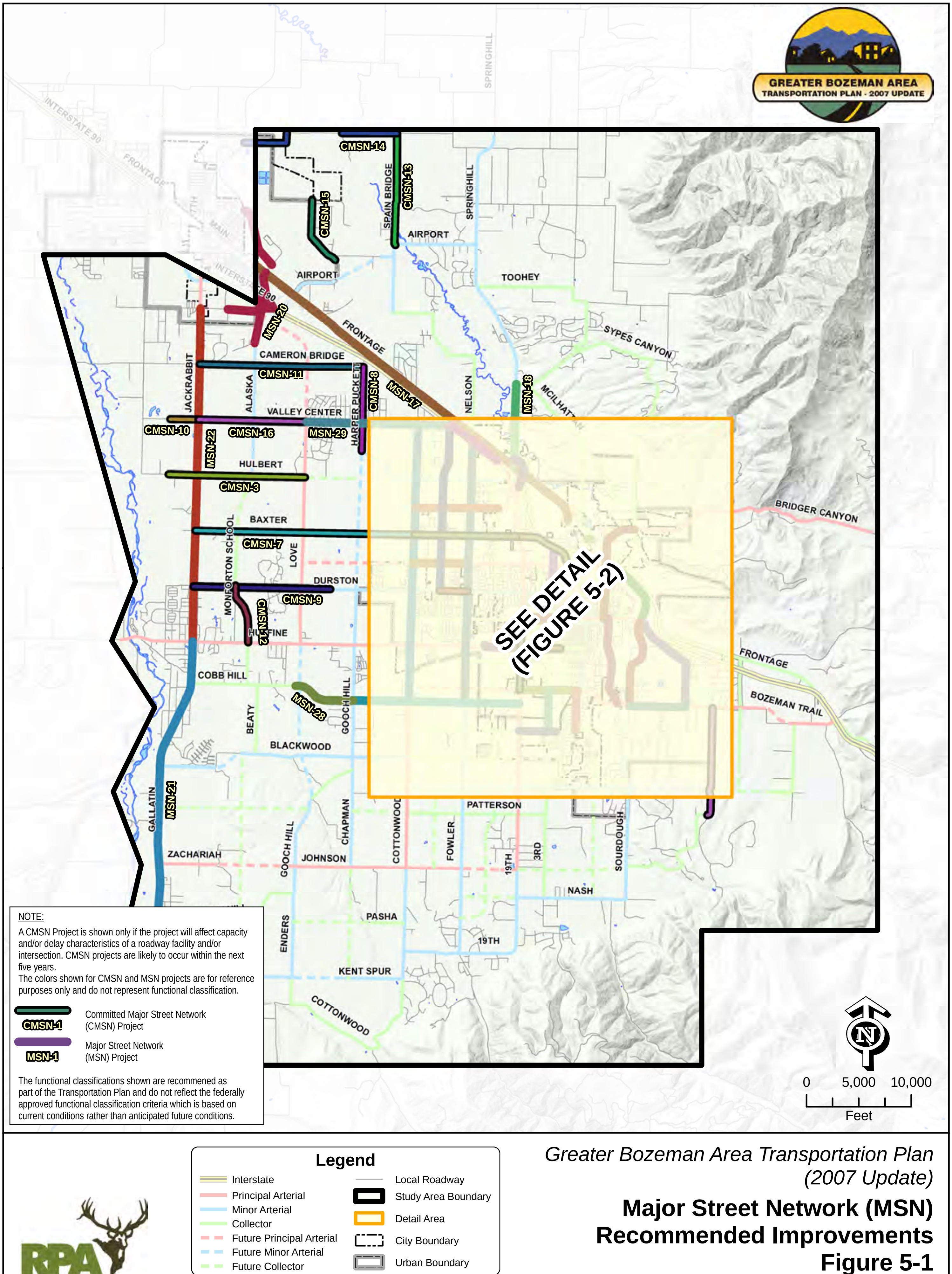
Estimated Cost: $2,900,000

MSN-29: **Valley Center Drive (Love Lane to Valley Center Underpass)**

This project consists of upgrading Valley Center Drive from the intersection with Love Lane to the intersection with the Valley Center Underpass to a two-

lane urban arterial standard. This section will consist of one travel lane in each direction, 6-foot shoulders on each side, curb and gutter, turn-lanes at major intersections, and sidewalks. This project in necessitated by the future development patterns in the region and will serve to access development area on the northwestern side of the city.
Estimated Cost: $7,300,000

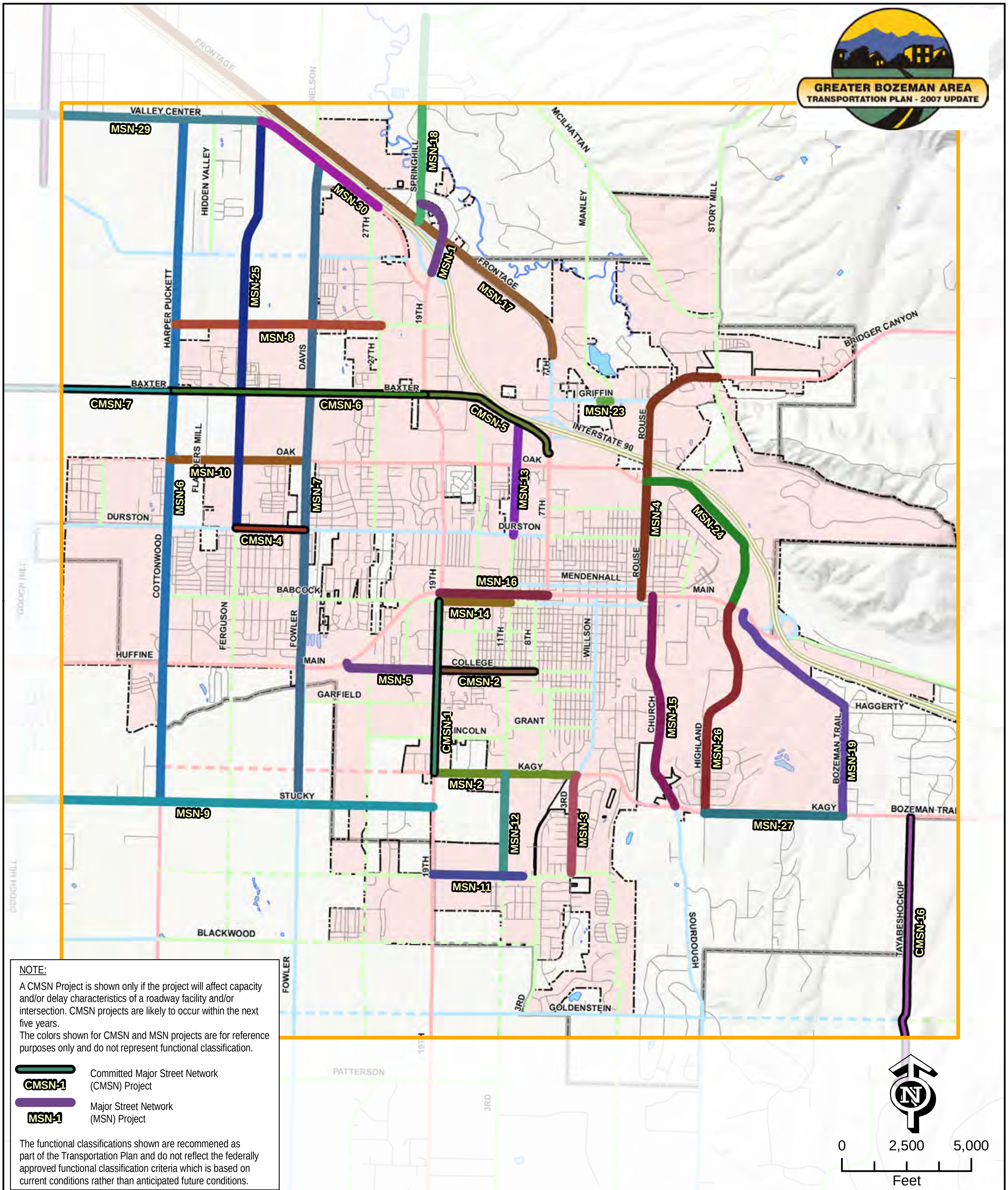
MSN-30: **<u>Valley Center Drive (Valley Center Underpass to N. 27th Ave)</u>**
This project consists of upgrading Valley Center Drive from the intersection with the Valley Center Underpass to the intersection with N. 27th Avenue to a three-lane urban arterial standard complete with one travel lane in each direction, bike lanes on each side, curb and gutter, boulevard, sidewalk, and a raised median. This roadway is a two-lane roadway and is classified as a principal arterial. This project in necessitated by the future development patterns in the region and will serve to access development area on the northwestern side of the city.
Estimated Cost: $3,900,000



Greater Bozeman Area Transportation Plan (2007 Update)

Major Street Network (MSN) Recommended Improvements

Figure 5-1



NOTE:

A CMSN Project is shown only if the project will affect capacity and/or delay characteristics of a roadway facility and/or intersection. CMSN projects are likely to occur within the next five years.

The colors shown for CMSN and MSN projects are for reference purposes only and do not represent functional classification.

CMSN-1 — Committed Major Street Network (CMSN) Project

MSN-1 — Major Street Network (MSN) Project

The functional classifications shown are recommened as part of the Transportation Plan and do not reflect the federally approved functional classification criteria which is based on current conditions rather than anticipated future conditions.

Legend

- Interstate
- Principal Arterial
- Minor Arterial
- Collector
- Future Principal Arterial
- Future Minor Arterial
- Future Collector
- Detail Area
- City Boundary
- Urban Boundary
- Local Roadway

Greater Bozeman Area Transportation Plan (2007 Update)

Major Street Network (MSN) Recommended Improvements

Figure 5-2

5.2 Recommended Transportation System Management (TSM) Improvements

In addition to MSN project recommendations this plan includes a variety of smaller transportation system management (TSM) projects. For the purposes of this Plan, an improvement project was classified as a TSM project if the estimated cost of the project was less than $500,000. This section summarizes these projects.

It should be noted that the Montana Department of Transportation are currently reconfiguring the signal timings for all traffic signals within the City of Bozeman. This effort will improve the level of service for several intersections that are currently operating at an unacceptable level.

5.2.1 TSM Projects from the 2001 Transportation Plan

A total of 49 TSM projects were recommended in the 2001 update of the Transportation Plan. The status of these projects were reviewed to determine which have been completed, which are no longer valid, and which projects should be included as part of this plan update. Of the 49 projects, 24 were completed, 7 are partially completed, and 18 were not completed. The complete listing of the 49 projects, and their subsequent status for this 2007 Update to the Transportation Plan, are listed in **Table 5-2**.

Table 5-2
TSM Projects from 2001 Transportation Plan & Status for 2007 Plan

TSM Location No.	Location of Past TSM Project	Past Recommendation	Status for this Plan Update
1	North 7th Ave. & Oak St.	Modify the traffic signal to include protected left turns for the north and south approaches.	Completed
2	3rd Ave. & Villard St.	Install stop signs on the north and south approaches to the intersection and trim limbs to improve the sight distance.	Completed
3	7th Ave. & Mendenhall St.	Restripe the east approach to include a designated right-turn lane.	Not Completed, modified and included herein as **TSM-1**
4	Wilson Ave., Olive St. to Main St.	Remove parking from the east side of the street and stripe two northbound lanes.	Not Completed, modified and included herein as **TSM-2**
5	Main St. & Rouse Ave.	Add a designated right-turn lane on the south approach by restricting parking along the east side of Rouse within a half block of the intersection.	Completed
6	Rouse Ave. & Babcock Street	Install an 8-inch wide solid white line between two travel lanes or install a raised channelization between the two travel lanes. Bulb-out the curb on the northeast corner to create a single eastbound traffic lane.	Completed
7	Grand Ave. & Koch St.	Install stop signs on the north and south approaches.	Completed
8	Kagy Blvd. & Fairway	Remove vegetation on the northeast and southwest corners.	Completed
9	Kagy Blvd. & Sourdough Rd.	Remove the vegetation along Kagy.	Completed
10	Kagy Blvd. & Highland Blvd.	Remove vegetation on the south side of Kagy.	Completed

TSM Location No.	Location of Past TSM Project	Past Recommendation	Status for this Plan Update
11	Frontage Rd., Bozeman to Belgrade	Conduct a speed limit study and modify the speed limit accordingly.	Not Completed
12	Frontage Rd., Bozeman to Belgrade	Eliminate the passing zones on the Frontage Rd. that are in the vicinity of driveways and all intersections.	Partially Completed
13	Jackrabbit Lane	Conduct a speed study and modify the speed limit accordingly.	Not Completed
14	S. 3rd Ave. & Goldenstein Rd.	Install a right turn lane or ramp on south approach.	Completed
15	Main St. & 11th Ave.	Increase the radius on the southwest corner to improve intersection geometrics.	Not Completed, modified and included herein as **TSM-3**
16	Galligator Corridor.	Acquire this old railroad bed on the southeast side of town for use as a portion of the ped/bike trail system.	Completed
17	N. 19th Ave. & Springhill Rd.	Add left turn lanes to the intersection as necessitated by the growing traffic demand. Install traffic signal, roundabout, or other adequate traffic control when warrants are met.	Completed
18	N. 19th Ave. & Deadman's Gulch Ct.	Add left turn lanes to the intersection as necessitated by the growing traffic demand. Install traffic signal, roundabout, or other adequate traffic control when warrants are met.	Completed
19	N. 19th Ave. & Tschache Ln.	Add left turn lanes to the intersection as necessitated by the growing traffic demand. Install traffic signal, roundabout, or other adequate traffic control when warrants are met.	Completed
20	N. 19th Ave. & Beall St.	Add left turn lanes to the intersection as necessitated by the growing traffic demand. Install traffic signal, roundabout, or other adequate traffic control when warrants are met.	Completed
21	S. 19th Ave. & Koch St.	Add left turn lanes to the intersection as necessitated by the growing traffic demand. Install traffic signal, roundabout, or other adequate traffic control when warrants are met.	Not Completed, modified and included herein as **CTSM-1**
22	S. 19th Ave. & Kagy Blvd.	Add left turn lanes to the intersection as necessitated by the growing traffic demand. Install traffic signal, roundabout, or other adequate traffic control when warrants are met.	Completed
23	S. 19th Ave. & Stucky Rd.	Add left turn lanes to the intersection as necessitated by the growing traffic demand. Install traffic signal, roundabout, or other adequate traffic control when warrants are met.	Completed
24	Highway 191 & Cottonwood Road	Add left turn lanes to the intersection as necessitated by the growing traffic demand. Install traffic signal, roundabout, or other adequate traffic control when warrants are met.	Completed
25	Highway 191 & Fowler Lane	Add left turn lanes to the intersection as necessitated by the growing traffic demand. Install traffic signal, roundabout, or other adequate traffic control when warrants are met.	Completed
26	Rouse Ave. & Griffin Dr.	Add left turn lanes to the intersection as necessitated by the growing traffic demand. Install traffic signal, roundabout, or other adequate traffic control when warrants are met.	Completed
27	Rouse Ave. & Oak St.	Add left turn lanes to the intersection as necessitated by the growing traffic demand. Install traffic signal, roundabout, or other adequate traffic control when warrants are met.	Completed
28	Rouse Ave. & Peach St.	Add left turn lanes to the intersection as necessitated by the growing traffic demand. Install traffic signal, roundabout, or other adequate traffic control when warrants are met.	Not Completed, modified and included herein as **TSM-4**
29	Main St. & Wallace Ave.	Add left turn lanes to the intersection as necessitated by the growing traffic demand. Install traffic signal, roundabout, or other adequate traffic control when warrants are met.	Completed
30	Main St. & Haggerty Ln.	Add left turn lanes to the intersection as necessitated by the growing traffic demand. Install traffic signal, roundabout, or other adequate traffic control when warrants are met.	Partially Completed, modified and included herein as **TSM-5**

TSM Location No.	Location of Past TSM Project	Past Recommendation	Status for this Plan Update
31	College St. & 23rd Ave.	Add left turn lanes to the intersection as necessitated by the growing traffic demand. Install traffic signal, roundabout, or other adequate traffic control when warrants are met.	Not Completed, modified and included herein as **TSM-6**
32	College St. & S. 11th Ave.	Add left turn lanes to the intersection as necessitated by the growing traffic demand. Install traffic signal, roundabout, or other adequate traffic control when warrants are met.	Not Completed, modified and included herein as **CTSM-2**
33	College St. & Willson Ave.	Add left turn lanes to the intersection as necessitated by the growing traffic demand. Install traffic signal, roundabout, or other adequate traffic control when warrants are met.	Not Completed, modified and included herein as **CTSM-3**
34	Willson Ave. & Garfield St.	Add left turn lanes to the intersection as necessitated by the growing traffic demand. Install traffic signal, roundabout, or other adequate traffic control when warrants are met.	Not Completed, modified and included herein as **TSM-7**
35	Kagy Blvd. & S. 11th Ave.	Add left turn lanes to the intersection as necessitated by the growing traffic demand. Install traffic signal, roundabout, or other adequate traffic control when warrants are met.	Not Completed, modified and included herein as **CTSM-4**
36	Kagy Blvd. & Sourdough Rd.	Add left turn lanes to the intersection as necessitated by the growing traffic demand. Install traffic signal, roundabout, or other adequate traffic control when warrants are met.	Partially Completed, modified and included herein as **TSM-8**
37	Kagy Blvd. & Highland Blvd.	Add left turn lanes to the intersection as necessitated by the growing traffic demand. Install traffic signal, roundabout, or other adequate traffic control when warrants are met.	Partially Completed, modified and included herein as **TSM-9**
38	Oak St. & Ferguson Rd.	Add left turn lanes to the intersection as necessitated by the growing traffic demand. Install traffic signal, roundabout, or other adequate traffic control when warrants are met.	Not Completed, modified and included herein as **TSM-10**
39	Oak St. & Cottonwood Rd.	Add left turn lanes to the intersection as necessitated by the growing traffic demand. Install traffic signal, roundabout, or other adequate traffic control when warrants are met.	Not Completed, modified and included herein as **TSM-11**
40	Baxter Ln. & Ferguson Rd.	Add left turn lanes to the intersection as necessitated by the growing traffic demand. Install traffic signal, roundabout, or other adequate traffic control when warrants are met.	Completed
41	Baxter Ln. & Cottonwood Rd.	Add left turn lanes to the intersection as necessitated by the growing traffic demand. Install traffic signal, roundabout, or other adequate traffic control when warrants are met.	Not Completed, modified and included herein as **TSM-12**
42	27th Ave. & Valley Center Rd.	Add left turn lanes to the intersection as necessitated by the growing traffic demand. Install traffic signal, roundabout, or other adequate traffic control when warrants are met.	Partially Completed
43	Durston Rd. & 27th Ave.	Add left turn lanes to the intersection as necessitated by the growing traffic demand. Install traffic signal, roundabout, or other adequate traffic control when warrants are met.	Partially Completed, modified and included herein as **TSM-13**
44	Hulbert & Valley Center Rd.	Add left turn lanes to the intersection as necessitated by the growing traffic demand. Install traffic signal, roundabout, or other adequate traffic control when warrants are met.	Not Completed, not carried forward in Plan update
45	N. 19th Ave. & I-90 South Ramps	Add left turn lanes to the intersection as necessitated by the growing traffic demand. Install traffic signal, roundabout, or other adequate traffic control when warrants are met.	Completed
46	N. 19th Ave. & I-90 North Ramps	Add left turn lanes to the intersection as necessitated by the growing traffic demand. Install traffic signal, roundabout, or other adequate traffic control when warrants are met.	Completed
47	Nelson Road & Frontage Rd.	Add left turn lanes to the intersection as necessitated by the growing traffic demand. Install traffic signal, roundabout, or other adequate traffic control when warrants are met.	Not Completed, modified and included herein as **TSM-15**
48	Sacajawea Peak & Frontage Rd.	Add left turn lanes to the intersection as necessitated by the growing traffic demand. Install traffic signal, roundabout, or other adequate traffic control when warrants are met.	Not Completed, modified and included herein as **TSM-16**
49	Gallatin Field & Frontage Rd.	Add left turn lanes to the intersection as necessitated by the growing traffic demand. Install traffic signal, roundabout, or other adequate traffic control when warrants are met.	Partially Completed, modified and included herein as **TSM-17**

5.2.2 Committed Transportation System Management (CTSM) Improvements

Committed projects are typically only listed if the project will affect capacity and/or delay characteristics of a roadway facility and/or intersection. This distinction is necessary since some committed improvement projects, likely to occur within the next five years, are not necessarily listed here since they will not have an effect on the traffic model. Those committed improvement projects not included in the traffic model, as well as those extending out beyond the five-year timeframe, are listed elsewhere in this *Transportation Plan*.

CTSM-1: **S. 19th Avenue / Koch Street**

This project includes the installation of a traffic signal, roundabout, or other adequate traffic control device to the intersection of S. 19th Avenue and Koch Street. S. 19th Avenue is currently a 3-lane principal arterial roadway at this location. Koch Street is a two-lane collector roadway east of the intersection and a two-lane local roadway west of the roadway. This intersection currently has stop control along Koch Street. This project will improve traffic flow and safety at this intersection.

CTSM-2: **College Street / 11th Avenue**

This project includes the installation of a traffic signal, roundabout, or other adequate traffic control device to the intersection of 11th Avenue and College Street. Both College Street and 11th Avenue are two-lane collector roadways at this location. This intersection is currently a 4-way stop control and backs up at peak hours significantly. Volumes for this intersection area approaching those predicted for 2020, and with increasing development to the immediate west and south of the City, warrants will likely be met in the very near future. This project would improve the traffic flow and safety at this intersection.

CTSM-3: **College Street / Willson Avenue**

This project includes the installation of a traffic signal, roundabout, or other adequate traffic control device to the intersection of College Street and Willson Avenue. College Street is a two-lane collector roadway west of the intersection and a two-lane local roadway east of the roadway. Willson Avenue is a two-lane minor arterial roadway at this location. This intersection currently has stop control along College Street. This project will improve traffic flow and safety at this intersection.

CTSM-4: **11th Avenue / Kagy Boulevard**

This project includes the installation of a traffic signal, roundabout, or other adequate traffic control device to the intersection of 11th Avenue and Kagy Boulevard. Kagy Boulevard is a three-lane roadway west of 11th Avenue and a 2-lane roadway east of 11th Avenue and is classified as a principal arterial. 11th Avenue is a 2-lane roadway classified as a collector. This intersection currently has stop control along 11th Avenue. Recent development proposals (primarily south of Kagy Boulevard as well as the hospital) and increasing traffic volumes indicate that the need for this signal improvement will soon be warranted. This intersection is a major access point for the MSU campus. This project will improve traffic flow and safety at this intersection.

CTSM-5: **27th Avenue / Oak Street**
This project includes the installation of a traffic signal, roundabout, or other adequate traffic control device to the intersection of 27th Avenue and Oak Street. Oak Street is a three-lane principal arterial at this location; 27th Avenue is a two-lane collector roadway. This intersection currently has stop control along 27th Avenue. Recent development proposals and increasing traffic volumes indicate that the need for this signal improvement will soon be warranted. This project will improve traffic flow and safety at this intersection.

CTSM-6: **College Street / 19th Avenue**
This project is consists of constructing additional northbound and southbound thru lanes. It is expected that this project will be completed in conjunction with **CMSN-1** which calls for 19th Avenue to be upgraded to a five-lane corridor at this location. This intersection is a signalized intersection and has a LOS failure during both AM and PM peak hours. The poor performance of this intersection is a result of the intersection and 19th Avenue corridor being undersized to adequately handle the large amounts of traffic that pass through.
Estimated Cost: $350,000

5.2.3 Recommended Transportation System Management (TSM) Improvements

During the preparation of this Plan, a number of TSM projects were identified. Estimated project costs are included for each recommended project. These costs are "planning level" estimates and do not include possible right of way, utility, traffic management, or other heavily variable costs.

The following list of TSM projects are **not** in any particular order with respect to priority:

TSM-1: **7th Avenue / Mendenhall Street**
It is recommended that the intersection of 7th Avenue and Mendenhall Street be re-striped to include a designated westbound right-turn lane. This is a signalized three-legged signalized intersection that current analysis shows has a poor LOS along the east approach. A designated right-turn lane on this approach will help improve the traffic flow characteristics of this intersection.
Estimated Cost: $15,000

TSM-2: **Willson Avenue (Olive Street to Main Street)**
It is recommended that parking be removed from the east side of Willson Avenue at the intersection with Olive Street. It is also recommended that two northbound lanes be striped from this intersection to the intersection with

Main Street. This intersection experiences stacking problems that cause increased delay and poor LOS.
Estimated Cost: $30,000

TSM-3: **<u>Main Street / 11th Avenue</u>**
It is recommended that the radius on the southwest corner be increased to improve the intersection geometrics. This corner causes maneuvering difficulties for larger vehicles turning right off of Main Street to travel south on 11th Avenue.
Estimated Cost: $50,000

TSM-4: **<u>Rouse Avenue / Peach Street</u>**
This project includes the installation of a traffic signal, roundabout, or other adequate traffic control device when warrants are met to the intersection of Rouse Avenue and Peach Street. The intersection is a skewed four-legged intersection with stop control on Peach Street. This intersection currently has a failing LOS on the eastbound leg during the PM peak hour. It should be noted that the Rouse Avenue Environmental Assessment recommends that a traffic signal be installed at this location.
Estimated Cost: $330,000

TSM-5: **<u>Main Street / Haggerty Lane</u>**
It is recommended that the intersection of Main Street and Haggerty Lane be modified to include a designated northbound right-turn lane, a northbound left-turn lane, and an eastbound right-turn lane. This intersection currently has stop control on Haggerty Lane. A designated westbound left-turn lane exists at this intersection. Current analysis of this intersection shows a LOS failure due to the northbound movement.
Estimated Cost: $475,000

TSM-6: **<u>College Street / 23rd Avenue / Technology Boulevard</u>**
It is recommended that left-turn lanes be added to the intersection of College Street and 23rd Avenue / Technology Boulevard as necessitated by the growing traffic demand. The intersection is a four-legged intersection with stop control on 23rd Avenue / Technology Boulevard. This intersection frequently has delay problems during peak traffic periods due to the inability of vehicles to make left-hand turns, particularly southbound left-turns. A traffic signal, roundabout, or other traffic control device should be added to this intersection when warrants are met.
Estimated Cost: $350,000

TSM-7: **<u>Willson Avenue / Garfield Street</u>**
It is recommended that left-turn lanes be added to the intersection of Wilson Avenue and Garfield Street as necessitated by the growing traffic demand. The intersection is a four-legged intersection with stop control on Garfield Street. This intersection frequently has delay problems during peak traffic periods due to the inability of vehicles to make left-hand turns. A traffic

signal, roundabout, or other traffic control device should be added to this intersection when warrants are met.
Estimated Cost: $350,000

TSM-8: **Kagy Boulevard / Sourdough Road / Church Street**
This project includes the installation of a traffic signal, roundabout, or other adequate traffic control device when warrants are met to the intersection of Kagy Boulevard and Sourdough Road / Church Street. This intersection currently has stop control on Sourdough Road and Church Street. Current LOS analysis shows that this intersection fails during AM and PM peak hours due to excessive delay along the northbound and southbound approaches.
Estimated Cost: $330,000

TSM-9: **Highland Boulevard / Kagy Boulevard**
This project includes the installation of a traffic signal, roundabout, or other adequate traffic control device when warrants are met to the intersection of Highland Boulevard and Kagy Boulevard. Highland Boulevard is currently a two-lane minor arterial roadway and Kagy Boulevard is a two-lane principal arterial. This intersection currently has stop control along Highland Boulevard. A modern roundabout will help to improve traffic flow and safety at this intersection.
Estimated Cost: $330,000

TSM-10: **Oak Street / Ferguson Road**
It is recommended that left-turn lanes be added to the intersection of Oak Street and Ferguson Road as necessitated by the growing traffic demand. The intersection will become a four-legged intersection with stop control on Ferguson Road. A traffic signal, roundabout, or other traffic control device should be added to this intersection when warrants are met. This project is expected to serve future need in the area and should be completed in conjunction with **MSN-10** and **MSN-25**.
Estimated Cost: $350,000

TSM-11: **Oak Street / Cottonwood Road**
It is recommended that left-turn lanes be added to the intersection of Oak Street and Cottonwood Road as necessitated by the growing traffic demand. The intersection will become a four-legged intersection with stop control on Cottonwood Road. A traffic signal, roundabout, or other traffic control device should be added to this intersection when warrants are met. This project is expected to serve future need in the area and should be completed in conjunction with **MSN-6** and **MSN-10**.
Estimated Cost: $350,000

TSM-12: **Baxter Lane / Cottonwood Road / Harper Puckett Road**
It is recommended that left-turn lanes be added to the intersection of Baxter Lane and Cottonwood Road / Harper Puckett Road as necessitated by the growing traffic demand. The intersection will become a four-legged

intersection with stop control on Cottonwood Road / Harper Puckett Road. A traffic signal, roundabout, or other traffic control device should be added to this intersection when warrants are met. This project is expected to serve future need in the area and should be completed in conjunction with **MSN-6** and **MSN-10**.
Estimated Cost: $350,000

TSM-13: **Durston Road / 27th Avenue**
It is recommended that left-turn lanes be added to the intersection of Durston Road and 27th Avenue as necessitated by the growing traffic demand. The intersection is a three-legged intersection with stop control on 27th Avenue. Durston Road is a minor arterial roadway and 27th Avenue is a collector roadway. This intersection experiences delay problems associated with the difficulty of vehicles being able to make left-turns during peak hours. A traffic signal, roundabout, or other traffic control device should be added to this intersection when warrants are met.
Estimated Cost: $350,000

TSM-14: **Hulbert Road / Jackrabbit Lane**
It is recommended that left-turn lanes be added to the intersection of Hulbert Road and Jackrabbit Lane as necessitated by the growing traffic demand. The intersection is a four-legged intersection with stop control on Hulbert Road. A traffic signal, roundabout, or other traffic control device should be added to this intersection when warrants are met.
Estimated Cost: $425,000

TSM-15: **Nelson Road / Frontage Road**
It is recommended that a left-turn lane be added to Nelson Road at the intersection with the Frontage Road as necessitated by the growing traffic demand. The intersection is a three-legged intersection with stop control on Nelson Road. The Frontage Road is a minor arterial roadway and Nelson Road is classified as a collector. A traffic signal, roundabout, or other traffic control device should be added to this intersection when warrants are met.
Estimated Cost: $200,000

TSM-16: **Sacajawea Peak / Frontage Road**
It is recommended that left-turn lanes be added to the intersection of Sacajawea Peak and Frontage Road as necessitated by the growing traffic demand. The intersection is a three-legged intersection with stop control on Sacajawea Peak. The Frontage Road is a minor arterial roadway and Sacajawea Peak is classified as a local. A traffic signal, roundabout, or other traffic control device should be added to this intersection when warrants are met.
Estimated Cost: $425,000

TSM-17: **Gallatin Field / Frontage Road**

It is recommended that a traffic signal, roundabout, or other adequate traffic control device be installed at the intersection of Gallatin Field and Frontage Road when warrants are met. This is a three-legged intersection with stop control on Gallatin Field. There currently are designated left-turn lanes on each approach leg of this intersection.

Estimated Cost: $330,000

TSM-18: **College Street / 8th Avenue**

It is recommended that a traffic signal, roundabout, or other adequate traffic control device be installed at this intersection when warrants are met. This intersection is currently four-way stop controlled and analysis shows a failing level of service due to excessive delay at the intersection.

Estimated Cost: $330,000

TSM-19: **West Babcock/Main Street**

It is recommended that the intersection signal timing/phasing be reconfigured to provide a dedicated left-turn phase along the Babcock leg. This intersection currently has a failing LOS due to the eastbound and westbound movements. If the LOS does not improve to an acceptable level by changing the signal timing/phasing, then this intersection should be reevaluated to determine other possible traffic control measures.

Estimated Cost: $35,000

TSM-20: **Highland Boulevard / Ellis Street**

This project includes the installation of a traffic signal, roundabout, or other adequate traffic control device when warrants are met to the intersection of Highland Boulevard and Ellis Street. Highland Boulevard is currently a two-lane minor arterial roadway and Ellis Street is a two-lane local roadway. This intersection currently has stop control along Ellis Street.

Estimated Cost: $330,000

TSM-21: **Kagy Boulevard / Willson Avenue**

The existing intersection should be modified to add a designated southbound right-turn lane. This intersection currently operates at a LOS of D or lower during the AM and PM peak hours. If conditions do not improve at this intersection, it should be reevaluated to determine other potential traffic control solutions.

Estimated Cost: $140,000

TSM-22: **Durston / 25th Avenue**

It is recommended that left-turn lanes be added to the intersection of Durston Road and 25th Avenue as necessitated by the growing traffic demand. The intersection is a four-legged intersection with stop control on 25th Avenue. Durston Road is a minor arterial roadway and 25th Avenue is a local roadway. This intersection experiences delay problems associated with the difficulty of vehicles being able to make left-turns during peak hours. A traffic signal,

roundabout, or other traffic control device should be added to this intersection when warrants are met. This intersection serves as a major access to Emily Dickinson School and as such, there are increases in traffic volumes and pedestrian traffic at this location.
Estimated Cost: $350,000

TSM-23: **Babcock Street / 11th Avenue**
It is recommended that crosswalks be painted on all legs of the intersection of Babcock Street and 11th Avenue. This intersection is a block south of Bozeman High School and experiences high pedestrian traffic. This is a four-legged intersection with stop control on Babcock Street.
Estimated Cost: $50,000

TSM-24: **Highway 191 Speed Zone Study**
It is recommended that a speed zone study be completed to determine if the 50 mph speed zone can be extended north to Axtell Anceney Road and south to Cottonwood Road along Highway 191. It is also recommended that signage be installed at both ends of the speed zone to indicate "congested area next 2 miles" or "dangerous intersection ahead". Also, determine if the speed differential can be eliminated between cars and trucks along the remainder of Highway 191 by posting a day speed of 65 mph and night speed of 60 mph.
Estimated Cost: $30,000

TSM-25: **Highway 191 / Mill Street**
It is recommended that a traffic signal with a pre-emptive traffic device be installed at the intersection of Mill Street and Highway 191 to allow the Gallatin Gateway Fire Department safer and speedier access to the highway. The west side of this intersection serves an elementary school, fire station, the Gallatin Gateway Community Center, and businesses and homes in town, as well as the Gallatin River and a network of rural roads. To the east, it serves the Post Office, and businesses and residences. Although the intersection is currently at a LOS C for the A.M. and P.M. peak hours, expected future growth could diminish the LOS to a failing grade.
Estimated Cost: $330,000

TSM-26: **Highway 191 / Axtell Anceney Road**
It is recommended that designated turn lanes complete with appropriate length turn bays be installed at the intersection of Highway 191 and Axtell Anceney Road as necessitated by the growing traffic demand. This is a three-legged intersection with stop control on Axtell Anceney Road. Designated turn lanes will help increase the safety level and traffic flow at the intersection.
Estimated Cost: $425,000

TSM-27: **Highway 191 / Zachariah Lane**
It is recommended that designated turn lanes complete with appropriate length turn bays be installed at the intersection of Highway 191 and Zachariah

Lane as necessitated by the growing traffic demand. This is a four-legged intersection with stop control on Zachariah Lane. Designated turn lanes will help increase the safety level and traffic flow at the intersection.
Estimated Cost: $425,000

TSM-28: **<u>Highway 191 / Cottonwood Road</u>**
It is recommended that designated turn lanes complete with appropriate length turn bays be installed at the intersection of Highway 191 and Cottonwood Road as necessitated by the growing traffic demand. This is a four-legged intersection with stop control on Cottonwood Road. Designated turn lanes will help increase the safety level and traffic flow at the intersection.
Estimated Cost: $425,000

TSM-29: **<u>Access Management Plan on Highway 191</u>**
Eliminate excessive curb cuts and access points on Highway 191 by restricting access as much as possible to major intersections with turn lanes. Require developers to provide frontage road access via intersections with turn lanes instead of multiple curb cuts. It is further recommended that a formal access control study be undertaken in hopes of preparing an access control management plan for this corridor.
Estimated Cost: $250,000

TSM-30: **<u>Highway 191 / Huffine Lane</u>**
It is recommended that a pre-emptive traffic device be installed at the intersection. A pre-emptive traffic device would allow for safer and speedier access for the Gallatin Gateway Fire Department.
Estimated Cost: $25,000

TSM-31: **<u>7th Avenue / Kagy Boulevard</u>**
This project includes the installation of a traffic signal, roundabout, or other adequate traffic control device to the intersection of 7th Avenue and Kagy Boulevard. 7th Avenue is a two-lane collector roadway north of the intersection and a two-lane local roadway south of the intersection. Kagy Boulevard is a two-lane principal arterial roadway at the intersection. This intersection currently has stop control along 7th Avenue. Recent development proposals and increasing traffic volumes indicate that the need for this signal improvement will soon be warranted. This intersection is a major access point for the MSU campus. This project will improve traffic flow and safety at this intersection.

TSM-32: **<u>Truck Route Alternatives</u>**
Study possible routes that would allow commercial trucks to by-pass Mill Street when accessing Highway 191. Possible routes include Gateway South, Axtell Gateway, and /or Axtell Anceney.
Estimated Cost: $30,000

TSM-33: **Mill Street Speed Zone Study**

Conduct a Speed Zone study to determine if the 25 mph speed zone can be extended to the west at the intersection with Cottonwood Road, Axtell Gateway Road, and Gateway South Road. Also, determine if Gateway South Road from the intersection with Mill Road should be a 35 mph speed zone for 3 miles.

Estimated Cost: $30,000

TSM-34: **Implement Huffine Lane Access Control Plan**

The MDT has an adopted Access Control Plan in place for Huffine Lane that delineates allowed access spacing, frontage road locations, and future signalization of intersections. As improvements and/or developments are considered along this corridor, reference should be made to the Access Control Plan for allowable traffic mitigation improvements.

Estimated Cost: N/A

TSM-35: **Implement Jackrabbit Lane Access Control Plan**

The MDT has an adopted Access Control Plan in place for Jackrabbit Lane that delineates allowed access spacing, frontage road locations, and future signalization of intersections. As improvements and/or developments are considered along this corridor, reference should be made to the Access Control Plan for allowable traffic mitigation improvements.

Estimated Cost: N/A

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.

Estimated Cost: N/A

TSM-37: **Formalize Transit Representation on TCC**

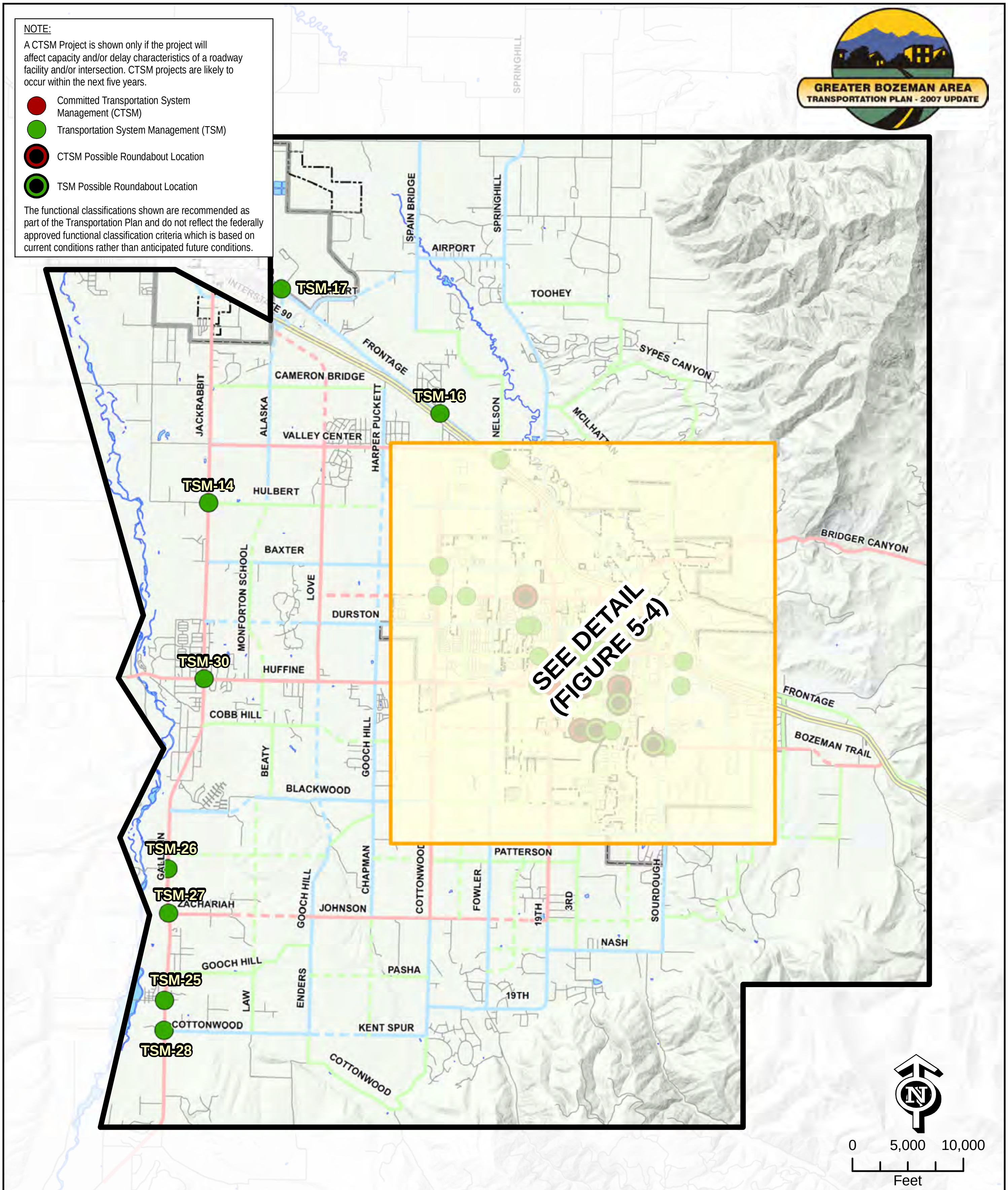
It is recommended that a member of Streamline (board or staff) have a formal, allocated seat on the Bozeman Transportation Coordinating Committee (TCC).

Estimated Cost: N/A

NOTE:
A CTSM Project is shown only if the project will affect capacity and/or delay characteristics of a roadway facility and/or intersection. CTSM projects are likely to occur within the next five years.

- Committed Transportation System Management (CTSM)
- Transportation System Management (TSM)
- CTSM Possible Roundabout Location
- TSM Possible Roundabout Location

The functional classifications shown are recommended as part of the Transportation Plan and do not reflect the federally approved functional classification criteria which is based on current conditions rather than anticipated future conditions.



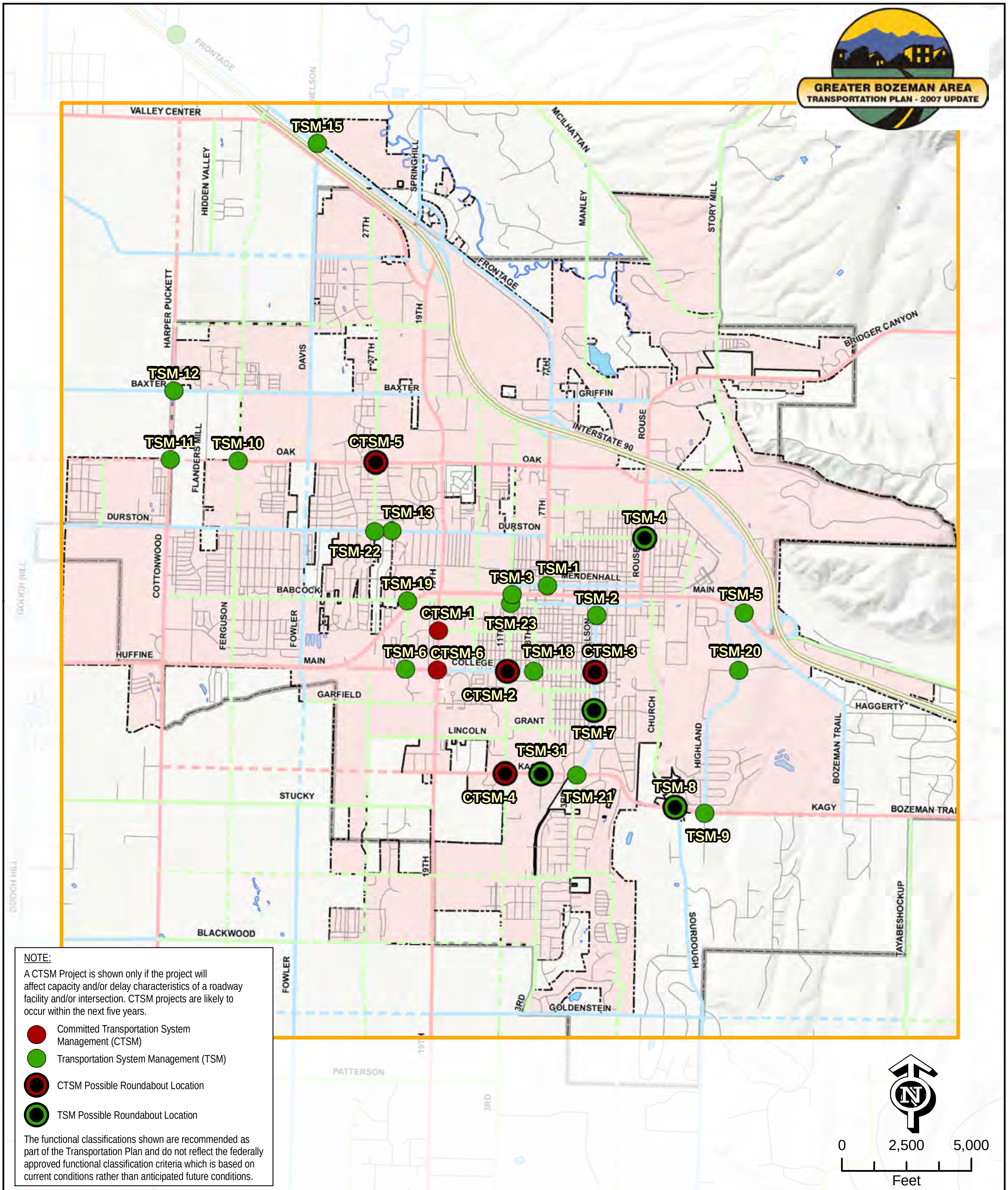
Legend

- Interstate
- Principal Arterial
- Minor Arterial
- Collector
- Future Principal Arterial
- Future Minor Arterial
- Future Collector
- Local Roadway
- Study Area Boundary
- Detail Area
- City Boundary
- Urban Boundary

Greater Bozeman Area Transportation Plan (2007 Update)

Transportation System Management (TSM) Recommended Improvements

Figure 5-3



Legend

Interstate	Local Roadway
Principal Arterial	Detail Area
Minor Arterial	City Boundary
Collector	Urban Boundary
Future Principal Arterial	
Future Minor Arterial	
Future Collector	

RPA

Greater Bozeman Area Transportation Plan (2007 Update)

Transportation System Management (TSM) Recommended Improvements

Figure 5-4

5.3 Recommended Pedestrian Facility Improvements

All residents within the Bozeman area are pedestrians whether walking the dog, walking to the store or work, or from a vehicle to a final destination. The following recommended pedestrian facility improvements were developed from the public involvement process and observations on the major street network (collector and arterial streets). Each proposed facility should be designed in accordance with the Americans with Disabilities Act (ADA) design standards and with the dimensions found in the street standards in **Chapter 9**. Planning level cost estimates have been provided for the recommended pedestrian facilities in this section. More detailed engineering level cost estimates should be undertaken at the time implementation for each project as individual challenges vary and material costs can escalate significantly over time. The cost estimates included in this section only account for the marginal cost of adding pedestrian facilities and do not include the cost of right-of-way acquisition (if applicable), or for major grading associated with roadway widening. Estimates assume a 5 foot wide sidewalk of 4 inch thickness for collector streets and a 6 foot wide sidewalk of 6 inch thickness for sidewalks along arterials.

5.3.1 Bozeman Specific Safe Routes to School Projects

Technical Safe Routes to School assessments of six of Bozeman's elementary schools were completed in the spring of 2008. These schools were, Hawthorne, Emily Dickinson, Irving, Longfellow, Morning Star, and Whittier Elementary Schools. The recommended 'engineering' related projects focused mainly on the local streets surrounding the schools and some crossings of collectors and arterials. Where applicable, Safe Routes to School (SRTS) projects that have been recommended on collectors or arterials have been identified with a 'SRTS' tag in the notes field of the recommended bicycle and pedestrian facilities tables. The School Improvement Plans for the six elementary schools are available within the Bozeman Engineering and Planning Departments and online at the City of Bozeman's website. These documents should be reviewed prior to any construction activities on local streets in Bozeman.

5.3.2 Sidewalks

The following streets within the Bozeman Area in **Table 5-3** have no pedestrian facilities for the identified segments. These corridors have been identified by their existing pedestrian need or anticipated future need. Cost estimates are provided in **Table 5-3** for sidewalk construction only, but in most cases full street improvements will also be necessary.

Table 5-3
Recommended Sidewalks

Street	From	To	Dist.	Notes	Cost
W. Babcock St.	S. 19th Ave.	S. 11th Ave.	2,800 ft	Construct Sidewalks along entire segment.	$150,000
Baxter Ln.	N. 19th Ave.	Davis Ln.	4,300 ft	Most of the north side and part of south side need construction.	$300,000
Baxter Ln.	N. 15th Ave.	N. 7th Ave.	3,500 ft	Construct sidewalks on both sides	$200,000

Street	From	To	Dist.	Notes	Cost
L St.	Story Mill Rd.	Railroad tracks	3,150 ft	Construct sidewalks on both sides	$175,000
Manley Rd.	W. Griffin Dr.	Existing Sidewalk	1,800 ft	Sidewalk recommended on both sides	$100,000
Mcilhatten Rd.	Story Mill Rd.	Agusta Dr.	2,200 ft	Construct sidewalk on south side	$60,000
N. 7th Ave.	Durston Rd.	Hemlock St.	1,400 ft	Multiple missing pieces of sidewalk. Wide driveways common. Short term: fill gaps Long term: redevelop N. 7th Ave with new streetscape, pedestrian lighting, boulevard planting strips, street trees, 7-foot minimum sidewalk.	$65,000
N. 7th Ave.	Southern I-90 ramps	Red Wing Dr.	2,700 ft	Multiple missing pieces of sidewalk. Only western side of I-90 overpass has pedestrian facilities. Crosswalks should be added across all cross streets and freeway ramps.	$120,000
N. Cottonwood Rd.	Huffine Ln.	W. Durston Rd.	5,300 ft	Construct sidewalks on both sides	$475,000
N. Rouse / Bridger Drive	E. Cottonwood St.	Griffin Dr.	4,700 ft	Construct sidewalks on both sides	$423,000
N. Rouse Ave.	E. Lamme St.	700 feet south of Peach St.	1,100 ft	Construct sidewalks on both sides	$100,000
S. 19th Ave.	W. Babcock St.	Patterson	5,300 ft	Construct Sidewalks along entire segment, partially through S. 19th MDT project, partially through new development.	$175,000
S. 3rd Ave. (and Graf St.)	W. Kagy Blvd.	Wagonwheel Rd (south of middle school)	5,000 ft	Road currently has an asphalt pedestrian zone with rumble strip on one side only. Sidewalk should be constructed to collector standard. Construct Sidewalk on one side minimum, both sides recommended. Two schools and shopping center would be connected to hundreds of homes.	$135,000-$270,000
S. Church Ave / Sourdough Rd.	E Story St.	E. Kagy Blvd.	6,400 ft	Roadway mostly without sidewalks, there are a few segments that have them, but they are overgrown and in need of maintenance.	$350,000
Story Mill Rd.	L St.	Boylan Rd.	3,700 ft	Construct sidewalks on both sides	$205,000
Story Mill Rd.	Boylan Rd.	Mcilhattan Rd.	850 ft	Construct sidewalks on both sides	$50,000
W. College St.	Huffine Ln.	S. 13th Ave.	5,600 ft	Sidewalk recommended for north side of the roadway. SRTS related.	$250,000
W. Griffin Dr.	N. 7th Ave.	N. Rouse Ave.	3,900 ft	Construct sidewalks on both sides	$350,000
W. Kagy Blvd.	S. 19th Ave.	S. 11th Ave.	1,600 ft	Construct sidewalks where missing along both sides. Most of segment lacks sidewalks. Only partially along vacant land.	$70,000

5.3.3 Intersections/Crossings

The following intersections and/or crossing locations in **Table 5-4** have been identified to provide for improved pedestrian crossing opportunities. In addition to the intersection improvements shown in **Table 5-4**, the potential for mid-block crossings described as the Durston Mid-Block Crossing on West Side Trail and the Oak Street/Regional Park Mid-Block Crossings should be studied.

Table 5-4
Proposed Pedestrian Intersection Improvements

Intersection	Type	Notes	Cost
Downtown areas of Babcock and Mendenhall Streets	Curb Extensions	Install curb extensions on all/most intersections. Few traffic controls are present with many parked cars. Pedestrians have low visibility in a high pedestrian use area.	$5,000 ea
E. Main St. &N. Broadway Ave	Dedicated pedestrian signal, full traffic signal with pedestrian signal heads, or grade separated crossing.	The 'Main Street to the Mountains' trail ends here with major destination such as the new Library, and Lindley Park located across Main Street from other businesses and trail systems to the north. This crossing has high interest from non-motorized users and is currently not signalized. A grade separated crossing should consist of a 10-foot underpass beneath East Main Street with 10-foot paved shared-use path connecting to existing segment in Lindley Park. On north side, portions could be funded/constructed through development of vacant parcels.	Dedicated pedestrian signal: $75,000; Pedestrian signal heads: $2,500 (Signal heads only); Underpass: $250,000-$600,000 depending on design.
N. 7th Ave & W Villard St	Dedicated Pedestrian Signal	This is a long crossing with no intersection control. Students will use it coming from the west side of 7th to Whittier School. Pedestrian signal recommended when warrants are met, H.A.W.K. variety recommended. SRTS related.	$75,000
S. 13th Ave & W. College St	Dedicated Pedestrian Signal or Pedestrian Signal heads on full signal	Safe Routes to School (SRTS) connection between MSU student housing and Irving School. Also will assist MSU Student access to campus. SRTS related.	$2,500 (Signal heads only) $75,000 for ped signal
W. College St. & S. Willson Ave.	Pedestrian Signal heads on full signal	Traffic Signal with pedestrian signal heads recommended when warrants are met. All pedestrian phase for school students during school commute periods. SRTS related.	$2,500 (Signal heads only)
W. College St. &S. 23rd Ave.	Pedestrian Signal heads on full signal	If traffic signal is installed then pedestrian signal heads should be included. Will provide access to shared-use path on the south side of W College St.	$2,500 (Signal heads only)
W. College St. @ Intersections between S. 8th Ave. and S. 11th Ave.	ADA Curb Ramps, Driveway Aprons, & Crosswalk Striping	The north side of College Street is inadequate as a pedestrian facility. Its proximity to Irving School, local neighborhoods and MSU make improvements necessary. SRTS related.	$70,000
W. Garfield St & S. 19th Ave	Dedicated Pedestrian Signal or Pedestrian Signal heads on full signal short-term. Grade Separation long-term	Help is needed at this intersection for pedestrians and bicycles trying to get to MSU from neighborhoods to the north and west of campus. A traffic signal with pedestrian signal heads would improve connectivity. Long-term campus plans call for a pedestrian/bicycle overpass of S 19th Ave.	$2,500 (Signal heads only)
W. Kagy Blvd & S. 11th Ave	Pedestrian Signal heads on full signal	This intersection frequently has long delays for pedestrians and bicyclists. A traffic signal with pedestrian signal heads would improve connectivity.	$2,500 (Signal heads only)
W. Kagy Blvd. & S. 7th Ave.	Pedestrian Signal heads on full signal	If intersection has access control then use pedestrian refuge island with crossing at the west side of the intersection to stay away from right turning traffic	$2,500 (Signal heads only)
W. Koch St & S. 11th Ave	Stripe Crossing	Place Piano Key crossing with stop lines and accompanying signage.	$15,000
W. Koch St & S. 19th Ave	Pedestrian Signal heads on full signal	Install pedestrian signal heads with Traffic signal	$2,500 (Signal heads only)
W. Oak St & N. Hunters Way	Refuge Island	Wide Crossing, Median exists, realign crossing or extend median. SRTS related.	$1,500
W. Oak St. & N. 27th Ave.	Refuge Island	Wide Crossing, Median exists, realign crossing or extend median. SRTS related.	$1,500

5.4 Recommended Bicycle Facility Improvements

Bicycle facilities vary dramatically from simply additional signage to separated paved facilities along exclusive rights-of-way. The following projects in **Table 5-5 through Table 5-9** have been identified through public involvement, existing and anticipated future travel demand, significant destinations for bicyclists, and the existing bicycle network. Planning level cost estimates have been provided for the recommended bicycle facilities in this section. More detailed engineering level cost estimates should be undertaken at the time implementation for each project as individual challenges vary and material costs can escalate significantly over time. The cost estimates included in this section only account for the marginal cost of adding bicycle facilities and do not include the cost of right-of-way acquisition (if applicable), or for major grading associated with roadway widening. Estimates assume appropriate signage, thermoplastic striping and stenciling (paint is significantly cheaper but less durable), additional paving (if applicable), curb and gutter, and other concrete work. For Shared Use paths, a 10 foot wide, 3inch thick asphalt section is assumed (city standard) if a 6 inch concrete section is used (also city standard) cost will roughly triple from estimate.

5.4.1 Bike Lanes

A bike lane provides a striped and stenciled lane for one-way travel on a street or highway. Many of the identified bike lanes will be completed through roadway improvements funded by new development. Some of the identified projects will need to be completed by the City of Bozeman, Gallatin County, or MDT through retrofit or as part of maintenance activities (striping and signage only). Additionally, any roadway to be built within the City of Bozeman that is a collector or arterial should have a bike lane constructed in accordance with the recommended roadway standards in **Chapter 9**.

Table 5-5
Recommended Bike Lanes

Street	From	To	Length (mi)	Notes	Cost
11th Ave.	College St.	Baxter Ln.	1.8	From Main to Durston width allows. Road missing between Durston Rd. and Oak St. Parking may need to be removed on one side of street from W. Curtiss to W. College or curb widening.	$40,000 not including unbuilt part.
Babcock St.	W. Main St	S. Wallace Ave.	1.83	May require removal of parking or lane configuration changes.	$65,000
Baxter Ln.	N. 15th Ave.	N. 7th Ave.	0.67	As new development occurs. Retrofit possible.	$100,000
Baxter Ln.	N. 19th Ave.	Jackrabbit Ln.	5.69	Build BLs with any new construction. (Gallatin Green to Ferguson already exists)	$900,000
Bozeman Trail Rd.	E. Kagy Blvd.	Haggerty Ln.	0.81	Adjoins new development.	$320,000
Catamont St.	Valley Center Rd.	Harper Puckett Rd.	1.26	Build BLs with any new construction. (Davis to 27th already exists)	$200,000

Street	From	To	Length (mi)	Notes	Cost
Cattail St.	S. 19th Ave.	Western extensions	1.29	Build BLs with any new construction.	$200,000
Cottonwood Rd.	Huffine Ln.	Baxter Ln.	2	Add BLs when full width is constructed.	$56,000
Cottonwood Rd.	Huffine Ln.	Blackwood Rd.	2.02	As new development occurs	$315,000
Davis Ln.	Oak St.	Valley Center Dr.	2.2	Adjacent to Regional Park. Add bike lanes when full width is constructed.	$340,000
Durston Rd.	Springbrook Ave.	Western Terminus	3.2	Build BLs with any new construction.	$500,000
E. Main St.	S. Wallace	Virginia Dr.	2.17	Striping & Signage needed	$15,000
Fowler Ln.	W. Oak St.	Blackwood Rd.	3.78	As new development occurs/ in conjunction with road projects. Improvements needed to E. side of St. only between Main and Durston.	$425,000
Graf St.	S. 3rd Ave.	Cottonwood Rd.	2.79	Build BLs with all new segments	$450,000
Griffin Dr.	N. 7th Ave.	Story Mill Rd.	1.24	As new development occurs	$350,000
Haggerty Ln.	Bozeman Trail Rd.	E. Main St.	1.04	Adjoins new development.	$400,000
Harper Puckett Rd.	Valley Center Rd	Baxter Ln.	2.73	Build BLs with any new segment. Retrofit built segments.	$435,000
Highland Blvd.	Main St.	E. Kagy Blvd.	1.63	Should be installed with work on Highland & Hospital development	$30,000
Huffine Ln.	Cottonwood Rd.	11th Ave.	2.76	Shoulder width allows. Signage/Striping only.	$20,000
Kagy Blvd.	S. 22nd Ave.	Cottonwood Rd.	1.77	Build BLs with any new construction.	$280,000
Kagy Blvd. / Bozeman Trail Rd.	S. 19th Ave.	I-90 Interchange	7.01	Mostly striping & signage only on Kagy, full road reconstruction on Bozeman Trail Road.	$80,000 from 19th to Highland, $650,000 to I-90
L St.	Story Mill Rd.	N. Wallace Ave.	0.64	Build BLs with any new construction.	$100,000
Manley Rd.	Exist bike lane	Mcilhatten Rd.	1.1	As new development occurs	$150,000
Mendenhall St.	N. 11th Ave.	N. Wallace Ave.	1.11	May require removal of parking or lane configuration changes.	$37,000
N. 15th Ave.	Durston Rd.	W. Main St.	0.44	Add BLs	$12,000
N. 15th Ave.	Oak St.	Baxter Ln.	0.48	Build BLs with any new construction.	80,000
N. 19th Ave.	W. Main St.	Springhill Rd.	3	Retrofit possible from Main to Springhill. Signage and stenciling only.	$20,000
N. 27th Ave. / Thomas Dr.	Durston St.	Valley Center Dr.	2.23	Some parts complete. Challenge is between Durston and Oak. St. is 40′ wide. Parking on W. side of St. may need to be sacrificed. Two 5′ BLs, two 11′ driving lanes, one 8′ parking lane	$70,000
N. 7th Ave.	W. Griffin Dr.	W. Main St.	1.43	Slight lane narrowing in some places, mostly signage & Striping	$40,000
N. Ferguson Ave.	Valley Center Rd.	Durston Rd.	2.91	Build BLs with all new segments	$650,000
N. Rouse Ave.	Story Mill Rd.	E. Main St.	0.84	Include as part of MDT reconstruction	$330,000
Oak St.	N. 7th Ave.	N. 19th Ave.	0.78	Signage and stenciling needed only	$5,000

Street	From	To	Length (mi)	Notes	Cost
Oak St.	Davis Ln.	Western terminus	1.76	As new development occurs	$275,000
Peach St.	N. 7th Ave.	N. Rouse Ave.	0.7	Remove parking on N. side install bike lanes.	$33,000
S. 11th Ave.	W. Grant St.	W. Kagy Blvd.	0.34	Striping & Signage only	$10,000
S. 11th Ave.	W. Kagy Blvd.	Goldstein Rd.	1.77	Build BLs with any new construction.	$275,000
S. 23rd Ave.	W. Main St.	W. College St.	0.5	Resize lanes, prohibit parking	$15,000
S. 27th Ave.	College St.	Southern terminus	1.51	Build BLs with any new construction.	$240,000
S. 3rd Ave.	Sacajawea School	Goldenstein Ln.	0.52	Add BLs	$60,000
S. 8th Ave.	W. Main St.	W. Cleveland St.	0.7	Narrow median and add bike lane	$280,000
S. Church Ave.	Kagy Blvd.	E. Mendenhall St.	1.67	Build BLs with roadway reconstruction.	$700,000
S. Ferguson Ave.	Huffine Ln.	Southern terminus	2.02	Build BLs with all new segments	unknown
S. Willson Ave.	Kagy Blvd.	Main St.	1.33	Narrow travel lanes to add Bike Lanes	$90,000
Story Mill Rd.	L St.	Mcilhatten Rd.	0.97	As new development occurs	$75,000
Tamarack St.	N. 7th Ave.	N. Wallace Ave.	0.86	Retrofit BLs. Possible signage/striping/parking removal.	$25,000
Valley Center Rd.	N. 19th Ave.	Jackrabbit Ln.	6.35	Build BLs with any new construction, retrofit existing improved roadway with signage and striping.	$950,000
W. College St.	Main St.	Willson Ave.	1.84	Possible retrofit on some areas. College from main to S. 11th will have to be reconstructed at some point.	$700,000
W. Garfield St.	Research Dr.	S. 19th Ave.	0.68	Mostly striping and signage	$17,000
W. Garfield St.	Cottonwood Rd.	Fowler Ave.	1.04	Build BLs with any new construction.	$160,000
W. Grant St.	S. 6th Ave.	S. Willson Ave.	0.32	Continue existing bike lane. May require removal of parking on one side of St.	$8,500
W. Kagy Blvd.	S. 22nd Ave	Cottonwood Rd.	1.77	Build BLs with any new construction.	$275,000
W. Lincoln St.	S. 11th Ave	Cottonwood Rd.	2.53	Build BLs with any new construction, retrofit existing improved roadway with signage and striping.	$330,000

5.4.2 Shared Roadways

Shared roadways are any on-street facility where bicycles share the travel lanes with automobiles. Typically, these facilities occur on local roadways or on roadways with low traffic volumes and speeds. Currently, the City of Bozeman's bike route network identified in **Chapter 2** makes up all of the shared roadways in the study area. Additional treatments to these roadways constitute a 'Bicycle Boulevard.' Treatments include turning stop signs to favor bicyclists, pavement markings, wayfinding signage, traffic diverters and other types of traffic calming. The level of treatment varies between facilities and is dictated by traffic conditions and safety. Proposed bicycle boulevards should be implemented with pavement stenciling (shared lane markings), 'City of Bozeman Bike Route' signs, and appropriate

wayfinding signage ('Downtown', 'Trails', 'MSU Campus', etc.). Traffic calming should only be applied to bicycle boulevards where traffic speeds or volumes are excessive.
It is recommended that pilot bicycle boulevards be implemented on the existing Bike Routes of Lamme Street from North 11th Avenue to Broadway, on West Koch Street between South 23rd Avenue to South Tracy Avenue, and on a proposed bike routes on North Wallace Avenue from end to end at the trailheads and on South 6th Avenue from West Babcock Street to West Grant Street.

New bike routes are also identified in **Table 5-6**.

Table 5-6
Designate as Bike Routes

Street	From	To	Length (mi)	Notes	Cost
Clifften Dr.	W. Babcock St.	Durston Rd.	0.53	Good Connection near park.	$1,000
Lamme St.	N. 11th Ave.	N. Broadway Ave.	1.28	Bicycle Boulevard Test. Estimate is for signage and stenciling only	$11,000
S. 6th Ave.	W. Babcock St.	W. Grant St.	1.24	Bicycle Boulevard Test. Estimate is for signage and stenciling only	$10,000
W. Koch St.	S. 23rd Ave.	S. Tracy Ave.	1.5	Bicycle Boulevard Test. Estimate is for signage and stenciling only	$13,000
Western Dr.	Durston Rd.	W. Babcock St.	0.51	Less traffic and no parking as compared to North Hunters Way.	$1,000

5.4.3 Shoulder Bikeways

Roadway shoulders can offer many of the benefits of bike lanes without the same level of infrastructure cost associated with bike lane stencils and signage. Roadway shoulders are ideal for rural roadways where bicyclists are present. Roadway shoulders should be a minimum of 4 feet wide with 6 feet recommended. If a rumble strip is necessary it should be as close to the white (fog) line as possible and have regular skips to allow bicyclists to leave the shoulder to avoid obstructions or obstacles if necessary. Roads that are recommended for shoulder bikeways are listed in **Table 5-7**.

Table 5-7
Recommended Expanded Shoulder (Minimum of 4-feet)

Street	From	To	Length (mi)	Notes	Cost
Blackwood Rd.	Cottonwood Rd.	US 191	4.74	In conjunction with road improvements.	$500,000
Cameron Bridge Rd.	Jackrabbit Ln.	Harper Puckett Rd.	2.97	In conjunction with road improvements.	$315,000
Cottonwood Rd.	Blackwood Rd.	Terminus	10.34	In conjunction with road improvements.	$1,100,000
Enders Rd.	S. Cottonwood Rd.	Gooch Hill Rd.	1.51	In conjunction with road improvements.	$160,000
Fort Ellis Rd.	Bozeman Trail Rd.	Frontage Rd.	0.91	In conjunction with road improvements.	$100,000
Fowler Ln.	Blackwood Rd.	S. 19th Ave.	3.53	In conjunction with road improvements.	$370,000

Street	From	To	Length (mi)	Notes	Cost
Frontage Rd.	N. 7th Ave.	Study Boundary (near Belgrade)	7.32	In conjunction with road improvements.	$770,000
Frontage Rd. (N. Side of I-90)	E. Main St.	Bozeman Trail Rd.	1.97	In conjunction with road improvements.	$200,000
Goldenstein Ln.	S. 19th Ave.	Sourdough Rd.	1.99	Area developed. County controlled. Rural character.	$200,000
Gooch Hill Rd.	Durston Rd.	US 191	7.65	In conjunction with road improvements.	$800,000
Jackrabbit Ln.	Huffine Ln.	Study Area Boundary	6.7	4-8 foot shoulders recommended. Shoulder should go into Belgrade as bike lane – not within Study Area.	$700,000
Johnson Rd.	Fowler Rd.	Gooch Hill Rd.	3.01	In conjunction with road improvements.	$315,000
Love Ln.	Valley Center Dr.	Huffine Ln.	4.02	In conjunction with road improvements.	$425,000
Mcilhattan Rd.	Story Mill Rd.	Sypes Canyon Rd.	3.02	In conjunction with road improvements.	$315,000
Monforton School Rd.	Huffine	Baxter Ln.	2.01	In conjunction with road improvements.	$200,000
Nash Rd.	S. 19th Ave.	Sourdough Rd.	1.97	In conjunction with road improvements.	$200,000
Patterson Rd.	S. 3rd. Ave.	Cottonwood Rd.	2.51	In conjunction with road improvements.	$260,000
S. 3rd Ave.	Goldenstein Ln.	Bristol Ln.	2.92	In conjunction with road improvements.	$315,000
Sourdough Rd.	E. Kagy Blvd.	Nash Rd.	3.59	Area Developed. County controlled. Rural Character	$375,000
Springhill Rd.	Frontage Rd.	End of pavement	6.08	In conjunction with road improvements. Do not re-install rumble strip. If rumble strip is to be kept, keep it as far left as possible and use bike-friendly design.	$640,000
Stucky Rd.	S. 19th Ave.	Gooch Hill Rd.	3.01	As new development occurs/with future county road improvements	$315,000
US 191	Huffine Ln.	Study Area Boundary	8.29	Ensure 4-ft minimum shoulder (outside of rumble strip area) in conjunction with any road improvements.	$870,000

5.4.4 Shared-Use Paths

A shared-use path provides bicycle travel on a paved right-of-way completely separated from any street or highway. Many shared-use paths in the Bozeman Area follow roadway rights-of-way with varying amounts of separation. Shared-use paths in the City of Bozeman are designed to be ten feet wide. **Table 5-8** lists the recommended shared-use paths to complement the existing network. Long-term connectivity to trails outside the study area boundary, specifically towards Three Forks and Manhattan, should be factored into future planning efforts and design concepts as the Bozeman to Belgrade trail is realized. This need is further discussed in the Gallatin County Interconnect Plan.

Table 5-8
Recommended Shared-Use Paths

Street / Route	From	To	Length (mi)	Notes	Cost
Arnold St.	S. 19th Ave.	Termination of existing St.	0.69	Elementary School Connection	$87,000
Bridger Canyon Dr.	I-90	'M' Trailhead	4.67	Access to popular trailhead.	$1,000,000
Cambridge Dr.	S. 19th Ave.	Existing path	0.63	Middle School Connection	$80,000
Cameron Bridge Rd.	Harper Puckett Rd.	Jackrabbit Ln.	2.97	Bozeman to Belgrade trail alternative	$375,000
Catamont St.	Harper Puckett	Stream Corridor	0.61	Bozeman to Belgrade trail alternative	$300,000
College St.	Huffine Ln.	S. 11th Ave.	1.2	Part of Existing CTEP funding request	$280,000
E. Kagy Blvd.	Highland Blvd.	Bozeman Trail Rd.	1	Build as development occurs, both sides.	$250,000
E. Valley Center Rd.	Stream Corridor	Jackrabbit Ln.	1.25	Bozeman to Belgrade trail alternative	$150,000
Ford Court	Stream Corridor	Harper Puckett Rd.	0.99	Connector for Chief Joseph Middle School	$125,000
Fowler Ave.	Oak St.	S. 19th Ave.	7.05	Goal of GVLT to reach Hyalite Rd.	$1,500,000
Harper Puckett Rd.	Baxter Ln.	Cameron Bridge	3.7	Bozeman to Belgrade trail alternative	$900,000
Huffine Ln.	Ferguson Ave.	W. College St.	0.24	Part of Existing CTEP funding request	$70,000
Huffine Ln.	Four Corners	Ferguson Ave.	3.71	Build as development occurs, both sides.	$800,000
Jackrabbit Ln.	Huffine Ln.	Study Area Boundary	6.52	East side only	$800,000
N. 19th Ave.	Durston Rd.	I-90	varies	Fill in gaps.	Varies.
Oak St.	N. 7th Ave.	N. Rouse Ave.	0.74	Improve or build to Shared Use Path Standard. Links fairgrounds, to points East and West.	$220,000
S. 11th Ave.	Opportunity Way	Southern terminus (future)	1.18	Parts already built. MSU connection from South.	$240,000
S. 19th Ave.	Goldenstein Ln.	College St.	2.52	Connection to MSU. College St. to Kagy Blvd. being built in 2009	$220,000
S. Alaska Rd.	Cameron Bridge Rd.	I-90	1.1	Bozeman to Belgrade trail alternative – to be integrated with proposed interchange (see **MSN 20**).	$130,000

Street / Route	From	To	Length (mi)	Notes	Cost
Story Hill Rail Trail	Village Downtown Blvd.	Big Gulch Dr.	1.2	8 to 10-foot Paved Shared-Use trail connecting N. Broadway Ave. to Big Gulch Dr. via abandoned rail corridor. Two missing bridge spans will need to be installed, the first consisting of 150 feet over three active rail lines, the second a 300 foot gap over I-90. Due to oversize load requirements on I-90 the trail bed will need to be raised and new abutments constructed at these crossings. MDT's "Adopt a Bridge" program may be able to supply period truss bridges suitable for bike and pedestrian traffic.	$350,000 for trail and abutments, $150,000 for "adopt a bridge" relocation and modifications, $800,000-$2,000,000 for new manufactured bridges.
Stream Corridor	Vaquero Pky.	E. Valley Center	1.74	Connects from future regional park to the North.	$220,000
W. Garfield St.	Cottonwood Rd.	S. 11th Ave.	2.5	Identified in MSU campus plan as future bicycle/pedestrian corridor.	$600,000
W. Kagy Blvd.	S. 19th Ave.	S. 3rd Ave.	1	Connection to MSU/Stadium	$250,000

5.4.5 Bicycle Parking Recommendations:

Adequate bicycle parking is as equally important as the quality of bicycle facilities on the road. The recommendations for bicycle parking are separated into three categories. First, the optimal type of bicycle rack is recommended, followed by locations that are deficient in bicycle parking, and lastly by recommendations for the UDO and County subdivision regulations to ensure future development is adequate with regard to bicycle parking.

Recommended Bicycle Rack Types

The Bozeman area has existing bicycle parking that varies dramatically in design and usability. The following guidelines are intended to aid selection of an appropriate rack design and still allow for more exotic or artistic rack designs provided they are designed correctly.

Bicycle Racks must be of a design that meets the requirements below:

Rack Type

The intent of the rack standards section is to ensure that required bicycle racks are designed so that bicycles may be securely locked to them without undue inconvenience and will be reasonably safeguarded from accidental damage.

Bicycle racks must hold bicycles securely, and meet the following criteria:

- Support the frame of the bicycle and not just one wheel
- Allow the frame and one wheel to be locked to the rack when both wheels are left on the bike

- Allow the frame and both wheels to be locked to the rack if the front wheel is removed
- Allow the use of either a cable or U-shaped lock
- Be securely anchored
- Be usable by bikes with no kickstand
- Be usable by bikes with water bottle cages
- Be usable by a wide variety of sizes and types of bicycle

Bicycle Parking Location

- Bicycle parking must be located within 50 feet on an entrance to the building. Bicycle parking should be permanently secured to a paved surface and be located such that it will not become buried by snow removal operations. Covered bicycle parking is recommended wherever possible.
- Bicycle parking may be provided within a building, but the location must be easily accessible.
- Bicycle Rack Design and Installation
- Bicycle racks and the area required for parking and maneuvering must meet the following standards.
- Bicycle parking spaces must be at least 6 feet long and 2 feet wide, and in covered situations the overhead clearance must be at least 7 feet.
- An aisle for bicycle maneuvering must be provided and maintained beside or between each row of bicycle parking. This aisle must be at least 5 feet wide.
- Each required bicycle parking space must be accessible without moving another bicycle.
- Areas set aside for bicycle parking must be clearly marked and reserved for bicycle parking only.

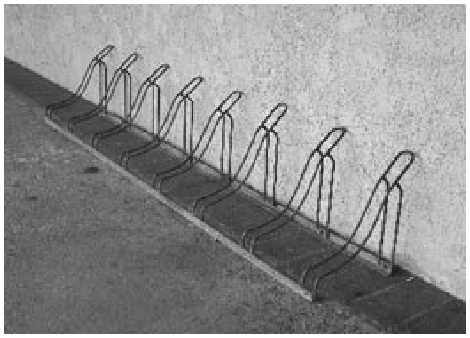
Recommended Bicycle Racks:

"Inverted U" or "Staple" Rack – This type of rack is typically secured to a concrete base and is very secure and easy to use.

Coat Hanger Rack – This rack if used properly can support a bicycle at two points and can operate fixed to a concrete base or can be moved where needed.

Post and Loop or 'Lollypop' Rack – This rack has many of the same characteristics as the Inverted U rack, but is more compact. This type of rack can be installed in series (shown) or along a curb line in the sidewalk furnishing zone.

Discouraged Bicycle Racks



Wheelbender Rack – This rack only supports the wheel of the bicycle and can cause serious damage to the bicycle if twisted while secured in the rack. This rack also does not work with all types of locks.

Comb Rack – This rack suffers from many of the same shortcomings as the wheelbender type rack where only the front or rear wheel of the bicycle is supported. Many users of this rack type lift there bicycle over the top and rest the frame on the rack to allow use of a bicycle lock.

Wave Rack – To properly use this rack the cyclist places the bicycle through the 'wave' pattern where it is only supported at one point. Bicycles parked in these racks are unstable and frequently tip over. Many cyclists park their bicycle sideways in this rack to gain stability, thereby reducing the capacity by 60-80 percent.

Locations Deficient in Bicycle Parking

The following locations are high-use areas that lack adequate numbers of bicycle parking spaces:

Table 5-9
Bicycle Parking Needed

Location	Notes
New City Library	Racks are constantly overflowing even in inclimate weather. Additional high-quality bicycle parking needed near main entrance of structure.
County Courthouse	Two racks available, additional short-term parking is needed for the public, long-term secure parking is needed for employees.
Downtown Bozeman	Overall numbers of racks are insufficient to meet demand. New racks of the existing design should be installed on Main Street and all cross-streets where space permits.
MSU Library	A new bicycle parking area is recommended near the front entrance to the library.
Hawthorne School	Upgraded bicycle parking is needed with additional racks and a concrete base
Irving School	Upgraded bicycle parking is needed with additional racks and a concrete base
Longfellow School	Upgraded bicycle parking is needed with additional racks and a concrete base

Recommended Bicycle Parking Ordinance (City of Bozeman)

It is proposed that the City of Bozeman incorporate the following into the Unified Development Ordinance section 18.46.040 E. The existing Mixed-Use Zoning District should also reference this section.

Bicycle Parking Required

Minimum Requirements – The number of spaces shown in the accompanying tables shall be provided.

Short Term Bicycle Parking - Bicycle parking meant to accommodate visitors, customers, and others expected to depart within two hours

Table 5-10
Short Term Bicycle Parking Requirements

Use Type	Required Bicycle Parking Spaces
Bank, financial institutions	10 percent of required auto parking
Church	10 percent of required auto parking
Community or recreation center	15 percent of required auto parking
Medical and dental offices	15 percent of required auto parking
Manufacturing and industrial uses	1 per 5,000 sq ft of floor space
Motels, Hotels	1 per 10 rooms
Commercial Office	The greater of 2 or 20 percent of required auto parking
Restaurants, cafes, bars and similar uses	10 percent of required auto parking
Retail store and service establishments	10 percent of required auto parking
Schools Elementary and/or Junior High	1 per 5 students
Schools a. Senior High b. Business or similar school	1 per 10 students
Theater, Auditorium or similar	The greater of 10 spaces or 5 percent of seating capacity

Long Term Bicycle Parking - Bicycle parking meant to accommodate employees, students, residents, commuters, and others expected to park more than two hours. This parking is to be provided in a secure, weather-protected manner and location.

Table 5-11
Long Term Bicycle Parking Requirements

Use Type	Required Bicycle Parking Spaces
Residential Categories Mulit-Family Single Family	 The greater of 2, or 1 per unit (if no garage is available) None
Commercial Office	The greater of 2 or 10 percent of required auto parking
Restaurants, cafes, bars and similar uses	The greater of 2 or 5 percent of required auto parking
Retail store and service establishments	The greater of 2 or 5 percent of required auto parking

The guidelines for bicycle rack type and location should be inserted in the UDO also to aid developers in rack selection and sitting.

Recommended Bicycle Parking (Gallatin County)

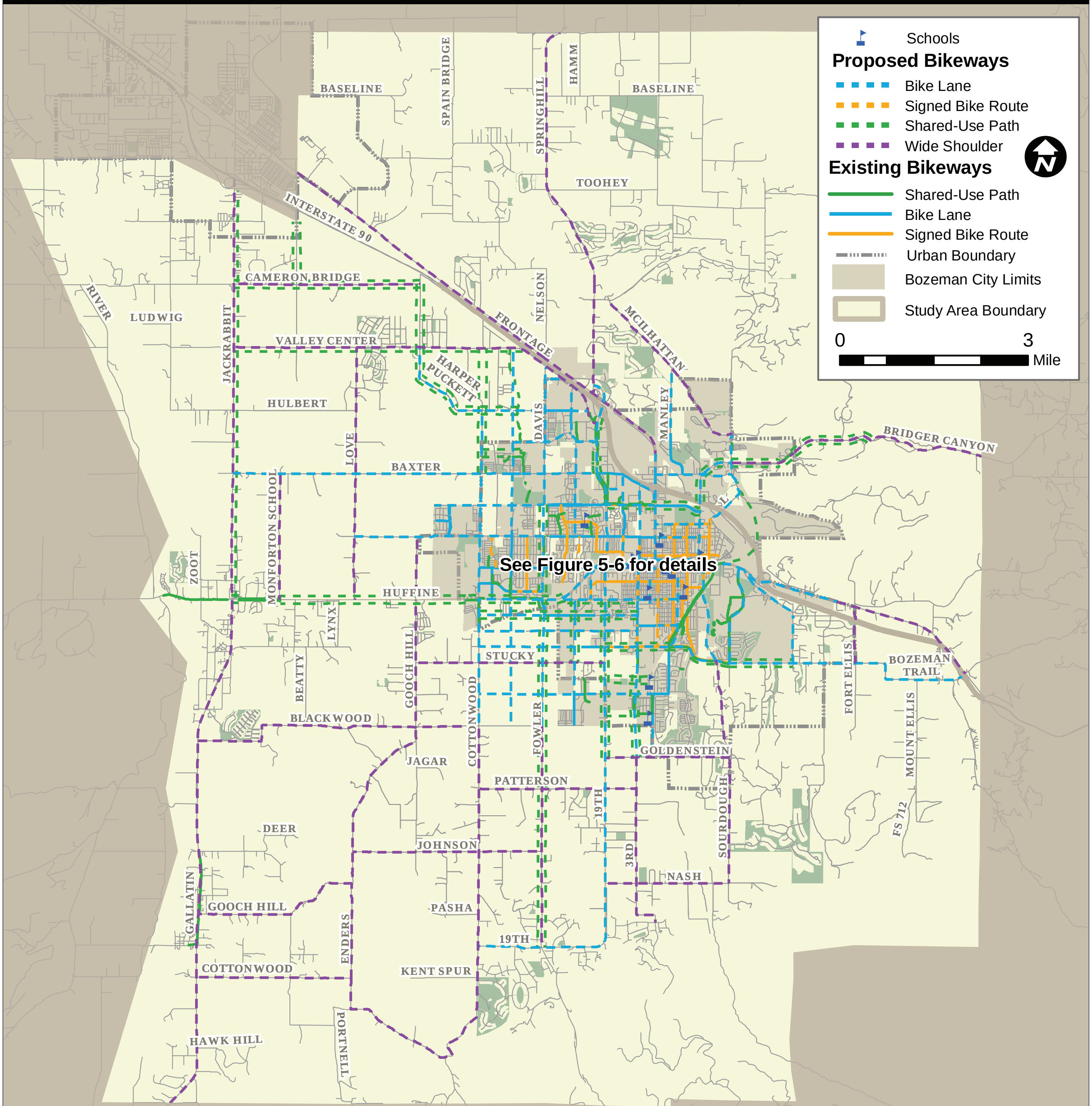
It is proposed that Gallatin County incorporate the same bicycle parking requirements as stated above into existing zoning districts where commercial uses are permitted. Additionally, Gallatin County should incorporate bicycle parking requirements into any proposed zoning districts or County-wide zoning efforts for commercial areas. Only those bicycle parking requirements pertaining to allowed uses for each zoning district should be included for that district.

5.5 Recommended Equestrian Facility Improvements

The *Greater Bozeman Area Transportation Plan* acknowledges that equestrians are users of the transportation system and does not make any recommendation to restrict equestrian access on trails, paths, or roadways where governing body deems appropriate. Equestrian facilities, similar to bicycle and pedestrian facilities, can serve both recreational and transportation uses. This document acknowledges several key destinations for equestrians within the study area including the Gallatin County Fairgrounds, parts of Montana State University, Equine Boarding/Training Facilities, and several popular trailhead facilities.

Planning efforts and facility recommendations for equestrian users are expected to be summarized in an update or addendum to the Bozeman Parks, Recreation, Open Space, & Trails (PROST) Plan, and the Gallatin County Interconnect Plan. Equestrian facility improvements shall complement, be consistent with, and implement equestrian facilities as identified in any officially adopted recreation and/or trails plan.

Recommend Study Area Bicycle Network Improvements



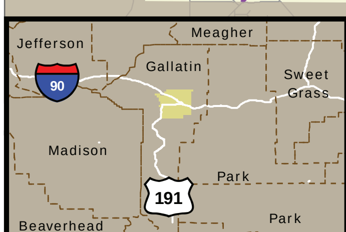
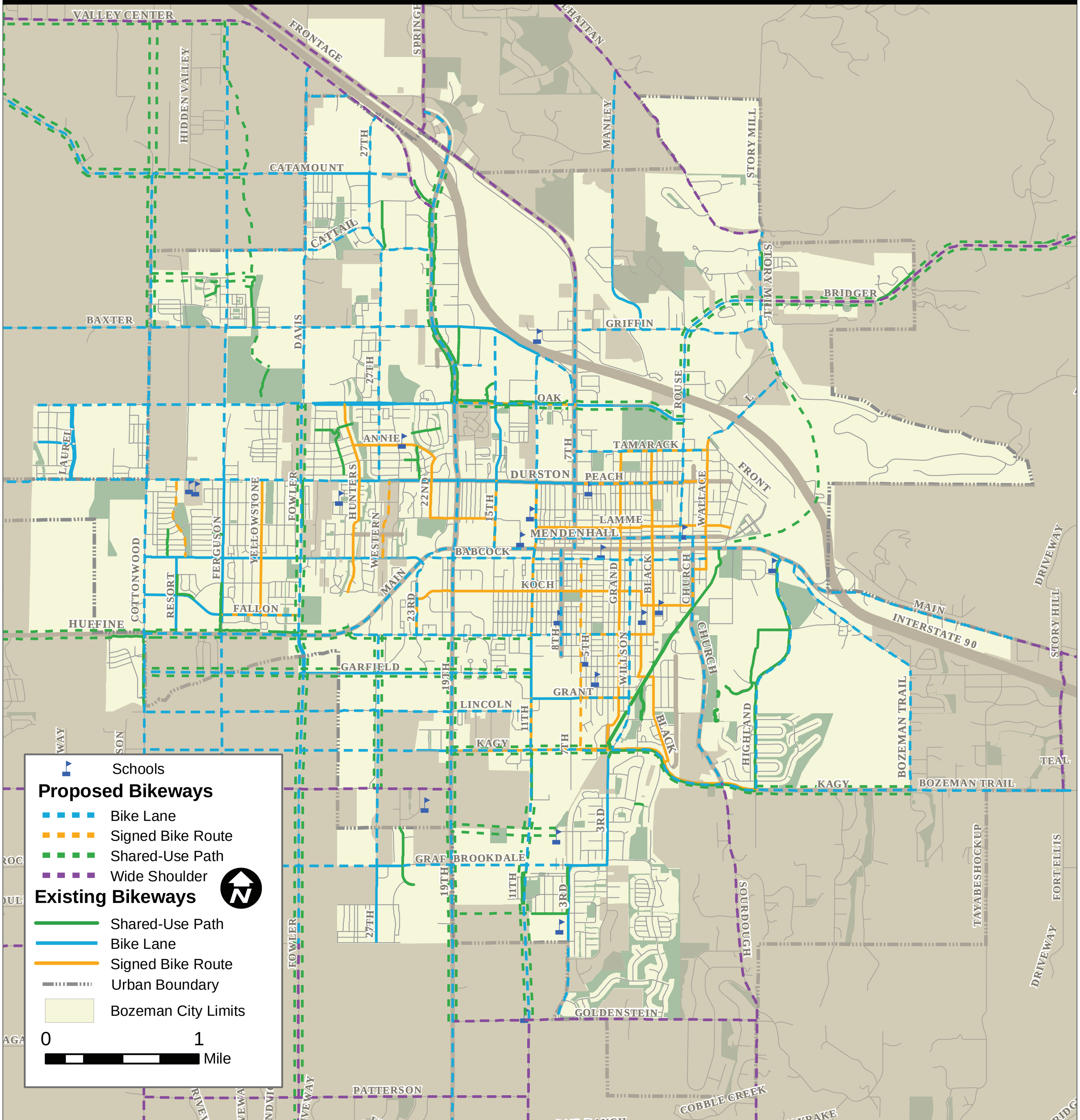


FIGURE 5-5
Recommend Study Area Bicycle Network Improvements
January 2009

Data Provided by: City of Bozeman, Alta Planning & Design
Map Prepared by: Alta Planning+Design January, 2009

Greater Bozeman Area Transportation Plan

Recommended Bozeman Bicycle Network Improvements



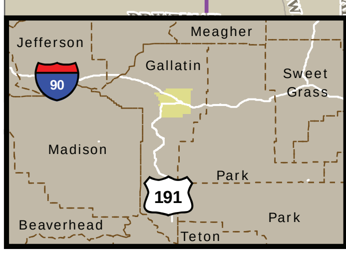
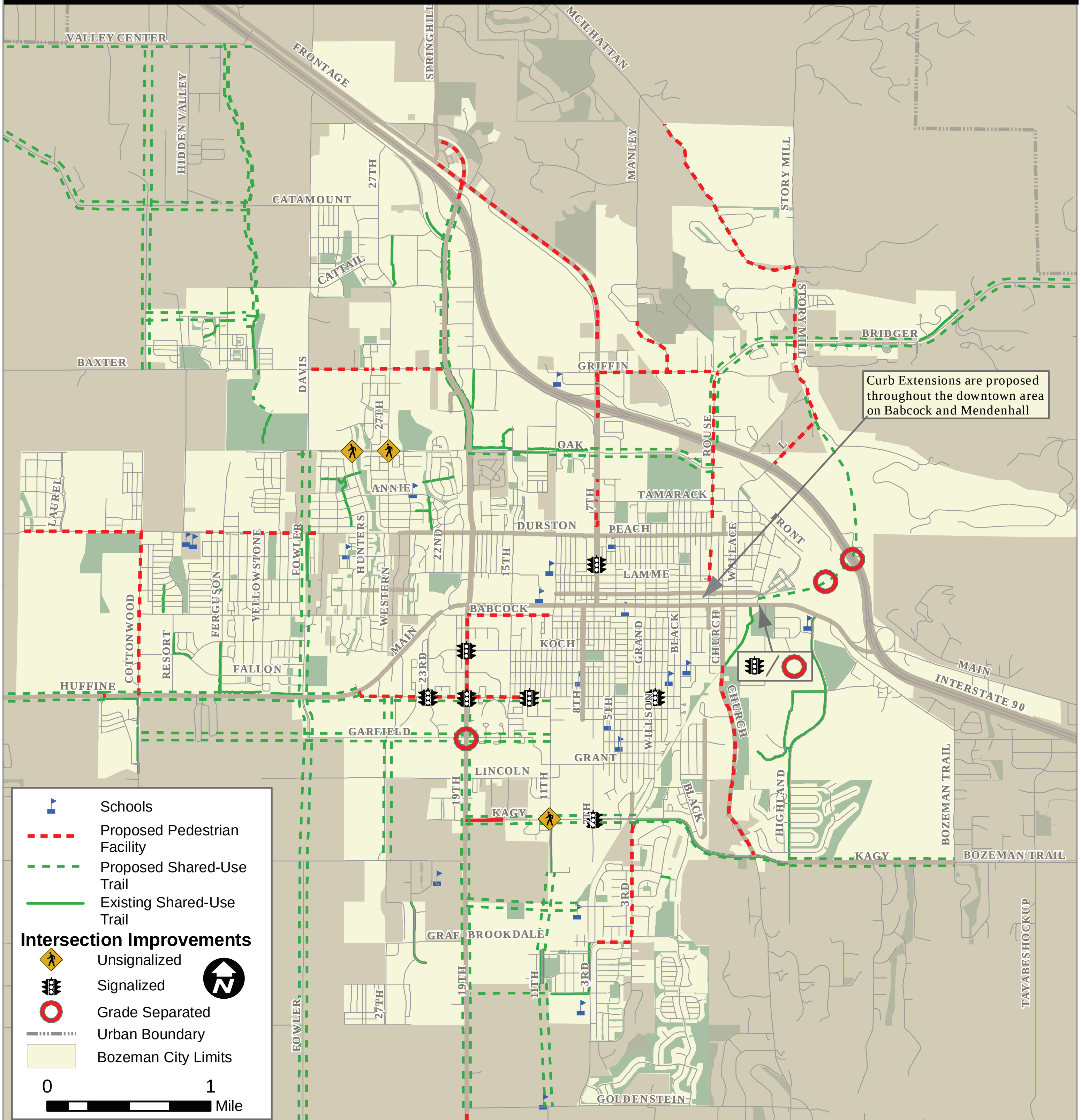


FIGURE 5-6
Recommended Bozeman Bicycle Network Improvements
January 2009
Data Provided by: City of Bozeman, Alta Planning & Design
Map Prepared by: Alta Planning+Design January, 2009

Greater Bozeman Area Transportation Plan

alta PLANNING + DESIGN

Recommended Bozeman Pedestrian Network Improvements



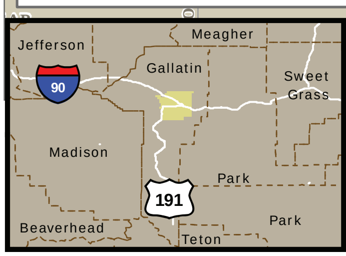


FIGURE 5-7
Recommended Bozeman Pedestrian Network Improvements
January 2009
Data Provided by: City of Bozeman, Alta Planning & Design
Map Prepared by: Alta Planning+Design January, 2009

Greater Bozeman Area Transportation Plan

alta PLANNING + DESIGN

6.1 COMPLETE STREET GUIDELINES

A complete street is one that is designed and operated to safely accommodate all users, including but not limited to: motorists, pedestrians, bicyclists, transit, and people of all ages and abilities. A complete streets philosophy causes transportation agencies to design and operate the entire right of way to encompass users of all types and to promote safe access and travel for the users. Complete streets ensure that the streets are safe for motorists, transit, pedestrians, bicyclists, children, the elderly, people with disabilities, and all users.

A complete street is comprised of many different elements; these elements may include, but are not limited to: sidewalks, bike lanes, crosswalks, wide shoulders, medians, bus pullouts, special bus lanes, raised crosswalks, audible pedestrian signals, sidewalk bulb-outs, and more. The elements that are used can vary from project to project, but the end result is still to achieve a connected network that is safe and effective for all modes of travel. A Complete Street accommodates the needs of all modes and users.

6.1.1 Elements of Complete Streets

Complete streets contain standard elements that together, create an effective and adoptable facility that benefits all transportation system users. Complete street guidelines contribute to a comprehensive, integrated, and connected network. A complete street concept also recognizes the need for flexibility: that all streets are different and user needs should be balanced. Any exceptions to complete street implementation must be clearly and specifically stated within the guideline and require high-level approvals so that there is no confusion what type of design is required. The design must fit in with the context of the community while using the latest and best standards.

Standards within the guidelines must be put in place to ensure that an effective guideline is created. The guideline must create a network that is complete and connected while still allowing for flexibility within the design. All streets are unique and require different levels of attention, so the guideline must be flexible enough to accommodate all types of roads and be adoptable by every agency.

Major street improvements are not a requirement through maintenance activities and should not be expected. Maintenance activities do present some opportunities that can improve the environment for other roadway users. While the construction of a sidewalk is not appropriate as part of maintenance activities, facilities such as improved crosswalks, or bike lanes, or a shoulder stripe may be included in a routine re-stripe of a roadway if adequate space exists and the facility is designated to have such facilities in the Bozeman Area Transportation Plan. For additional examples of improvements that could be associated with various roadway maintenance activities, see **Section 6.6**.

6.1.2 Recommendation

It is recommended that the City of Bozeman and Gallatin County adopt the following complete streets guidelines:

> The City of Bozeman and Gallatin County will plan for, design, construct, operate, and maintain appropriate facilities for pedestrians, bicyclists, transit vehicles and riders, children, the elderly, and people with disabilities in all new construction, maintenance activities, and retrofit or reconstruction projects subject to the exceptions contained herein.
>
> These jurisdictions will incorporate Complete Streets principles into: The Greater Bozeman Area Transportation Plan, the Bozeman 2020 Community Plan, the Parks Recreation Open Space Trails (PROST) Plan, the Unified Development Ordinance (UDO), Gallatin County Subdivision Regulations, the Gallatin County Trails Plan, Gallatin County Growth Policy, Gallatin County Community/Neighborhood Plans and other plans manuals, rules, regulations and programs as appropriate.
>
> Complete Streets principles will be applied on single projects, privately funded development, and incrementally through a series of smaller improvements, operations and maintenance activities over time. All sources of transportation funding, public and private, should be drawn upon to implement Complete Streets within the Gallatin Valley. The City of Bozeman and Gallatin County believe that maximum financial flexibility is important to implement Complete Streets principles.
>
> Complete Streets principles will be applied in street construction, retrofit, reconstruction and maintenance projects except in unusual or extraordinary circumstances contained herein:
>
> 1. Bicyclists and pedestrians are prohibited by law from using the facility. In this case, alternative facilities and accommodations shall be provided within the same transportation corridor.
> 2. Where the existing right-of-way does not allow for the accommodation of all users. In this case alternatives shall be explored such as the use of revised travel lane configurations, paved shoulders, signage, traffic calming, education or enforcement to accommodate pedestrians, cyclists, transit, and persons with disabilities.
> 3. The cost of establishing bikeways or walkways or other accommodations would be disproportionate to the need, particularly if alternative facilities are available within a reasonable walking and/or bicycling distance.
> 4. Where there is no need, including future need.
> 5. Where application of Complete Streets principles is unnecessary or inappropriate because it would be contrary to public safety.
> 6. When routine maintenance is being performed.
>
> Any project that does not include complete streets principles based on the above exceptions should have said determination confirmed and filed with the City or County Commission for review.

6.1.3 Next Steps

After adoption, effective implementation of the complete streets guidelines requires additional steps to ensure success. City of Bozeman and Gallatin County will need to review their procedures and, if necessary, restructure them, to accommodate all users on every project. In addition, applicable changes to design manuals or public works standards may need to be made to fully encompass the safety and needs of all users by employing the latest in design standards and innovation. Periodic education and training of planners and engineers is also recommended to ensure the latest techniques in balancing the needs of roadway users are being applied. Finally, existing data sources and projects can be tapped to track how well the streets are serving all users.

6.2 Context Sensitive Design / Context Sensitive Solutions Guidance

6.2.1 History and Definition

The Institute of Transportation Engineers defines context sensitive solutions as a "…process of balancing the competing needs of many stakeholders starting in the earliest stages of project development. It is also flexible in the application of design controls, guidelines, and standards to design a facility that is safe for all users regardless of the mode of travel they choose."

The initial principals of Context Sensitive Solutions (CSS) came about in 1998 at the "Thinking Beyond the Pavement Conference" in Maryland. The key component to CSS is that it brings all of the stakeholders and the public together in the earliest phases of the project. Context sensitive designs incorporate a multidisciplinary design team. Residents, business owners, local institutions, city officials, and designers all have a part in the design and implementation of CSS. Addressing these needs in the early stages can save valuable time and money in the development process and can help to achieve a widely accepted product.

A Context Sensitive Design (CSD) is one that balances safety, mobility, community, and environmental goals. The idea is to achieve a design that works for all of the users and for the area. A CSD focuses not only on moving traffic, but also on pedestrians, bicycles, transit, and aesthetic issues. A properly constructed road will be safe for all users, regardless of their mode of travel which allows flexibility for its users when choosing their travel type.

A CSD should also encourage "smart growth" within the area. This refers to a type of city center growth that discourages urban sprawl by creating an area where pedestrians, bikes, transit, and vehicles can function in harmony within the network. Mixed-use development is also used in the area to allow for a variety of activities to take place. Another purpose of a CSD is to give users flexibility in the design process of transportation elements. All projects are different and should be treated as such. It is appropriate for some areas to incorporate 12' travel lanes, for example, while others may benefit more from smaller 10' lanes. Roads cannot be designed simply based on their functional classification or traffic volumes.

6.2.2 The Makeup of CSS

CSS designed roads are built with every user in mind. All users' needs are balanced when designing a road based on this approach. Moving traffic of all kinds safely and efficiently is of primary concern. Pedestrian and bicycle traffic are of just as much concern as vehicular traffic with this design. Walking and riding bikes is encouraged by using designated bike lanes and sidewalks. Road lane widths are generally decreased to promote slower traveling speeds for vehicles and to create safer crossings for pedestrians. Medians are also commonly used to make protected turning lanes for motorists and to limit unregulated turning movements.

CSS combines mixed land use with compact development to help create areas where mixed activity can be used. Mixed activity areas create a greater need for more adequate and safer pedestrian and bicycle networks. The networks should be created using a circular approach which creates connectivity to all areas within the network.

Under CSS, projects would also be designed with the context of the area in mind. Areas with historical value would see projects that utilize aesthetic touches to help preserve the historic feel and look. Areas with dense foliage would have the same types of trees and bushes planted in the area. Design flexibility is another key component to CSS designs. Road designers are allowed to have flexibility in their design which can be tailored to the specific context. CSS designs help blend roadways and networks into the area giving them a more natural appeal.

Below is an example of CSS being applied to Lyndale Avenue on US Highway 12 in Helena. The before photo shows a deteriorating roadway with a raised median, sidewalk, limited shoulder space, and poor aesthetic appeal. The after photo shows a context sensitive roadway that implements a landscaped raised median, larger shoulder area, sidewalk, updated guardrail, bicycle and pedestrian underpass, and updated lighting. This roadway now adds greater aesthetic value to the Great Northern Town Center area of Helena.

It should be noted that promoting slower traveling speeds, which is a common CSS attribute, does have an effect on the capacity of the roadway. A discussion on the relationship between speed and capacity can be found in **Chapter 4**.

Before

After

Photos courtesy of MDT

6.2.3 Recommendation

It is recommended the CSS principles and procedures be considered in all transportation projects. This complements the aforementioned concept of Complete Streets. Direct, honest, and meaningful dialogue at the beginning of a transportation project can lead to a successful end product and serve to build consensus going forward as the community grows.

6.3 MDT CURRENT PRACTICES

The following is MDT's policy on context sensitive solutions:

- **Start early –** Making context-sensitive solutions part of our culture means beginning early in the project selection process and continuing on through design, construction and maintenance with consideration for community and customer values and needs.

- **Involve local government and citizens –** To help the process get off to the best possible start, remember to include all affected parties (e.g. local government) and those with a partnership interest (e.g. Federal Highway Administration.) In fact, to make this concept work, local government and citizens must be a genuine part of the process and feel they have been heard…otherwise we are just offering lip service.

- **Balance wants, needs, money and the law –** Since the availability of transportation funds will also continue to be a major factor affecting decision-making during the project development process, balancing the needs of the community with safety/mobility and multiple project needs will certainly challenge the transportation designers of the future. And, of course, any context-sensitive solution must be accomplished within the parameters of existing laws, rules and regulations.

- **Think "outside the box"– innovation is key –** No "cookie cutter" approach is available on exactly how to approach context-sensitive solutions.

- **Listen and keep an open mind –** Be willing to listen to our customers – some of our best solutions come from them. Individuals and communities will have different ideas on what constitutes the ideal context sensitive solution in any given situation. The fact that there are differences does not mean there is a "right" or "wrong" outcome.

- **Support, teamwork and communication –** To make this policy work at MDT, all staff need to support context-sensitive solutions, recognize the physical and financial limitations involved, and communicate as a team to make the best possible decision.

6.3.1 Examples of Montana Based CSS Projects

The picture below shows North Main Street located in Helena. This road was previously a two-lane country road with no median, no sidewalks, and limited shoulders. The context sensitive design is complete with four travel lanes, a landscaped raised median, curb and gutter, and sidewalks.

Photo courtesy of MDT

The following is an example located on Main Street in Boulder Montana. This context sensitive design of the roadway included a raised landscaped median, sidewalks, curb and gutter, and shoulder area.

Photo courtesy of MDT

The project shown below is located on Woodward Avenue in Absorkee and received an award from the *AASHTO Center for Environmental Excellence* for "Best Practices in Context Sensitive Solutions". The award stated that, "…the Woodward Avenue Project represents an absolutely remarkable example of a transportation agency going the extra mile to address the needs of a small community…"

Photo courtesy of MDT

The following project is located on US Highway 92 between Evaro and Polson. The design for the corridor was said to be a "hallmark of context sensitive design" by the Federal Highway Administration and won a national award in June, 2008.

Photo courtesy of MDT

Main Street in Bozeman is another example of a context sensitive design. In the beginning phases of this project, a number of design features were proposed to help alleviate traffic congestion and increase safety. MDT proposed a three-lane configuration with raised median and limited left turns. At the request of the community and by vote of the Bozeman City Commission, it was determined that this corridor would be left as a four-lane configuration. A raised median and limited left turns were also not incorporated in this project due to community response. Features that were included in this project were the addition of count-down walk/don't walk signs, the addition of colored pedestrian crossings, and the replacement of traffic signals.

Photo courtesy of MDT

6.3.2 Other Programs and Policies

MDT has a number of other programs and policies that are in place to aid in the design and funding process that helps to encourage multimodal transportation. One of these programs is MDT's Community Transportation Enhancement Program (CTEP). This program is defined by MDT as "…a Montana program that funds transportation related projects designed to strengthen the cultural, aesthetic, and environmental aspects of Montana's intermodal transportation system." CTEP funds are sub-allocated to local and tribal governments based on population. Since CTEP was established in 1992, local and tribal officials have directed about half of all CTEP funds have been directed to bicycle and pedestrian projects.

Montana also has a multimodal transportation policy plan called TranPlan 21. TranPlan 21 was created in 1995 with an update occurring in 2002. A recent amendment occurred in March 2008 to update the plan to meet current requirements. TranPlan 21 is a long-range transportation policy plan intended to identify transportation issues, identify needs and priorities (both of the public and stakeholder), and establish programs and policies. The plan serves as a guide for MDT for the development and management of multimodal transportation.

In addition to CTEP funding and the multimodal transportation policy plan TransPlan 21, MDT also manages several transit programs, the state Safe Routes to School Program, and sponsors courses in bicyclist and pedestrian accommodation design.

Projects developed on routes under MDT's jurisdiction within the City of Bozeman and Gallatin County must comply with applicable National Environmental Policy Act (NEPA) / Montana Environmental Policy Act (MEPA) provisions as a condition of receiving federal and state funding. In short, the NEPA/MEPA process requires that proposed projects: be developed in response to an identified purpose and need; give consideration to viable alternatives where applicable; undergo an evaluation for potential environmental effects; and be duly coordinated with the public and involved agencies. As part of the required project coordination activities for these environmental compliance processes, local policies and plans will be considered during the project development phase.

6.4 Level of Service Guidelines

Level of service (LOS) is a qualitative measure developed by the transportation profession to quantify driver perception for such elements as travel time, number of stops, total amount of stopped delay, and impediments caused by other vehicles. It provides a scale that is intended to match the perception by motorists of the operation of the intersection. LOS provides a means for identifying intersections that are experiencing operational difficulties, as well as providing a scale to compare intersections with each other. The LOS scale represents the full range of operating conditions. The scale is based on the ability of an intersection or street segment to accommodate the amount of traffic using it. LOS values range from an "A" which is the best performing value and has free flow characteristics, to an "F" which represents the worst performing value and has traffic that flows at extremely slow speeds and is considered to be in a forced or breakdown state.

6.4.1 Roadway LOS vs. Intersection LOS

Roadway LOS:

In order to calculate the LOS of a roadway, a number of characteristics must be looked at. Factors such as lane widths, lateral clearances, access frequency, terrain, heavy vehicle traffic, and driver population characteristics are used to establish base conditions for a roadway. Once these factors are determined, the free-flow speed can be determined. The free-flow speed is the mean speed of traffic on the road when the flow rates are low. After the free-flow speed is determined, the flow rate can be calculated. To determine the flow rate, the highest volume in a 24-hour period (peak-hour volume) is used, with adjustments being made for hourly variation, heavy vehicle traffic, and driver characteristics. Once these parameters are defined, the LOS for the roadway can be calculated using an additional set of calculated factors.

The primary factor for calculating roadway LOS is *percent time delay*. *Percent time delay* is defined as the average percent of the total travel time that all motorists are delayed while traveling in platoons due to the inability to pass. Multi-lane highways have a demand for passing that increases as the traffic volume increases. However, the opportunities for passing decrease as the traffic volume increases. This effect causes the LOS to decrease as the traffic levels increase. The secondary factors that go into LOS calculations are *average travel speed* and *capacity utilization*. *Average travel speed* is used to determine the mobility of the roadway. *Capacity utilization* represents accessibility to the roadway and is defined as the ratio of the demand flow rate to the capacity of the facility. Other factors that go into LOS calculations include *terrain type*, *lane and shoulder widths*, *heavy vehicle traffic*, and the *peak hour factor*. All of these parameters are used to calculate a single LOS that is used to represent the overall characteristic of the roadway.

The *Highway Capacity Manual – 2000* defines the LOS categories for roadways as follows:

- **LOS A** represents free flow. Individual users are virtually unaffected by the presence of others in the traffic stream. Freedom to select desired speeds and to maneuver within the traffic stream is extremely high. The general level of comfort and convenience provided to the motorist, passenger, or pedestrian is excellent. **(Free flow)**

- **LOS B** is in the range of stable flow, but the presence of other users in the traffic stream begins to be noticeable. Freedom to select desire speeds is relatively unaffected, but there is a slight decline in the freedom to maneuver within the traffic stream from LOS A. The level of comfort and convenience provided is somewhat less than at LOS A, because the presence of others in the traffic stream begins to affect individual behavior. **(Reasonably free flow)**

- **LOS C** is in the range of stable flow, but marks the beginning of the range of flow in which the operation of individual users becomes significantly affected by interactions with others in the traffic stream. The selection of speed is now affected by the presence of others, and maneuvering within the traffic stream requires substantial vigilance on the part of the user. The general level of comfort and convenience declines noticeably at this level. **(Stable flow)**

- **LOS D** represents high-density, but stable, flow. Speed and freedom to maneuver are severely restricted, and the driver or pedestrian experiences a generally poor level of comfort and convenience. Small increases in traffic flow will generally cause operational problems at this level. **(Approaching unstable flow)**

- **LOS E** represents operating conditions at or near the capacity level. All speeds are reduced to a low, but relatively uniform value. Freedom to maneuver within the traffic stream is extremely difficult, and it is generally accomplished by forcing a vehicle or pedestrian to "give way" to accommodate such maneuvers. Comfort and convenience levels are extremely poor, and driver or pedestrian frustration is generally high. Operations at this level are usually unstable, because even small increases in flow or minor perturbations within the traffic stream will cause breakdowns. **(Unstable flow)**

- **LOS F** is used to define forced or breakdown flow. This condition exists wherever the amount of traffic approaching a point exceeds the amount which can traverse it and queues begin to form. Operations within the queue are characterized by stopping and starting. Over and over, vehicles may progress at reasonable speeds for several hundred feet or more, then be required to stop. Level-of-service F is used to describe operating conditions within the queue, as well as the point of the breakdown. It should be noted, however, that in many cases once free of the queue, traffic may resume to normal conditions quite rapidly. **(Forced or breakdown flow)**

Intersection LOS:

The current practice to analyze intersection LOS is to use average vehicle delay to determine the LOS of the intersection as a whole. Individual LOS values can also be determined for each approach leg and turning lane for intersections based on the average vehicle delay on that lane. There are multiple types of intersections, all of which receive a LOS value based on vehicle delay.

Signalized intersections are considered to be ones that have a signal control for every leg of the intersection. This type of intersection takes an average of the delay for each vehicle that uses the intersection and determines the LOS based on that average vehicle delay. An unsignalized intersection is one that does not have traffic signal control at the intersection. These intersections use the average vehicle delay for the entire intersection to determine the LOS (for four-way stop-controlled). Two-way stop-controlled (TWSC) intersections utilize stop control on the minor legs of the intersection while allowing free flow characteristics on the major legs. TWSC intersections take the average vehicle delay experienced on the most constrained approach, rather than the average vehicle delay for the entire intersection, to determine the LOS of the intersection. This can cause problems at intersections with high volumes of traffic along the uncontrolled major legs. Left turns off of the minor approach legs may be difficult at these intersections, which may cause high delay values and poor levels of service. The LOS for this type of intersection is based on the LOS for the worst case minor approach leg. Under these traffic conditions the worst case minor approach leg can easily have a high delay from a low number of vehicles wanting to make a left-turn onto the major approach; this may result in a poor LOS for the entire intersection.

A description and average delay range for each LOS value for signalized and unsignalized intersections, as defined by the *Highway Capacity Manual (HCM) 2000*, is found in **Table 6-1** on the following page.

An intersection that has a roundabout also has a LOS value associated with it. The LOS for these types of intersections is more difficult to determine than that of a standard intersection. While programs such as *SIDRA, RODEL,* and *ARCADY* exist to help analyze roundabouts, the results from these programs can vary greatly. These programs generally use a form of average vehicle delay as their main component for LOS determination. The variance between the different programs lies in how each program calculates the capacity of the intersection, which is a factor used in conjunction with others to determine the average vehicle delay.

The average vehicle delay at a roundabout is comprised of two components: *queuing delay* and *geometric delay*. *Queuing delay* is the delay a vehicle experiences while outside of the roundabout waiting to enter. This type of delay is similar to the delay experienced by vehicles in unsignalized and signalized intersections. Queuing delay represents the delay experienced by the driver waiting to enter the intersection.

Geometric delay is the delay experienced while negotiating through the roundabout. This type of delay is generally very small, especially at small roundabouts. However, the geometric delay can play a big part in LOS determination at intersections with roundabouts installed at locations with high speed approaches and a large center island. This type of intersection requires a driver to drastically slow down to maneuver through the roundabout resulting in increased geometric delay times. Combining queuing delay and geometric delay gives a total average vehicle delay which is used to determine the LOS of the intersection.

Table 6-1
Intersection Level of Service (LOS) Criteria

LOS	Unsignalized Intersections		Signalized Intersections	
	Description	Average Delay (sec/veh)	Description	Average Delay (sec/veh)
A	Little or no conflicting traffic for minor street approach.	< 10	Uncongested operations; all queues clear in a single cycle.	< 10
B	Minor street approach begins to notice presence of available gaps.	10 – 15	Very light congestion; an occasional phase is fully utilized.	10 – 20
C	Minor street approach begins experiencing delay while waiting for available gaps.	15 – 25	Light congestion; occasional queues on approaches.	20 – 35
D	Minor street approach experiences queuing due to a reduction in available gaps.	25 – 35	Significant congestion on critical approaches, but intersection is functional.	35 – 55
E	Extensive minor street queuing due to insufficient gaps.	35 – 50	Severe congestion with some longstanding queues on critical approaches.	55 - 80
F	Insufficient gaps of sufficient size to allow minor street traffic to safely cross through major traffic stream.	> 50	Total breakdown, stop-and-go operation.	> 80

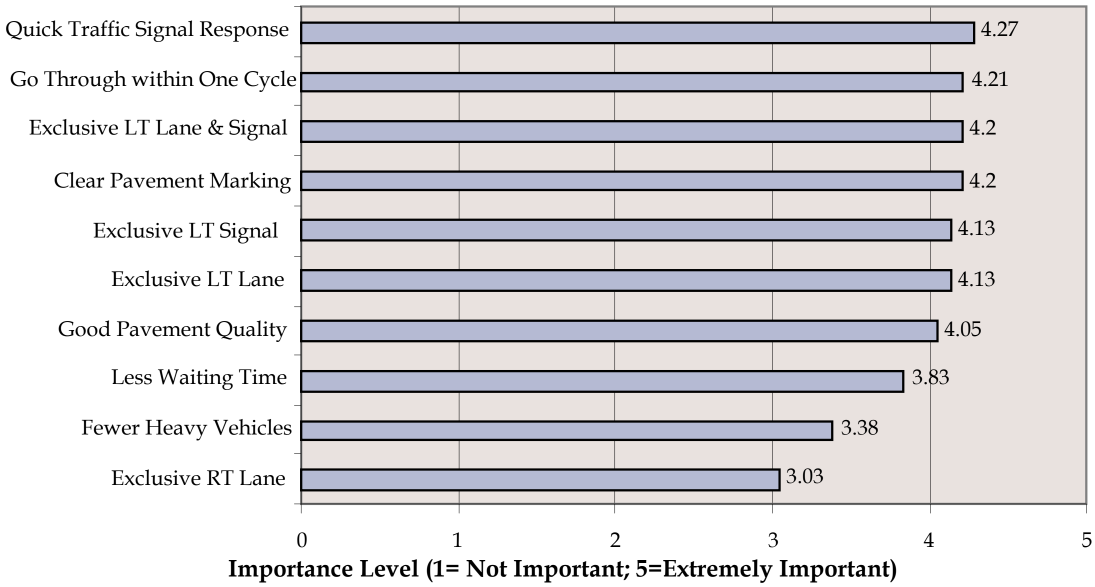
6.4.2 User Perceived LOS

The LOS of a roadway or intersection is intended to serve as a qualitative measure of the performance level of a roadway or intersection that represents driver perception. LOS is determined solely from the average vehicle delay at an intersection. While delay may be a part of determining user perceived LOS, it may not be the primary factor for a driver's perception of the intersection's performance. Multiple traffic and non-traffic related factors may go into a drivers perceived LOS for an intersection. These factors include traffic signal efficiency, pavement conditions, left-turn treatment, delay, and overall safety of the intersection. A study done by the University of Hawaii at Manoa found that safety was stated to be "three to six times more important than delay" when evaluating LOS. A ranking of driver importance factors determined from this study can be found in **Figure 6-1**.

Under the current HCM, all intersections of the same type (i.e. signalized, unsignalized…) that have the same average vehicle delay, would receive the same LOS ranking, independent of other factors found to be important to driver perceived LOS. While LOS values are intended to represent a driver's perception of the intersection's overall performance level, delay is the only tool used to determine the LOS. Delay is, however, based on a number of factors. Changes to intersection geometry, including addition or deletion of turn-lanes or protected turn phases, can affect the average vehicle delay, and therefore the LOS of that intersection. While protected left-turn signals and designated turn-lanes change average vehicle delay values, these factors may affect driver perceived LOS values more dramatically. Two intersections that have the same average vehicle delay, and therefore the same LOS, associated with them may have a significantly different driver perceived LOS.

Figure 6-1

Driver Perceived Intersection Importance Levels



- "User Perceptions of Signalized Intersection Level of Service", Zhang & Prevedouros

6.4.3 Bozeman's Current LOS Standard

Bozeman's *Unified Development Ordinance (UDO)* defines a basic set of rules for land development and subdividing in Bozeman. The *UDO* specifies street improvement standards that must be met by the developer. The level of service standard as defined by the *UDO* is stated below:

> *"Streets and intersection level of service "C" shall be the design and operational objective, and under no conditions will less than level of service "D" be accepted. All arterial and collector streets, and movements on intersection approach legs designated as arterial or collector streets, shall operate at a minimum level of service "C". The design year for necessary improvements shall be a minimum of fifteen years following construction of said improvements."*
>
> *- Bozeman Unified Development Ordinance, Section 18.44.060.D*

The current application of the Bozeman UDO has been subject to interpretation. In practice, the UDO is interpreted by City staff under two different scenarios as described below:

Scenario 1: Existing intersection operation is a LOS D or better and development traffic impact continues the LOS at a D or better, then no mitigation is being required.

Scenario 2: Pre-development or post-development analysis shows intersection operations below LOS D, then intersection mitigation (i.e. improvements) must achieve a LOS of C over the next fifteen years.

6.4.4 Recommended Revised LOS Standard

A revised LOS standard for development in Bozeman is suggested and defined in this section. These revised standards should be used to determine if there are sufficient transportation improvements being made to meet the requirements for proposed developments. LOS values shall be determined by using the methods defined by the *Highway Capacity Manual – 2000*. A development shall be approved only if the LOS requirements are met by the developer through mitigation measures. A list of revised LOS standards is listed below:

- Signalized intersections shall have a minimum acceptable LOS of "C" for the intersection as a whole; individual movement and approach leg LOS lower than "C" shall be allowed such that the total intersection LOS is a "C" or higher.
- Unsignalized intersections shall have a minimum acceptable LOS of "C" for the intersection as a whole for four-way stop controlled; individual movement and approach leg LOS lower than "C" shall be allowed such that the total intersection LOS is a "C" or higher.
- Two-way stop-controlled (TWSC) intersections shall have a minimum acceptable LOS of "C" or higher for the stop-controlled, minor legs.
- An intersection with a roundabout shall have a minimum acceptable LOS of "C" or higher for the intersection as a whole.

It is recommended that the entire intersection LOS be the controlling factor in determining if an intersection performs at a proper level for all intersections except a "two-way, stop-controlled (TWSC)" intersection. In the TWSC scenario, the intersection LOS should be for the stop-controlled, minor legs.

It is recommended, however, that individual movement and approach LOS still be calculated and presented in the various traffic impact studies to determine if the network as a whole functions properly and if additional steps need be looked at.

6.4.5 Bicycle Level of Service

There are two established tools available for estimating the compatibility of roads for bicycling: the first, developed by Alex Sorton and others at the Northwestern University's Traffic Institute in the 1980's, is called the "Bicycle Stress Level" analysis (hereafter referred to as "Sorton"). The second, called the "Bicycle Compatibility Index", (BCI) was developed for the FHWA by David Harkey and others at the University of North Carolina's Highway Safety Research Center, and became available in late 1998.

Both models are based on many years of careful research and surveying of bicyclists under simulated bicycling conditions, and can produce worthwhile results. More often, unfortunately, transportation planners are presented with at least two significant barriers to implementation. First, both the Sorton and the BCI are expressly intended for urban and suburban application, and are therefore of very limited utility for use in rural areas. Second, many agencies that wish to estimate bicycle compatibility on their roads do not possess the rather extensive data required for employing the BCI model.

Sorton

The Sorton model is significantly simpler than the BCI in that it measures only three parameters: curb lane volume, curb lane width, and motor vehicle speed. The following table relates each parameter's measurement with a corresponding stress level, with 1 being low stress (safe) and 5 being high stress (unsafe).

Variable	Quantitative Value	Stress Analysis
Curb Lane Volume (vehicles/hr)	≤ 50	1
	150	2
	250	3
	350	4
	≥ 450	5
Curb Lane Width (m)	≤ 4.6	1
	4.3	2
	4	3
	3.7	4
	≥ 3.3	5
Motor Vehicle Speed (km/hr)	≤ 40	1
	50	2
	60	3
	65	4
	≥ 75	5

Source: University of North Carolina Highway Safety Research Center

Bicycle Compatibility Index

The BCI considers the following parameters:

1. Number of lanes (in one direction)
2. Width of the curb lane (ft)
3. Bicycle lane width (ft)
4. Paved shoulder width (ft)
5. Residential development (y/n)
6. Speed limit (mi/h)
7. 85th percentile speed (mi/h)
8. ADT
9. Large truck % (HV)
10. Right turn % (R)
11. Parking lane (y/n)
12. Occupancy (%)
13. Parking time limit (minutes)

These thirteen parameters are converted into data that are then entered into a formula. The outputs of this formula, normally ranging from about 1 to 6, are converted to letter grades ranging from level of service 'A' (extremely high compatibility; low output values) to 'F' (extremely low compatibility; high output values).

The Sorton method and the BCI are similar but differ in some important respects:

1. Number of parameters: The Sorton model requires fewer variables: volume, width and speed are the primary ones, and driveways, percent trucks and parking turnover are added in a non-mathematical fashion. The BCI treats nine primary variables and allows for three additional (mathematical) adjustment factors.
2. Weighting of variables: The Sorton model treats all variables equally; that is, there is no weighting. The BCI weights each parameter in relation to the others.
3. Slope / Grade: A revision of the Sorton model allows for the inclusion of slope (or grade) in the model, whereas the BCI discounts this variable.

Although the BCI provides a more sophisticated system for evaluating the compatibility of roads for bicycling, its data requirements – as mentioned – are frequently beyond the bounds of the average agency's budget and time constraints. The Sorton method is far more practical in this respect, but it is limited to urban and suburban applications.

6.5 Pedestrian and Bicycle Program & Policy Recommendations

The following education and outreach programs are designed to raise awareness of walking and bicycling; connect current and future cyclists to existing resources; educate them about their rights and responsibilities; and encourage residents to walk and bicycle more often. Key target audiences include drivers; current and potential (interested) cyclists; students, children and families; school personnel; and employees (through employer programs).

The following education and outreach programs have basic cost estimates associated with them. Since the cost to implement such programs can vary considerably depending on the availability of volunteer (versus professional) resources and available funding, an estimated range is provided according to the following ranges.

$	= Minimal to $500	Volunteer effort and low funding required
$$	= $500 to $2,500	Low amounts of funding required
$$$	= $2,500 to $10,000	Moderate amounts of funding required
$$$$	= $10,000 to $50,000	High amounts of funding required
$$$$$	= $50,000+	Very high amounts of funding required

6.5.1 Education Program Recommendations

Bike Buddy Campaign	
Target	New cyclists who are interested in using a bicycle for transportation
Primary agency	City of Bozeman
Partners	Bozeman Area Bicycle Advisory Board, Gallatin County
Key elements	Less-experienced cyclists are paired with a trained cycling mentor who assists them in route selection, training rides, reading bike maps, and gear questions in order to lower the barriers to using a bicycle for transportation.
Time frame	Spring, on-going
Cost	$ - $$ (depends on scope of program)
Potential funding sources	Bike shops (in-kind donations); transit agencies and local news outlets (donated ad space); traffic safety foundations and grant programs; businesses interested in increasing the number of employees who ride bicycles
Sample programs	http://www.bicyclealliance.org/commute/bikebuddy.html
	http://www.sfbike.org/?bikebuddy
	http://bicycling.511.org/buddy.htm

Bike Rodeos	
Target	Children and youth
Primary agency	City of Bozeman
Partners	Bozeman Police and/or Fire Department, Bozeman Area Bicycle Advisory Board, Safe Routes to School Taskforce
Key elements	Drop-in event aimed at teaching kids basic skills and safety rules. Often organized by Police or Fire Bureaus. Can include free or low-cost helmet distribution.
Time frame	Fall and spring, annually
Cost	$$-$$$ (depending on size and organization)
Potential funding sources	Bike shops (in-kind donations); transit agencies and local news outlets (donated ad space); traffic safety foundations and grant programs; hospitals and insurance companies
Sample programs	http://www.bicyclinglife.com/SafetySkills/BicycleRodeo.htm
	http://www.saferoutestoschools.org/pdfs/lessonplans/RodeoManualJune2006.pdf
	Guide to Bicycle Rodeos, by John Williams and Dan Burden. Available from the Adventure Cycling Association, PO Box 8308-Z5, Missoula, MT 59807, 800-721-8719, M-F, 8-5 Mountain time. Price $5.00.

Police Education Courses	
Target	Law enforcement agencies
Primary agency	Bozeman Police Department, Gallatin County Sheriff's Department, MSU Police Department
Partners	Bozeman Area Bicycle Advisory Board
Key elements	Pedestrian and Bicycle Law Enforcement Training Course includes a How Pedestrian and Bicycle Crashes Happen, Education on Pedestrian Laws and Bicycle Laws, and Crash Investigation and Reporting. The course can be open to all law enforcement entities for a fee, which covers instruction and materials.
Time frame	Spring, annually
Cost	$ - $$
Potential funding sources	Federal and state safety grant funding
Sample programs	http://www.bicyclinginfo.org/enforcement/training.cfm
	http://www.massbike.org/police/

Women on Bikes Program	
Target	Women who ride bicycles
Primary agency	City of Bozeman, Bozeman Area Bicycle Advisory Board
Partners	Local Bicycle Shops
Key elements	Women-only clinics, workshops, and rides, designed to be welcoming and supportive for participants at any stage of comfort. Topics may include maintenance basics, bike cleaning, riding in the rain and dark, shopping by bike, or commute tips. Rides are themed (e.g. historic houses, heritage trees, ice cream shops, rain gardens), and are low-mileage.
Time frame	Spring and summer, annually
Cost	$ - $$
Potential funding sources	Bike shops (in-kind donations); transit agencies and local news outlets (donated ad space); traffic safety foundations and grant programs;
Sample programs	http://www.portlandonline.com/transportation/index.cfm?c=44100
	http://www.toronto.ca/cycling/canbike/canbike_cffw.htm

Technical/Professional Training	
Target	Planners and traffic engineers
Primary agency	Gallatin County, City of Bozeman, Western Transportation Institute, MDT
Partners	Montana Department of Transportation, Local Engineering, Architecture, and Planning Firms.
Key elements	Agency planners and traffic engineers receive training on how to plan and build facilities to accommodate bicycles and pedestrians. Courses can be taught by experts brought in or electronically via webinars.
Time frame	As needed, annually
Cost	$-$$$ (ranging from webinar to visiting expert)
Potential funding sources	Federal and state funding
Sample programs	Federal Highway Administration's Designing Streets for Pedestrian Safety:
	http://www.fhwa.dot.gov/resourcecenter/teams/safety/0608pedsafety.pdf

Create Bike and Walking Maps	
Target	Current and potential cyclists and walkers
Primary agency	City of Bozeman – Bozeman Area Bicycle Advisory Board
Partners	Gallatin County
Key elements	Clear symbology, designations and services attractive for cyclists and walkers, good selection of routes. Continue with current map production with periodic updates, Consider map encompassing Gallatin County in the future.
Time frame	regular updates; every 3 years, or as needed.
Cost	$$ - $$$
Potential funding sources	City of Bozeman, Bike shops (in-kind donations); transit agencies and local news outlets (donated ad space); traffic safety foundations and grant programs; hospitals and insurance companies
Sample programs	http://www.sfbike.org/download/map.pdf
	http://www.cityofchicago.org/Transportation/bikemap/keymap.html
	http://www.nycbikemaps.com/

One of the most effective ways of encouraging people to bike and walk is through the use of maps and guides showing that the infrastructure exists, to demonstrate how easy it is to access different parts of the city by bike or on foot, and to highlight unique areas, shopping districts or recreational areas. Bicycling and walking maps can be used to promote tourism, encourage residents to walk, or promote local business districts. Maps can be citywide, district-specific, or neighborhood/family-friendly maps.

Diversion Class	
Target	Motorists, cyclists, and pedestrians
Primary agency	Bozeman Police Department, Gallatin County Sheriff's Department, MSU Police Department
Partners	Bozeman Area Bicycle Advisory Board
Key elements	A Share the Road class is tailored to first-time offenders of certain bicycle and pedestrian-related traffic violations, including running a stop sign/light on a bike. In lieu of the citation, cyclists, motorists and pedestrians can take the class instead. Interested citizens can take the class even if they did not receive a ticket.
Time frame	Anytime; on-going
Cost	$$ -$$$
Potential funding sources	Federal and state traffic safety funding
Sample programs	http://www.marinbike.org/Campaigns/ShareTheRoad/Index.shtml#StreetSkills
	http://www.legacyhealth.org/body.cfm?id=1928

Bozeman Bike Central Website	
Target	Current and potential cyclists
Primary agency	City of Bozeman, Gallatin County
Partners	Bozeman Area Bicycle Advisory Board
Key elements	Resources, maps and map orders, safety, events, groups. This website becomes the starting point for any bicycling related query linking to other local cycling groups and activities. This website becomes the informational clearinghouse for any bicycle or pedestrian related program/activity and is essential for Bike Week activities in May.
Time frame	Ongoing
Cost	$ - $$ (depending on design and scope)
Potential funding sources	Low cost; may not require outside funding
Sample programs	Vėlo Quėbec website: http://www.velo.qc.ca/english/home.lasso

Bozeman already has numerous resources for cyclists, and more services and resources are planned for the future. Many cyclists or potential cyclists do not know where to turn to find out about laws, events, maps, tips, and biking groups. The City of Bozeman should develop a "one stop shopping" website aimed at bicyclists. A potential name is Bozeman Bike Central, though other names could be used.

The Bozeman Bike Central website should contain:

- A list of all **bicycling groups**, including clubs, racing teams, and advocacy groups
- Information about the Bozeman Area Bicycle Advisory Board (how to get involved, meeting times and dates, agendas and minutes)
- Information about **current projects and how to get involved** (e.g. public meetings, comment periods)
- **Maps and brochures** (links to online maps and brochures, where to find in person, and how to request mailed materials)
- Links to **laws and statutes** relating to bicycling

- Information about **cycling events** (rides, classes, volunteer opportunities)
- A list of **local bike shops**, including phone number and address
- Relevant **phone numbers** (hotlines for pothole repair, parking enforcement, bike rack installation request, etc.)

The website may also feature:

- Events calendar
- Request form for route planning assistance
- Message boards
- Blog featuring stories and news
- Photo galleries from events and submitted by readers
- Popular ride routes
- Maintenance requests for bicycle facilities

Note that these additional features may increase the cost to set up and maintain the website. A one-stop bike website will not be difficult to set up, but it will only be successful if the site is both easy to use and updated regularly. Corners should not be cut in either design or in maintenance of the site and its information. All Bike Central website content should be reviewed annually for accuracy.

The bicycle community can assist in keeping the site up to date. The Bozeman Area Bicycle Advisory Board should consider adding a standing agenda item for the BAC to discuss the Bike Central website in order to hear about new content that should be added or out-of-date content that should be updated or removed.

"Lights On" Campaign	
Target	Cyclists (especially students and low-income bicycle commuters)
Primary agency	Varies
Partners	Area law enforcement, Montana State University, Bozeman Area Bicycle Advisory Board, Gallatin County
Key elements	Media outreach, enforcement, bike light giveaways or subsidies
Time frame	Fall, annually
Cost	$$ - $$$ (depends on scope of program)
Potential funding sources	Bike shops (in-kind donations); transit agencies and local news outlets (donated ad space); traffic safety foundations and grant programs; hospitals and insurance companies
Sample programs	Portland's "See & Be Seen" campaign: http://www.portlandonline.com/transportation/index.cfm?&c=deibb&a=bebfjh
	Dutch "Lights On" campaign: http://www.fietslichtaan.nl/

While Montana state law requires bicyclists to use lights at night, cyclists riding without lights are common in the Bozeman area. Many cyclists, especially students, are unaware that lights are required by law, or they have simply not taken the trouble to purchase or repair lights. Research shows that cyclists who do not use lights at night are at much greater risk of being involved in bike-car crashes. For these reasons, increasing bicycle light usage is a top priority for Bozeman, and a successful effort will reduce crash risk for bicyclists.

Every fall in the Netherlands, as days get shorter, a national "lights on" campaign reminds cyclists to use bicycle lights. This "lights on" campaign focuses several complementary strategies into a short time frame for maximum impact, pairing media messages (ads, posters, radio spots, and TV ads) with police enforcement of 'fix it' tickets.

- This poster from Portland, OR uses simple graphics to communicate the importance of using bicycle lights

A similar Lights On campaign is recommended for Bozeman. This multi-pronged outreach effort should take place every September, as the days are getting shorter and as kids and university students are returning to school.

The *Bozeman Lights On* campaign should include the following elements:

- Well-designed **graphic ads**, to be placed on transit benches, transit vehicles, and local newspapers, as well as around MSU. Ad space may be purchased or donated. Small-format ads can be placed on bike handlebars as well if desired.

- Police **enforcement of bike light laws**. This enforcement will be most likely to result in behavior change if the cyclist is able to avoid penalty if they obtain a bike light. Ideally, the police would give a warning, explain the law, and then install a bike light on the spot. If this is not possible, the cyclist should receive a 'fix it ticket' along with a coupon for a free or discounted light at a local bike shop; once the cyclist shows proof that they have purchased a bike light, their fine will be waived.

- Every fall, Dutch cyclists receive many messages to use lights, including these bike hangers

- **Partnership with local cycling groups** to get the word out to their members and partners. These groups can be counted as campaign partners at no cost to them, enhancing the campaign's credibility and community exposure. Groups should be supplied with key campaign messages to distribute with their constituents along with coupons for free or discounted bike lights.

- **Earned media outreach**: The City of Bozeman should distribute media releases with statistics about the importance of using bike lights, relevant legal statutes, and the campaign's goal, timing, activities, and partners. If possible, a meeting with local media editorial boards should be sought.

Depending on partners, volunteer capacity and interest, the *Bozeman Lights On* campaign may also include the following:

- **In-school presentations** about bike lights, including reflective material giveaways
- A **community bike light parade** with prizes
- **Discounts on bike lights** and reflective gear at local bike shops during September (publicized through the campaign outreach)
- Volunteers stationed at key intersections, trails, and on the MSU campus **who thank bicyclists using bike lights** and reward them with a small gift

"Drive Less, Live More" Campaign	
Target	Drive-alone commuters
Primary agency	City of Bozeman, Gallatin County
Partners	Bozeman Area Bicycle Advisory Board, Pedestrian Traffic Safety Committee
Key elements	Media marketing campaign and website around commute options
Time frame	On-going
Cost	$$ - $$$$ (depending on advertising strategy)
Potential funding sources	Bike shops (in-kind donations); transit agencies and local news outlets (donated ad space); traffic safety foundations and grant programs; hospitals and insurance companies
Sample programs	Drivelesslivemore.org
	Drivelesslivemore.com
	Drivelesssavemore.com

The "Drive Less, Live More" campaign website would include transit tips, facts and tools, including a commute cost calculator, trip planning assistance, links to transit and bike maps, transit schedules and updates, and bicycle trip planning information.

6.5.2 Commuting Program Recommendations

Bike to Work Week or Month	
Target	Current and potential cyclists
Primary agency	City of Bozeman, Gallatin County
Partners	Bozeman Area Bicycle Advisory Board
Key elements	Publicize Bike to Work Month in May. Offer classes, rides and events.
Time frame	May, annually
Cost	$$ - $$$ (depending on scope and length of program)
Potential funding sources	Local businesses and bike shops (in-kind or cash support); hospitals and insurance companies; City of Bozeman
Sample programs	Bay Area Bike to Work Day: http://www.bayareabikes.org/btwd/index.php
	Bike Commute Challenge (Oregon): http://www.bikecommutechallenge.com/

Many local groups and agencies currently collaborate on the area Bike to Work Week in May. Many of the programs and activities outlined in this section would be appropriate for inclusion as an activity under the Bike to Work Week organization structure. Based on the large number of potential activities it is recommended that Bike to Work Week transition to Bike Month coinciding with 'National Bike Month' in May of each year. Spreading out the activities keeps the focus on non-motorized transportation for an entire month and helps spread out volunteer resources to avoid burnout.

MSU Bike Program	
Target	Montana State University students, faculty and staff
Primary agency	MSU Planning
Partners	Student groups
Key elements	Tools and stands; mechanic services; clinics. Tie into 'Bozeman Bike Central' website.
Time frame	Ongoing
Cost	$$$
Potential funding sources	MSU parking fees
Sample programs	UC Davis Bicycle Program: http://www.taps.ucdavis.edu/bicycle/

Commuter Calculator	
Target	Commuters and Transportation Demand Management Organizations
Primary agency	City of Bozeman, Gallatin County
Partners	Bozeman Area Bicycle Advisory Board
Key elements	Cost calculator on monthly and annual commuting costs based on one's mode of transportation.
Time frame	One-time with ongoing website maintenance
Cost	$
Potential funding sources	Health agencies, pollution mitigation funds
Sample programs	Missoula In Motion commuter calculator: http://missoulainmotion.com/commuter_calculator.php

6.5.3 Enforcement Program Recommendations

Speed Limit Enforcement	
Target	Speeding motorists
Primary agency	City of Bozeman and Bozeman Police Department
Partners	Schools and community organizations
Key elements	Work with police to do targeted enforcement of speed limits on designated bikeways, near schools, and in response to cyclist/pedestrian complaints
Time frame	Anytime; on-going
Cost	$-$$$$ (depending on scale or necessity of officer overtime pay)
Potential funding sources	Federal and state traffic safety funding
Sample programs	Federal Highway Administration "A Resident's Guide for Creating Safe and Walkable Communities:
	http://transportation.stanford.edu/alt_transportation/BikingAtStanford.shtml

Radar Speed Sign Deployment	
Target	Speeding motorists
Primary agency	Bozeman Police Department and the City of Bozeman
Partners	Schools and community organizations
Key elements	Schools and community organizations request a radar speed sign from the City of Bozeman. The sign is deployed to key locations (schools, community centers, etc) and reminds motorists to follow the designated speed limit.
Time frame	Anytime, on-going
Cost	$$
Potential funding sources	Federal and state traffic safety funds and Safe Routes to School funding
Sample programs	Issaquah, Washington:
	http://www.ci.issaquah.wa.us/Page.asp?NavID=309

Bicycle Patrol Unit	
Target	N/A
Primary agency	Bozeman Police Department, Gallatin County Sheriff's Department
Partners	Community organizations
Key elements	On-bike officers are an excellent tool for community and neighborhood and special event policing.
Time frame	One-time setup, ongoing maintenance and training
Cost	$-$$$ (depending on existing equipment inventory)
Potential funding sources	Crime prevention funding
Sample programs	Central Point, Oregon:
	http://www.bta4bikes.org/btablog/2008/01/30/alice-award-nominee-chief-jon-zeliff/

6.5.4 Encouragement Program Recommendations

MSU Bike Orientation	
Target	MSU students, especially incoming freshmen
Primary agency	City of Bozeman and MSU
Partners	MSU Cycling Team
Key elements	Bicycle safety & promotion orientation for incoming freshmen and returning students. Classes & clinics, materials, social events, rides.
Time frame	September, annually
Cost	$-$$
Potential funding sources	MSU parking fees, TDM funding sources
Sample programs	Stanford University Bike Program: http://transportation.stanford.edu/alt_transportation/BikingAtStanford.shtml

University students are ideal candidates for bicycling outreach programs; many students live near campus and may not own a car or choose to drive. The City of Bozeman should partner with Montana State University to promote bicycling to students at the beginning of the school year.

The MSU Bike Orientation should include:

- **Bike maps and information** provided to incoming and returning students at the beginning of the year through school information packets
- **Flat clinics, bike legal clinics, and guided rides**, advertised through flyers, email and bulletin boards, and campus newspaper
- **Information tabling** at campus events and prominent locations (e.g. bookstore, quad) during the first few weeks of school
- A **Bikes at MSU web page** with links and more information
- At-cost or low-cost **bike lights** sold at tabling events and through the campus bookstore
- If desired, a “bike buddy” program may be implemented to match current cycling students with interested students. This can be a simple program where bicyclists wear a sticker that says “I bike to MSU, ask me how,” or a more elaborate program that matches bike buddies with interested students who live in their neighborhood for mentoring. A bike buddy program would increase the cost of the program. This could be set up through the existing campus rideshare website.

6.5.5 Policy Recommendations

Bozeman Area Bicycle Advisory Board	
Target	Citizen advocates
Primary agency	Continuation of Regular meetings of the Bozeman Area Bicycle Advisory Board to advise the City of Bozeman on bicycle technical issues.
Partners	City of Bozeman, bicycle advocacy groups, health organizations, etc
Key elements	Regular meetings of the Bicycle Advisory Committee to advice the City of Bozeman on technical issues. Gallatin County may also explore the concept in the future if the need arises.
Time frame	Ongoing
Cost	$
Potential funding sources	City of Bozeman
Sample programs	UC Davis Bicycle Program: http://www.taps.ucdavis.edu/bicycle/

Complete Streets	
Target	Planners and engineers
Primary agency	City of Bozeman, Gallatin County,
Partners	Montana State University
Key elements	Policy language that creates streets to work for all users, including drivers, freight, walkers, cyclists and transit riders. Recommended Guidelines can be found in **Section 6.1** of this Plan.
Time frame	One-time; can happen at any time
Cost	$
Potential funding sources	N/A
Sample programs	http://www.completestreets.org/ contains sample policies and real-life examples

Perform Annual Bicycle and Pedestrian Counts	
Target	N/A
Primary agency	Gallatin County, City of Bozeman
Partners	Bozeman Area Bicycle Advisory Board
Key elements	Annual bicycle user counts and surveys at set locations to provide for evaluation over time.
Time frame	Annually
Cost	$$-$$$
Potential funding sources	General Funds, Private Donations
Sample programs	National Bicycle & Pedestrian Documentation Project
	(http://www.fhwa.dot.gov/environment/bikeped/study/)

Many jurisdictions do not perform regular bicycle user counts. As a result, they do not have a mechanism for tracking ridership trends over time, or for evaluating the impact of projects, policies, and programs.

It is recommended that the City of Bozeman and Gallatin County perform and/or coordinate annual counts of bicyclists (and pedestrians if desired) according to national practices. The

National Bicycle and Pedestrian Documentation Project has developed a recommended methodology, survey and count forms, and reporting forms, and can be modified to serve the needs and interests of individual jurisdictions.

If desired, further bicycle and pedestrian data collection opportunities may be pursued as well, including:

- Include before-and-after bicycle/pedestrian/vehicle data collection on priority roadway projects
- Insert bicycle/pedestrian survey questions into any existing travel mode or city audit survey instrument
- Require counting of bicyclists/pedestrians in all traffic studies
- Purchase National Household Travel Survey add-on

Bicycle Parking Guidelines	
Target	City & County planners and engineers
Primary agency	City of Bozeman, Gallatin County
Partners	Bozeman Area Bicycle Advisory Board
Key elements	Adopt Bicycle Parking Design Guidelines and parking requirements contained in the Bozeman Area Transportation Plan (Chapter 5.4.5)
Time frame	One-time
Cost	$
Potential funding sources	N/A
Sample programs	Association of Pedestrian and Bicycle Professionals:
	http://www.bfbc.org/issues/parking/apbp-bikeparking.pdf

Request a Bike Rack Program	
Target	City & County planners and engineers
Primary agency	City of Bozeman, Gallatin County
Partners	Bozeman Area Bicycle Advisory Board, Downtown Bozeman Association
Key elements	Provide a system by which a business can request additional bicycle parking be installed to meet high demand by bicyclists
Time frame	On-going
Cost	$$-$$$ per year
Potential funding sources	Bozeman Area Bicycle Advisory Board. Private Donations
Sample programs	City of Chicago:
	http://www.chicagobikes.org/forms/bikerackrequest.php

Crash Reporting Methodology	
Target	Law enforcement agencies
Primary agency	County 911, Bozeman Police Department
Partners	Bozeman Area Bicycle Advisory Board
Key elements	Adopt a uniform methodology for reporting crash data for pedestrian and bicycle crashes. Training for law enforcement agencies on crash reporting is incorporated in the police education courses on pedestrian and bicycle awareness. Ensure accurate accounting of bicycle and pedestrian crashes. Separate out bicycle crashes from motorcycle crashes
Time frame	One-time with on-going training
Cost	$
Potential funding sources	Federal and state traffic safety funds
Sample programs	Wisconsin Department of Transportation:
	http://www.dot.state.wi.us/library/research/docs/finalreports/05-18bicycle-f.pdf

Fund and Staff a Pedestrian/Bicycle Coordinator Position	
Target	N/A
Primary agency	City of Bozeman and/or Gallatin County
Partners	Bozeman Area Bicycle Advisory Board, health organizations, etc
Key elements	Staff position charged with managing bicycle-related policies, programs, and projects. Could be a shared position with Gallatin County.
Time frame	Ongoing
Cost	$-$$$
Potential funding sources	General funds
Sample programs	Portland Office of Transportation
	Chicago Department of Transportation

To take full advantage of bicycle planning efforts in the Bozeman, and to assist with implementation of the many projects and programs recommended in this Plan, the City of Bozeman may wish to consider filling this position. The job duties for this staff person may include:

- Work with community partners
- Monitor the design and construction of on-street bikeways and shared use paths, including those constructed in conjunction with private development projects
- Ensure bicycle facilities identified in planning documents, development applications and/or as mitigation measures are designed appropriately and constructed expediently
- Coordinate implementation of the recommended projects and programs listed in this Plan
- Identify new projects that would improve the region's access for bicyclists

6.6 NON-MOTORIZED MAINTENANCE CONSIDERATIONS

Pedestrians and cyclists are more sensitive to conditions within the roadway right-of-way than motorists. Any roadway maintenance activities to be undertaken should not degrade the user experience of pedestrians and cyclists and should be seen as an opportunity to make some simple changes that can enhance conditions usually at minimal, or no cost to the City of Bozeman, Gallatin County or MDT. A healthy maintenance program is necessary to ensure bikeway and walkway facilities are usable to the public to the greatest extent possible.

6.6.1 Overlay / Resurfacing Projects

Roadway surfacing projects create an opportunity to make improvements for bicyclists or pedestrians at minimal cost. If resurfacing activities are scheduled, the bikeway and pedestrian project recommendations in Chapter 5 should be referenced to determine if some projects might be completed as part of the job.

Rural Overlay Projects

On uncurbed roads with wide, stable gravel shoulders, there are often opportunities to widen shoulders without major grading. If the shoulders are paved prior to a resurfacing project, the ensuing overlay provides seamless shoulders and a roadway that is safer for all users.

Some sections of roadway may require minor grading to provide additional width; this can be justified on roads with high or potentially high bicycle use (see **Chapter 5** for roads recommended for shoulder expansion).

Other Areas

In areas where widening isn't possible because of existing curbs and sidewalks or a constrained right-of-way by natural features such as ditches or other major changes in grade, the most effective way to provide non-motorized facilities is by reconfiguring lanes after paving if there is adequate width. This saves the expense and inconvenience of removing existing stripes. In many cases no additional right-of-way is required for adding bicycle facilities as adequate width may already exist.

Chip Sealing

Chip seals are useful maintenance tools for prolonging pavement life for vehicles, but present significant obstacles to bicyclists. Chip seals typically leave the shoulder or pavement edge covered in debris and present a rough riding surface that can increase the chance of flat tires for bicyclists.

Chip Seal Recommendations:

- Do not cover part of the shoulder or bike lane leaving a 'lip' for cyclists to contend with.
- Use a fine textured material: 3/8"-10 or ¼"-10 aggregate; and
- After chip sealing, thoroughly sweep the shoulder area of debris

6.6.2 Utility Cuts

Utility cuts can leave rough transitions for cyclists if they are not filled properly.

Utility Cut Recommendations:

- If possible, perform pavement cuts in locations that will not interfere with bicycle travel;
- When resurfacing, back fill cuts in bikeways flush with the surface as bicycles will not carry sufficient force to pack down a hump;
- Ensure that cuts parallel to bicycle traffic do not leave a ridge or groove in the bicycle track; and
- Back fill cuts in concrete sidewalks or shared use paths with concrete flush with the finished sidewalk grade.

6.6.3 Snow Removal

In the Bozeman area, increasing numbers of cyclists and pedestrians are choosing to travel by these modes year-round. Snow stored on bike lanes or sidewalks presents a significant impediment and disincentive to bicycling and walking in the winter.

Snow Removal Recommendations:

- Bike Lanes and roadway shoulders can offer additional snow storage capacity following a large snow event. Snow plow operators should always attempt to clear roadways from curb-to-curb barring prohibitive accumulations.
- If roadway snow removal operations obstruct publicly maintained sidewalks the sidewalks should be cleared following roadway clearing operations.

6.6.4 Bikeway and Walkway Maintenance During Construction Activities

The summer months constitute the bulk of roadway maintenance and construction activities in the Bozeman area. Cyclists and pedestrians frequently have to contend with narrowed roadways, temporary closures of bikeways and sidewalks, and debris on bikeways and sidewalks. The following recommendations provide for improved conditions for bicyclists and pedestrians during construction activities.

Construction Activity Recommendations:

- Pedestrians do not have the patience to tolerate long detours around construction sites and typically ignore signs or trespass on site. It is preferable to create passages that allow pedestrians to proceed as close to their normal route as possible. Barricades or traffic cones should be utilized within the travel way if space permits to create temporary facilities. If possible, temporary ramps can be installed from wood or steel that can provide access to the disabled;
- Intersections and crosswalks should be kept open if possible. Temporary crosswalks can be marked if they need to be relocated;
- Bicycle access should also be maintained. Bicyclists can share the lane with vehicles for a short distance, 15 mph construction zone speed limits can help keep vehicle speeds down. For longer projects a wide outside lane or temporary bike lane is

preferred. Bicyclists should not be directed to ride on sidewalks through construction zones;

- Construction debris in bike lanes and sidewalks can present an uncomfortable and potentially dangerous situation and should be cleared routinely during construction activities; and
- A final sweeping of bicycle and pedestrian facilities should be undertaken following completion of any construction activity.

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

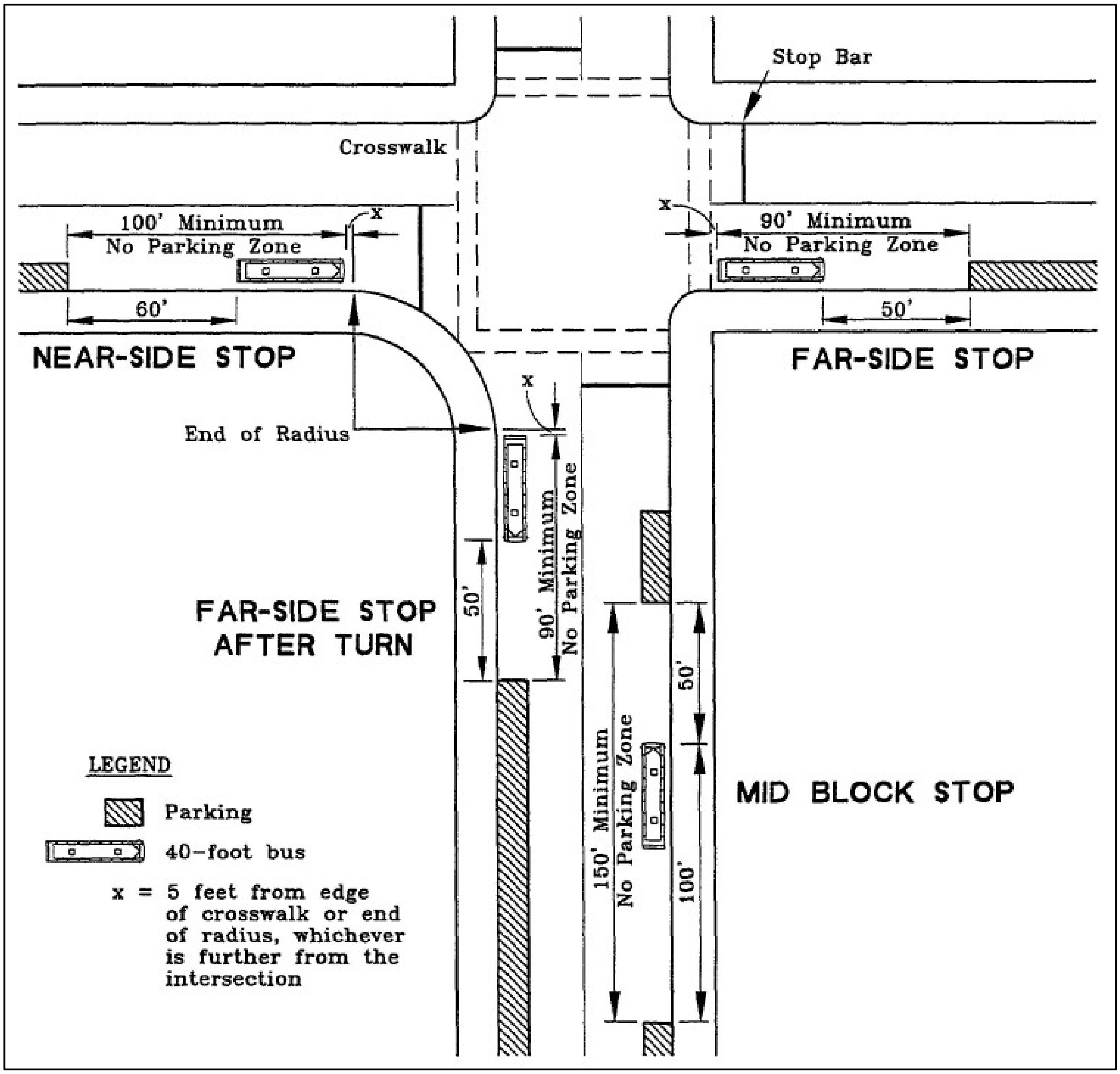


Figure 7-1
Suggested Bus Stop Distance

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.

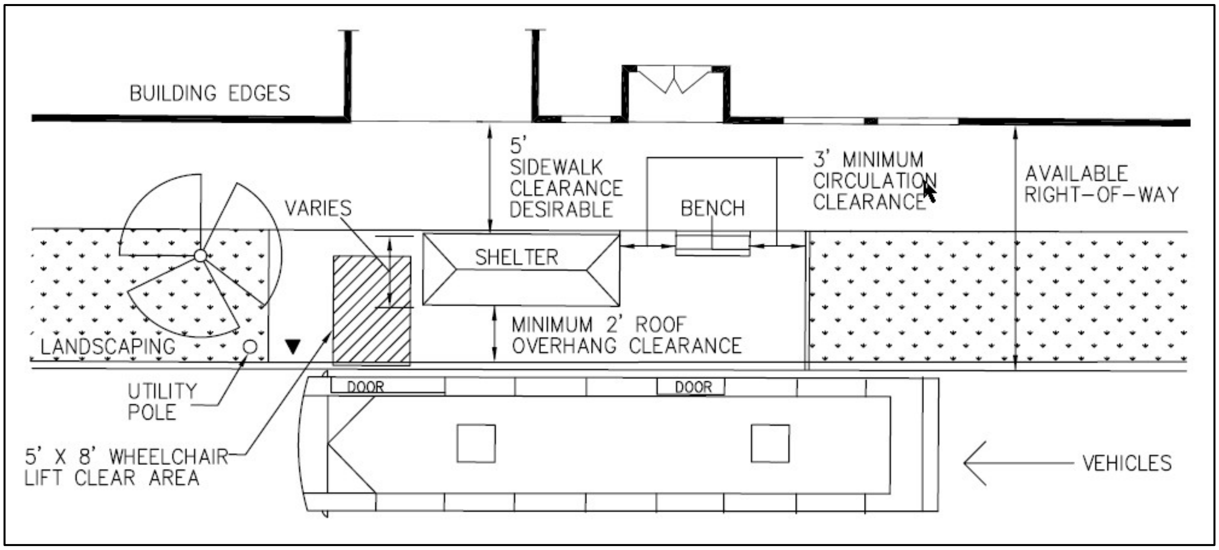


Figure 7-2
Typical Shelter Layout

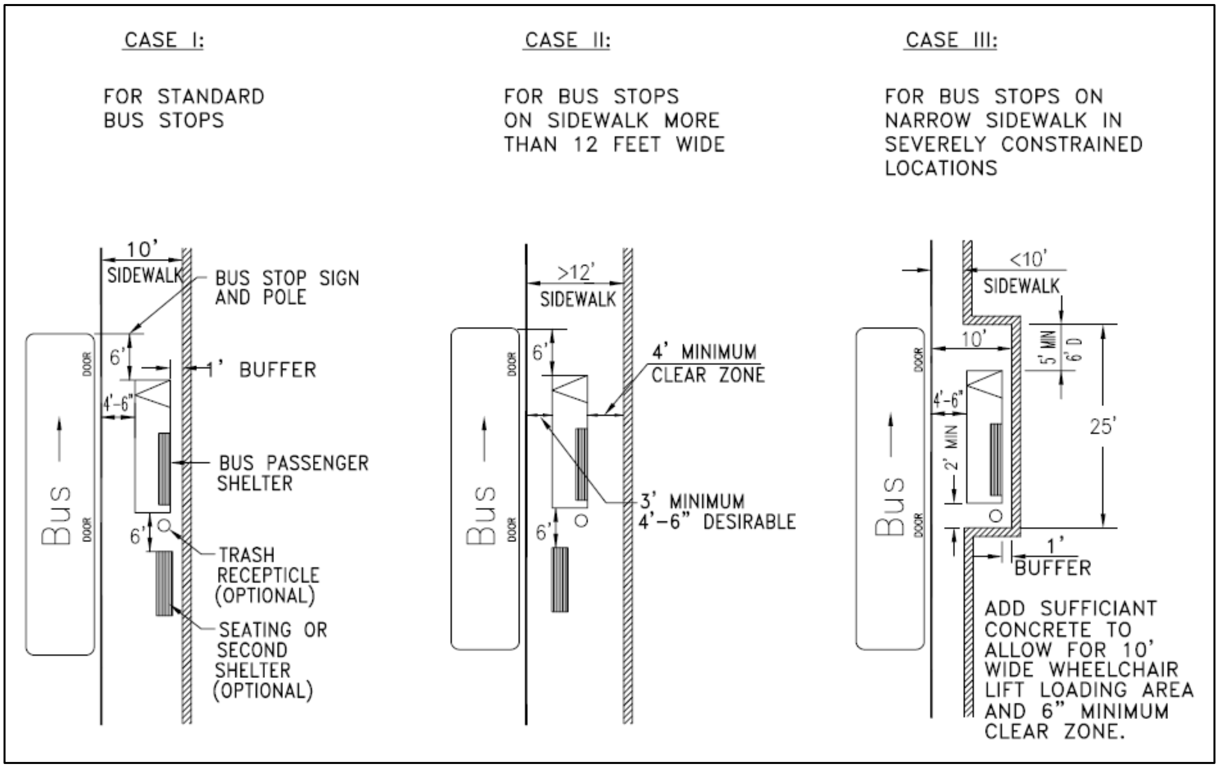


Figure 7-3
Shelter Placement

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.

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.

8.1 PURPOSE OF TRAFFIC CALMING

The Institute of Transportation Engineers (ITE) defines traffic calming as a "combination of mainly physical measures that reduce the negative effects of motor vehicle use, alter driver behavior, and improve conditions for non-motorized street users." In simple terms, traffic-calming techniques are typically aimed at lowering vehicle speeds, decreasing truck volumes, and/or reducing the amount of cut-through traffic in a given area. If applied properly, these techniques result in a more pleasant environment for pedestrians and bicyclists.

Some of the most universal goals of traffic calming are as follows:

- Reducing the frequency and severity of accidents.
- Improving the quality of life in residential areas.
- Reducing negative environmental impacts of traffic such as air and noise pollution.
- Promoting walking and bicycling.

Traffic calming measures can also have the following beneficial side effects:

- Reduced need for police enforcement.
- Improved street environment (street scaping).
- Improved water infiltration into the ground.

There are two forms of traffic calming, active and passive. Active measures are described in some detail in the following sections and are usually applied after a street has been constructed to correct a perceived problem with driver behavior. Passive measures are more likely to be included during the initial design of a roadway and include such things as the placement of street trees, medians, narrower lane widths, intersection design, pedestrian bulbs and other safety features, and similar design elements. Active measures are not appropriate for the arterial network as they interfere with the purpose of arterials to move larger volumes of vehicles. However, appropriate use of passive measures may accomplish the purpose of encouraging safer driver, cyclist, or pedestrian behavior without restricting traffic flow. Arterials should be considered in any active traffic calming plan since speeding and cut-through traffic on local streets can be an indicator that the arterial network is not functioning properly. Therefore, improvements to the arterial network may be a more effective solution than active traffic calming on smaller streets.

8.2 HISTORY OF TRAFFIC CALMING

Traffic calming originated in Europe in the 1960's, specifically with the "pedestrianization" of downtown shopping areas in Germany. In the 1970's, the Dutch expanded the concept to include residential streets when they integrated motorized and non-motorized traffic. On the residential blocks, the street served as an extension of the residents' yards, and pedestrians were given priority over automobiles. Obstacles, bends, and bottlenecks were placed at regular intervals to restrict vehicle speeds to a walking pace. Finally, the German philosophy of area-wide traffic calming emerged, which considers the entire road system in order to avoid merely shifting a problem to another location.

Over the past thirty years, a variety of traffic calming techniques have been applied in numerous European countries. More recently, these strategies have been adopted in Japan, Australia, and North America. In the United States, traffic-calming efforts have occurred throughout the country. In the northwest region, several municipalities have actively pioneered traffic calming, including the communities of Seattle and Bellevue, Washington and Eugene, Oregon. As was the case in Europe, emphasis has shifted from alleviating problems at specific locations to improving neighborhood street systems as a whole. Consequently, traffic-calming programs in the U.S. are sometimes known as Local Area Traffic Management Programs, Neighborhood Traffic Management Programs, or Neighborhood Traffic Control Programs.

8.3 TYPES OF TRAFFIC CALMING MEASURES

Traffic calming measures typically fit into one of six categories: 1) passive measures; 2) deflection; 3) narrowing; 4) diversion and restriction; 5) education and enforcement and 6) signage and pavement markings. Many of the specific techniques within these categories are described below.

8.3.1 Passive Measures

There are several passive techniques that produce a calming effect on traffic. These measures are usually built into the design of the street. Examples of passive forms of traffic calming include tree-lined streets, streets with boulevards separating the sidewalks, streets with raised center medians, on-street parking, highly visible pedestrian crossings, and relatively short building set-back distances. Each of these elements has the tendency to slow vehicle speeds without actually restricting or interfering with the flow of traffic. The best results are usually obtained when two or more of these techniques are used in combination.

8.3.2 Deflection, Narrowing, Diversion, and Restriction

Descriptions of a wide variety of physical traffic calming measures, as well as the advantages and disadvantages of each are presented in the following pages. A general magnitude cost range is shown for a basic installation of each measure. These costs can increase significantly with the addition of irrigation systems and street lighting, or the acquisition of right-of-way. Beautification amenities, such as brick pavers or extensive landscaping, can also dramatically impact project costs.

When implementing these types of physical traffic calming measures, several guidelines should be taken into consideration:

1) attempt less restrictive measures before resorting to road closures and other route modifications;

2) space devices 300 to 500 feet apart in order to restrict speeds to a 20 to 25 mile per hour range; and
3) make the appropriate accommodations for drainage and snow removal, as well as considering the needs of emergency vehicles, pedestrians, and bicyclists. Road closure or obstruction, for example, can often be achieved through the use of traversable barriers that allow for the passage of bicycles, pedestrians, and emergency vehicles.

8.3.3 Education and Enforcement

The following techniques are designed to raise public awareness of a traffic problem, and change the behaviors that contribute to that problem:

- **Neighborhood Traffic Safety Campaign** - An educational program consisting of meetings, newsletters, etc., with the purpose of informing residents of the neighborhoods' particular traffic issues and outlining safety recommendations. (This technique is not effective for traffic generated outside the neighborhood.)
- **Radar Speed Monitoring Trailer** - A portable trailer equipped to measure and digitally displays vehicle speeds.
- **Neighborhood Speed Watch Program** - A speed-monitoring program in which residents of a neighborhood measure vehicle speeds with a radar unit and record license plate numbers of those exceeding the speed limit. The registered owners are sent letters explaining the safety concerns in the neighborhood and asking them to reduce their speeds.
- **Target Enforcement** - Increased police enforcement of traffic regulations within a designated area.

8.3.4 Signage and Pavement Markings

The installation of traffic control signs and placement of pavement markings constitute the most passive category of traffic calming. Signs indicating speed limits, school crossings, and dead ends can be used where appropriate to slow traffic. Pavement markings used to calm traffic include school crossings and speed limits or other legends. Some specific traffic calming techniques include:

- **Truck Route Signing** - Signs placed along streets at appropriate intervals to designate truck routes or restrict truck traffic.
- **Edge Lines** - Lines painted along the side of the road to narrow traffic lanes and/or provide shoulder space for bicycles.

8.4 VERTICAL DEFLECTION METHODS

8.4.1 Speed Bumps, Humps, Tables, and Cushions:

Speed bumps, humps, tables, and cushions are all design features which are raised above the roadway. The differences between the four types are in their geometry.

Speed bumps are the smallest and are generally 3 to 6 inches high and 1 to 3 feet long. They are typically used in parking lots and low speed residential areas. Speed bumps slow vehicles traveling at slow speeds down to approximately 5 miles per hour. Vehicles traveling at higher speeds may be impacted less by the bumps.

Speed humps are larger than speed bumps and range from 3 to 4 inches high and 10 to 14 feet long. They can be used on streets where a low speed limit is desired. Speed humps generally can slow vehicles down to approximately 15 miles per hour. If traveled over at higher speeds the vehicle will experience a severe jolting effect.

A speed table is a lengthened speed hump with a flat top. Speed tables are typically long enough so that the entire wheelbase of a car rests on the table. The design of speed tables allows for higher speeds than those of speed humps, but creates a smoother ride for larger vehicles. The height of speed tables is similar to speed humps, but the length can vary. A typical 22 foot long speed table has a design speed of approximately 30 miles per hour.

Speed cushions are a series of speed humps installed across the width of the roadway with spaces between them. The spaces are spaced so that emergency vehicles can pass between them without being affected by the bumps. Ordinary cars have smaller axels and will therefore need to travel over the bump with at least one side of their car. Speed cushions have about the same effect on slowing cars down as speed humps do while still allowing emergency vehicles to be unaffected by them.

These traffic calming measures can be placed at spaces ranging from 250 feet to 800 feet to gain a continuous effect on slowing vehicle speeds. If they are placed at distances greater than 800 feet, there is enough room between them for driver to speed up between the devices which will limit their effectiveness.

It should be noted that speed bumps, as defined herein, should not be used on the public street system, and are more applicable to private roadway facilities, accesses, and parking lots.

Advantages:

- Slows traffic down
- Increases safety levels
- Decreases traffic volume
- Self-enforcing
- Relatively inexpensive

Disadvantages:

- May promote speeding between them
- May increase volume on other streets
- Difficult to properly construct

Special Considerations:

- Emergency vehicles
- Drainage
- Signage
- Snow Removal

Estimated Cost:

- $1,000 to $8,000

8.4.2 Raised Intersections:

Raised intersections are flat raised areas around the intersection with ramps attaching each approach to the intersection. The ramps and/or the intersection can be made out of a textured or painted material to make them stand out visually. By raising the level of the intersection and the cross walks, the area becomes more noticeable to the driver. This creates a safer environment for pedestrians crossing at the intersection. Raised intersections are ideal in areas with heavy pedestrian traffic and on-street parking that doesn't allow for other measures to be taken.

Advantages:

- Improved safety for vehicles and pedestrians
- Can be visually appealing
- They work for the entire intersection, not just one street
- Better for emergency vehicles than speed humps

Disadvantages:

- Increases turning difficulty
- Increased maintenance
- Requires additional signage
- Less effective at reducing speeds than speed humps and speed tables
- Can be expensive depending on the materials used

Special Considerations:

- Emergency vehicles
- Drainage
- Signage
- Snow Removal

Estimated Cost:

- $4,000 to $12,500 depending on materials used and size of intersection

8.4.3 Raised Crosswalks:

Raised crosswalks are simply speed tables that have crosswalk signage and markings to allow for pedestrians to cross the roadway. The raised level of the crosswalk makes it more visible to the driver and therefore safer for the pedestrians. Raised crosswalks are ideal in locations where there is heavy pedestrian traffic and high vehicle speeds. Raised crosswalks have the advantage of slowing vehicles down who drive over them and alerting vehicles to possible pedestrian traffic in the area.

Advantages:
- Improved safety for vehicles and pedestrians
- Can be visually appealing
- Effective at reducing vehicle speeds
- Makes the crosswalk and pedestrians more visible

Disadvantages:
- May promote speeding between them
- Difficult to properly construct
- May slow down emergency vehicles

Special Considerations:
- Emergency vehicles
- Drainage
- Signage
- Snow Removal

Estimated Cost:
- $2,500 to $8,000

8.4.4 Textured Pavement:

Textured pavement can be created by either stamping the pavement or by using an alternative material like brick or cobblestone. The purpose of both methods is to create a surface that is unpleasant to drive over at high speeds due to the uneven texture of the surface. If driven over at higher speeds the texture will cause a noticeable vibration to the car, much like a rumble strip does. The variation in the surface will also cause an audible difference when driven over. Generally the pavement area that is textured is either painted a different color or the materials used are of a different color. The change in color makes the area standout visually and will alert the driver that caution needs to be taken in the area. Textured pavement creates a space that acts less as a roadway and more like a pedestrian zone causing drivers to take greater care. Warning signs can also be used in conjunction with the textured pavement to increase their effectiveness. Textured pavement can also be used to highlight crosswalks or other areas of interest.

Advantages:
- Can reduce vehicle speeds
- Can increase driver awareness
- Provide visual and physical warnings to the driver
- Can be used to highlight most areas
- Aesthetically pleasing if properly designed

Disadvantages:
- May be difficult for pedestrians and bicyclists
- Can be very expensive depending on material and area covered
- Can add additional noise to the area
- Maintenance issues may arise

Special Considerations:
- Emergency vehicles
- Snow Removal
- Maintenance

Estimated Cost:
- Varies by design

8.4.5 Rumble Strips:

Rumble strips are grooved patterns placed in the pavement perpendicular to the direction of travel. When a vehicle passes over a rumble strip the driver receives an audible warning (rumbling sound) and feels a vibration. Rumble strips are used to alert the driver to use caution in the area or to alert them to changes in traffic characteristics. They can be painted a different color or be made of a different material than the road surface so that they stand out to the driver. This method is commonly used in high speed areas to give the driver advance warning to slow down or about an upcoming intersection.

The FHWA classifies rumbles strips into three types:

- **Shoulder rumble strips (SRS)** are the most common type and are located on the road shoulder of expressways, interstates, parkways, and two-lane rural roadways. They are intended to alert the drive when they encroach onto the shoulder.
- **Centerline rumble strips (CRS)** are located along the centerline of the roadway and are often used on two-lane rural roadways. They alert the driver that they are encroaching into the centerline.
- **Transverse rumble strips (TRS)** are installed on approaches to intersections, toll plazas, horizontal curves, and work zones. They alert the driver that they are approaching an area of concern and that they should use caution.

Advantages:
- Can reduce vehicle speeds
- Can increase driver awareness
- Provide visual and physical warnings to the driver
- Relatively inexpensive

Disadvantages:
- May be difficult for pedestrians and bicyclists
- Can add additional noise to the area
- Maintenance issues may arise

Special Considerations:
- Emergency vehicles
- Snow Removal
- Maintenance

Estimated Cost:
- $1,000 to $5,000

8.5 Horizontal Deflection Methods

8.5.1 Chicane:

Chicanes are offset curb extensions that form S-shaped curves which cause a deviation in the vehicle's path of travel. They realign the road horizontally to force the driver to alter their path causing them to slow down. Chicanes can also be created by alternating parking between each side of the road. Chicanes can be effective at reducing vehicle speeds without the noise and inconvenience of speed bumps or other methods.

Advantages:
- Can reduce vehicle speeds
- Easily negotiated by emergency vehicles
- Imposes minimal inconvenience on local traffic
- Reduces pedestrian crossing distance
- Can be aesthetically pleasing

Disadvantages:
- May create opportunities for head-on conflicts
- Expensive
- If not designed properly drivers may deviate from their lane
- May lose some on-street parking

Special Considerations:
- Lighting
- Drainage
- Maintenance

Estimated Cost:
- $15,000 to $40,000

8.5.2 Traffic Circles and Roundabouts:

Traffic circles are raised circular islands placed in the center of the intersection about which drivers must navigate around. They cause vehicles to slow down through the intersection because they are forced to make turning movements. They are very effective at slowing vehicle speeds down. Pedestrian safety is also increased due to the decrease in speeds. Large vehicles may have trouble navigating around the traffic circles, especially when making left-hand turns. Traffic circles work well for low volume intersections where speeding is a common problem.

Roundabouts are larger traffic circles with splitter islands and yield signs at each entry way. They are intended for larger intersections with higher traffic volumes. Roundabouts provide refuge areas on the splitter islands which allow crossing pedestrians a place of refuge so that they only have to cross one direction of traffic at a time. Large trucks may have problems navigating around roundabouts, although the use of mountable islands or aprons helps to accommodate larger vehicles.

Roundabouts and traffic circles both slow drivers down and decrease the number of conflict points from the 32 present in a standard four-legged intersection to only 8 in a roundabout or traffic circle. The decrease in speed and number of conflict points has resulted in a reduction of 90% of fatal intersection crashes compared to signalized intersections.

Advantages:
- Vehicle speed reduction
- Increased vehicle and pedestrian safety
- No traffic signals

Disadvantages:
- May be difficult for large trucks to navigate around
- May require additional right-of-way and/or loss of on-street parking
- May cause difficulties for sight impaired pedestrians

Special Considerations:
- Emergency vehicles
- Maintenance
- Large trucks
- Signage

Estimated Cost:
- Varies based on size and materials used

8.5.3 Intersection Realignment:

This method changes the alignment of a standard T-intersection with a straight approach into curving streets that connect at right angles. The previously straight through movement through the intersection becomes a turning movement. The straight through movement through an intersection realignment is a sweeping turn that causes the driver to slow down to take the corner. Intersection realignment is one of the few traffic calming methods available for T-intersections. This method forces drivers to slow down through the intersection which makes for a safer environment for drivers on the side street.

Advantages:

- Good at reducing speeds at T-intersections
- Increases safety for motorists at the intersection
- May provide space for landscaping

Disadvantages:

- Can cause confusion regarding priority movements
- Curb realignment can be costly
- May require additional right-of-way

Special Considerations:

- Lighting
- Signage
- Drainage

Estimated Cost:

- $5,000 to $20,000

8.6 Horizontal Narrowing Methods

8.6.1 Neckdown:

Neckdowns are curb extensions put in place at intersections. They reduce pedestrian crossing distance while drawing attention to crosswalks. Neckdowns cause vehicles to slow down at intersections and around corners due to the narrower lanes. The most common place for a neckdown is in an area where there is substantial pedestrian traffic and other traffic calming methods would be unacceptable due to noise or other constraints. Neckdowns also create additional area that can be used for landscaping.

Advantages:
- Reduces pedestrian travel distance
- May be aesthetically pleasing
- May slow vehicle speeds down, especially right turns
- Increases awareness of pedestrians
- Easily negotiated by large and emergency vehicles
- Creates protected on-street parking bays

Disadvantages:
- Unfriendly to bicyclists unless they are designed to accommodate them
- Landscaping may cause sight problems
- Doesn't force vehicles to slow down

Special Considerations:
- Lighting
- Signage
- Drainage
- Maintenance
- Bicyclist constraints

Estimated Cost:
- $20,000 to $80,000 for all four corners

8.6.2 Choker:

Chokers are similar to neckdowns but are placed at midblock locations rather than at intersections. They narrow the travel lanes by increasing the length of the sidewalks or by increasing landscape areas. This method creates a narrower roadway section that may cause the driver to slow down. Chokers can be installed so that they only allow for one lane of traffic to pass through at a time. Only allowing for one traffic lane on a two-lane road works well for areas that are prone to significant speeding problems; this method, however, can create problems with head-on conflicts. Chokers also provide protected parking areas and can add additional area for landscaping.

Advantages:
- If used at a crosswalk they can reduce pedestrian travel distances
- May be aesthetically pleasing
- Easily negotiated by large and emergency vehicles
- Create protected on-street parking bays

Disadvantages:
- Effect on vehicle speed is limited
- Unfriendly to bicyclists unless designed to accommodate them
- May need to eliminate some on-street parking

Special Considerations:
- Lighting
- Signage
- Drainage
- Maintenance
- Bicyclist constraints

Estimated Cost:
- $8,000 to $20,000

8.6.3 Center Island Narrowing and Pedestrian Islands:

A center island narrowing is a raised island in the center of the street that narrows the overall width of the travel lanes. When the islands have an opening and allow a crosswalk to go through them they are called pedestrian islands. The islands create a refuge for crossing pedestrians which makes it so that they only have to cross one direction of traffic at a time. This, combined with the islands also increasing visual awareness to the area, can create a safer environment for crossing pedestrians. The installation of the islands may narrow the travel lanes and cause vehicles to deviate from a straight path in order to travel around them. This may force the vehicles to slow down in the area.

Advantages:
- Increases pedestrian safety
- May be aesthetically pleasing
- Provide a refuge for pedestrians
- Possible traffic and vehicle speed reduction

Disadvantages:
- Limited reduction in vehicle speed
- May need to eliminate some on-street parking

Special Considerations:
- Lighting
- Signage
- Drainage
- Maintenance

Estimated Cost:
- $5,000 to $15,000

8.6.4 Angle Point:

Angle points are created by placing offset curb extensions on the side of the road in order to narrow the street and create angled deviations in the path of travel. Angle points cause vehicles to take an S-shaped path through the area in much the same way chicanes do. They are also similar to chokers but are shorter and are offset if installed on both sides of the street. Having to deviate from a straight path causes the driver to slow down and be more alert to the area. Angle points can require additional attention to be paid to the area which allows for safer pedestrian travel. Some designs may allow drivers to cut across and take a straight path through the angle point. This design is advantageous for emergency vehicles as they do not generally need to slow down for these zones.

Advantages:
- Minor inconvenience to drivers
- Shorter crossing distance for pedestrians
- Provide additional spacing for landscaping
- Effective at slowing vehicle speeds when used in series

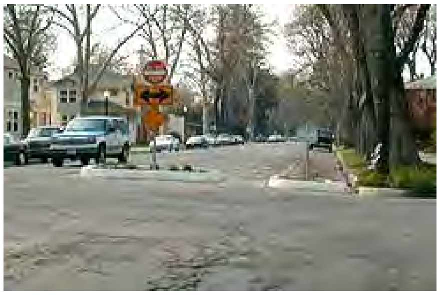
Disadvantages:
- Unfriendly to bicyclists unless designed to accommodate them
- Causes conflict between opposing drivers arriving simultaneously
- Drivers may deviate from their path to cut through in a straight line
- Limited speed control if not designed properly

Special Considerations:
- Lighting
- Signage
- Drainage
- Maintenance

Estimated Cost:
- $8,000 to $20,000

8.7 Diversion and Restriction Methods

8.7.1 Half Closures:



Half closures are put in place to block a single lane of traffic. They can be used to prevent vehicles from entering a road but still allow vehicles to exit the road. This is an effective means of limiting traffic on a roadway and also limiting turns off of the intersecting roadway. Half closures are generally made by extending the curb or placing a barrier to block entry. Ample signage must be put into place to alert drivers to the partial closure. Half closures are commonly used in areas where a residential road is experiencing heavy amounts of traffic due to its connection to a main road. Most of this traffic can be attributed to cut-through traffic and can be significantly decreased through the use of half closures.

Advantages:

- Reduces through traffic in one direction
- Allows two-way traffic on the remainder of the street
- Provides space for landscaping
- Two-way bicycle access can be maintained
- Emergency vehicles can drive around barrier if needed

Disadvantages:

- Reduces access for residents or businesses
- May increase trip length
- Increases volumes on other streets
- Drivers may be able to drive around the barrier

Special Considerations:

- Emergency vehicle access
- Signage
- Maintenance

Estimated Cost:

- $10,000 to $40,000

8.7.2 Full Closures:

Full street closures are created by placing barriers at an existing intersection. The full closures can be done to create a dead end or a cul-de-sac style road. An opening or trail can be placed to connect pedestrians and bicycles to the abutting road. The type of barrier used to create the closures can range from a bollard style to a full landscaped closure. A landscaped style is more aesthetically pleasing to the area, but is also much more expensive then placing bollards to stop vehicle traffic. Another method commonly used to create road closures is installing curb extensions to the roadway.

Road closures are very effective at lowering traffic volumes on the roadway. Cut through traffic can be greatly reduced through the use of full closure. It is common to use full closures to limit the amount of traffic on a residential street that was connected to a main street. By closing the connection to the main street, the traffic that previously used the residential street to connect to the main street would diminish thereby decreasing the overall traffic on that road. This does, however, create more traffic on other roads in the area since those vehicles would still have to access the main street via another street.

Advantages:
- Eliminates through traffic
- Improves safety for all street users
- Can still have pedestrian and bicycle access
- Can be aesthetically pleasing

Disadvantages:
- May inhibit emergency vehicles
- Reduces access to properties
- May increase trip lengths
- Increases volumes on other streets
- Can be expensive

Special Considerations:
- Emergency vehicle access
- Signage
- Drainage
- Maintenance

Estimated Cost:
- $15,000 to much higher depending on design

8.7.3 Diagonal Diverters:

Diagonal Diverters consist of a barrier being placed diagonally across a four-legged intersection which interrupts the traffic flow across the intersection. The traffic is diverted away from and is not allowed to drive straight through the intersection. The diverter gets rid of conflict points caused by thru traffic and turning movements within the intersection. They also discourage non-local traffic flow in the area, but still allow for local traffic. This method is effective in areas where there are problems with cut through traffic. The diverter needs to be visible enough to alert the driver to slow down and make the turn.

Advantages:

- Eliminates through traffic and reduces traffic volumes
- Not a full road closure
- Provides space for landscaping
- Reduces traffic conflict points
- Increases pedestrian safety
- Can include bicycle path connection

Disadvantages:

- May be an inconvenience to area businesses or residents
- May inhibit emergency vehicles
- Can be expensive if done as a retrofit
- Cause circuitous routs

Special Considerations:

- Emergency vehicle access
- Lighting
- Signage
- Drainage
- Maintenance

Estimated Cost:

- $10,000 to $80,000

8.7.4 Median Barriers

Median barriers are put in place in the middle of intersections to restrict cut-through movements at a cross street. They also restrict left-turns onto the cross streets from the main street. Putting a median barrier in place will reduce the number of conflict points and therefore increase the safety of the intersection. The barrier can be used as a pedestrian refuge for people wanting to cross the main street. This, along with the reduction in left-turns, increases pedestrian safety at the intersection. Median barriers also reduce traffic volumes on the side streets while increasing the traffic flow on the major street since there will no longer be vehicles stopping to take left-turns at the intersection. This type of barrier can work well in areas where the side street has turned into a popular cut-through street or in areas where there are problems with people stopping to make left-turns. The median barrier does restrict all vehicles, including emergency vehicles. However, the barrier can be designed so that emergency vehicles can travel around them if needed.

Advantages:

- Lowers traffic volumes on the side street
- Provides space for landscaping
- Reduces traffic conflict points and increases safety
- Increases pedestrian safety

Disadvantages:

- May be an inconvenience to area businesses or residents
- May inhibit emergency vehicles
- Require additional street width on the major street

Special Considerations:

- Emergency vehicle access
- Lighting
- Signage
- Drainage
- Maintenance

Estimated Cost:

- $15,000 to $20,000 per 100 feet

8.7.5 Forced Turn Islands:

Forced turn islands are small traffic islands placed at intersections to restrict and channelize turning movements. They are generally put in place to block left-turn and through movements while still allowing for right-turn movements. This method is commonly used where smaller side streets intersect with a larger major street. Heavy left-turn or through traffic off of side streets can cause safety and traffic problems for the area. Restricting the movements from the side streets can increase the safety and traffic levels of the intersection. Forced turn islands are common place for parking lots or similar areas that have multiple entrances and exits. The islands encourage people wanting to turn left or go straight out of the area to use the designated intersections that don't have the forced turn islands; the designated intersections are generally larger safer intersections.

Advantages:
- Provides space for landscaping
- Reduces traffic conflict points and increases safety
- May reduce cut through traffic
- Causes vehicles to use designated intersections

Disadvantages:
- May be an inconvenience to area businesses or residents
- Driver may be able to maneuver around the island
- Diverts traffic to other roads
- May inhibit emergency vehicles
- May increase cornering speeds

Special Considerations:
- Emergency vehicle access
- Lighting
- Signage
- Maintenance

Estimated Cost:
- $4,000 to $8,000

8.7.6 Gateway:

A gateway is an entry treatment to the roadway or surrounding area that creates a sense of passage or change in traffic conditions to the area. Gateways can consist of vertical elements such as posts, trees, bushes, signs, poles, or columns. They can also be formed using curb extensions, changes in pavement color or type, or any other method that creates a sense of entry into an area. Gateways can cause a small reduction in traffic volume because they can make drivers feel uncomfortable about entering the area. A slight speed reduction can also be achieved through the use of narrowing the roadway at the gateway. Safety levels in the area may be increased as well since attention would be drawn to the area.

Advantages:

- May slow vehicle speeds
- Highlights the intersection
- Increased pedestrian safety
- Aesthetically pleasing
- Does not inhibit emergency vehicles
- Possible small volume reduction

Disadvantages:

- Increased maintenance
- May have limited effect
- Can increase the difficulty level to maneuver the area
- Can be very expensive

Special Considerations:

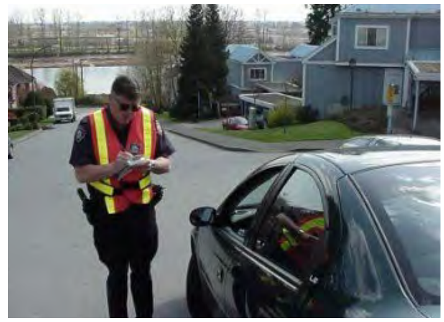
- Lighting
- Signage
- Drainage
- Maintenance

Estimated Cost:

- $4,000 to much higher depending on design

8.8 OTHER CALMING METHODS

8.8.1 Police Enforcement:



Increasing the level of police enforcement on streets that are prone to speeding problems can be an effective way to reduce the number of speeding vehicles. Additional police enforcement can help to discourage drivers from breaking speed limit laws in the area. The speed reduction, however, usually is only reduced for a short period of time or as long as the enforcement is maintained. In order to have a long term effect on speeding, police enforcement must be enforced on a repetitive non-routine basis while having signage and/or brochures in the area to indicate that enforcement will be increased in the area. There can be significant budget and manpower constraints to having continual police enforcement. Using police personnel to enforce speed limits is typically a low priority for police departments. The cost of enforcing speed limits on a continual basis can be unjustifiable.

Advantages:
- Effective at slowing vehicle speeds down
- Widely accepted
- Increases safety level of the area

Disadvantages:
- Requires continual enforcement
- Not of high priority to police departments
- Expensive

Special Considerations:
- Signs
- Continual enforcement

Estimated Cost:
- Varies

8.8.2 Decreased Speed Limits:

Decreasing speed limits in an area prone to speeding is a simple low cost approach to trying to deter drivers from breaking the speed limit. However, the posted speed limit is generally ignored by the driver. Drivers generally travel at speeds they consider reasonable and are often influenced by other drivers in the area. There is usually little to no affect on vehicle speeds by simply lowering the speed limit in the area. To have an effect on vehicles, the lower speed limits must be accompanied by other means of speed control. These other means could be increased law enforcement, speed bumps, or any other method that would help promote lower speeds in the area. Decreasing speed limits in areas such as school zones is common and does tend to have some effect on speeding. The effect can be much higher by using law enforcement to help monitor the area. Outside of a school zone, a speed zone study may be required to make a decreased speed limit enforceable.

Advantages:
- Low cost
- Useful when done in conjunction with other speed control methods
- Useful in areas such as school zones

Disadvantages:
- Little to no effect on vehicle speeds when done alone
- Often times ignored
- Requires additional measures

Special Considerations:
- Signs
- Enforcement
- Maintenance
- May require a speed zone study

Estimated Cost:
- Minimal

8.8.3 Variable Speed Display Board:

Variable speed display boards are commonly placed in areas that are prone to high levels of speeding. The boards display the speed limit for the road to the driver and also have built in speed sensors that detect and display their actual speed. Their current speed is then displayed on the board to alert the driver to how fast they are going compared to the actual speed limit in hopes that they will keep their speeds at or below the speed limit. The board can have a computer on them that can be used to detect what time of day the most number of people are speeding in an area so that additional enforcement can be placed there if needed. The boards basically run themselves and can be powered off of batteries or by solar power. The portable boards work well for moving to different areas where speed is of concern. Permanent boards can also be installed at problematic locations. One concern with these boards is that it may encourage certain groups of drivers to speed if not monitored.

Advantages:

- Widely accepted
- Basically run themselves
- Can save data and be used to determine problem areas and times
- Works as a driver education method
- Portable

Disadvantages:

- May require additional enforcement
- Can encourage speeding of some groups of drivers
- Vandalism may occur
- Limited effectiveness when not used in conjunction with additional enforcement

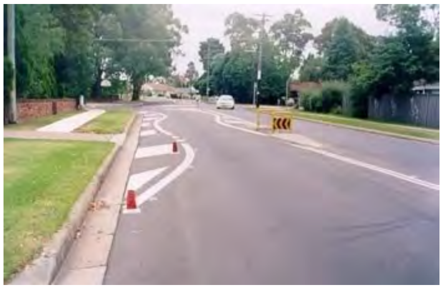
Special Considerations:

- Signing
- Enforcement level
- Maintenance

Estimated Cost:

- $10,000 to $20,000

8.8.4 Pavement Markings:



Pavement markings can be used for anything from on-street parking, to accentuating already existing features, to creating new features. Using pavement markings to indicate areas where on-street parking would occur creates a safer parking environment and also directs traffic in the area. A slight speed reduction may occur if the travel lanes are narrowed due to the markings. When pavement markings are used to accentuate already existing features, they can make the features look bigger and give advanced warning about them. Pavement markings can also be used to create turning lanes and to direct traffic flow without having to use expensive medians or curbs.

Pavement markings are generally not overly effective on vehicle speed reduction unless they create the impression of a narrowed roadway. While pavement markings don't force drivers to act, they do give them guidance on how to act.

Advantages:

- Inexpensive
- Can accentuate already existing features
- Can help create areas of caution
- Gives guidance to the drives

Disadvantages:

- Limited effect on vehicle speed reduction
- Must be maintained
- Not easily visible under snow or water

Special Considerations:

- Maintenance
- Signage
- Visibility

Estimated Cost:

- Varies

8.9 COUNTY SPECIFIC TRAFFIC CALMING

Implementing traffic calming measures along county roadways can be a challenging task. Techniques that work along high-volume low-speed city roadways may not work along rural routes. Special care must be given to the type of traffic calming measures installed along rural routes. For instance, installing speed bumps along a straight road with a high design speed may cause vehicles to slow down to cross the bumps, however they may also cause an increase speeding between the bumps to make up for lost time.

A list of suggested traffic calming measures for rural routes along with a short description of each is found below:

- **Transverse Rumble Strips** are perpendicular groves cut into the roadway that provide an audible sound and vibration that is felt inside the vehicle. They are used to alert the driver to use caution in the area or to alert them of changes in the traffic characteristics. Transverse rumble strips are often installed to warn the driver about approaches to intersections or of an upcoming crosswalk. See **Section 8.4.5** for more detail on rumble strips.

- **Decreased Speed Limits** are commonly used in areas such as school zones. Decreasing speed limits in school zones is common and does tend to have some effect on speeding. However, it is recommended that other speed control measures be used in conjunction with decreased speed limits to have the maximum effect. Simply reducing the speed limit, especially outside of school zones, may have little effect on speeding vehicles when used alone. See **Section 8.8.2** for more information on decreased speed limits.

- **Variable Speed Display Boards** can be used to help deter speeding. These boards display the posted speed limit and the actual speed of the driver. The boards can be equipped with computers that keep track of the speeds of vehicles so that it can be determined what time of day there is the highest rate of speeding. These boards are generally most effective when used with other speed control measures, such as increased police enforcement. Using the variable speed display boards alone generally has an initial effect on speeding vehicles; although this tends to diminish the longer the signs are in place. See **Section 8.8.3** for more information on variable speed display boards.

- **Pavement Markings** can be used to call attention to already existing features or can be used to create new features. Pavement marking can be used to create on-street parking or bike lanes or they can be used to make a visually narrower lane. They can also be used to call attention to existing features making them look bigger or give advanced warning about them. Pavement markings can also be used to alert the driver to change their driving behavior. Messages such as “SLOW” or “SCHOOL ZONE” can be placed on the roadway to let the driver know they are entering an area with changing traffic characteristics. Generally pavement markings and signage are used in conjunction to have the maximum effect. See **Section 8.8.4** for more information on pavement markings.

- **Signs** indicating speed limits, school crossings, school zones, or ones warning about curves or approaching intersections can be used where appropriate to help aid in traffic calming. Signs can help provide warning to changes in the traffic characteristics of the roadway. Installing signs, however, does not guarantee compliance; they merely help aid the driver in their decision making process. They should generally be used to call attention to existing features or changing conditions.

8.10 Incorporating Traffic Calming in New Street Designs

Roadway designs for new development should be appropriate for the intended function of each street or street segment. Those designed to function as part of the major street system (major collectors and arterials), should be designed primarily to move traffic in as efficient, convenient, and safe a manner as possible. Local streets and residential collectors, on the other hand, should be designed to provide access to properties while discouraging through-traffic and higher travel speeds that often accompany it. As a result, new developments should include traffic calming strategies to reinforce the appropriate functions of local streets. These would include layout and connectivity of street systems and pedestrian/bicycle facilities, intersection treatments, and basic design standards for width, curvature, parking, and landscaping. Specific traffic calming features which are easily incorporated into the design phase include: gateway treatments; street narrowing; short block lengths; small corner radii; surface valley gutters; "T" intersections; roundabouts; and landscaping to create a "closed-in" environment.

Traffic calming design characteristics should be incorporated into the City's development review and annexation review processes. Proposed developments or requests to annex would be reviewed by staff to determine whether or not traffic-calming improvements are appropriate for any given location, what strategies are best suited, and what design details are appropriate. The process should be designed to pro-actively assist developers in utilizing traffic strategies to improve quality of life in their developments, while minimizing or eliminating costs for retrofit efforts. Because of the long-term effects of original roadway layout and construction, the City may wish to coordinate with the County to incorporate traffic calming into its development review process.

8.10.1 Multi-Jurisdictional Cooperation

In some cases, traffic problems may be located near a City/County line, or may be caused by conditions outside the City limits, such as on the State highway system or at the State complex. For these reasons, it is desirable for the City to have cooperative agreements with the County and the State government. Cooperative agreements would enable this process to cross jurisdictional boundaries. Other agencies would take an active role in the traffic calming process and participate in financing permanent solutions when deemed appropriate.

8.11 Traffic Calming Program Summary

The Traffic Calming Program for the greater Bozeman area should provide a regular and ongoing opportunity for neighborhoods to nominate, test, and implement improvements to address problems with the local street network. The process should be standardized to minimize administrative effort and cost, while ensuring that improvements are necessary, effective and safe. The process should be repeated as necessary to ensure that resident concerns are addressed with reasonable timeliness, and that projects are advanced in an orderly and efficient manner. Sample forms necessary throughout this procedure are included in the Appendix for easy access by the public.

Traffic calming is a physical construction designed to reinforce the perceived need for caution by the user of the transportation system. The primary responsibility for safe use of the streets lies with the individual driver, cyclist, or pedestrian. The need for physical traffic calming devices indicates a consistent occurrence of failure by the transportation user to appropriately interact with their surroundings.

It is likely that the large majority of traffic calming issues will focus on traffic problems that occur within the city limits. Therefore, this program has been developed with the City in mind. It is also very possible that similar problems will arise within the County jurisdiction. In those cases the same program should be implemented with the County, assuming the same role applies as that described for the city.

Traffic calming projects depend on the strong support by residents in the immediate area. Traffic calming methods should also be used only to address real, rather than perceived, problems. For these and other related reasons, traffic calming projects should meet several criteria before being considered for implementation.

The Traffic Calming Program is a three-phase process consisting of 12 individual steps. The main activities of each of the phases are as follows: Phase I) identification and verification of a traffic problem; Phase II) selection and implementation of educational activities and enforcement techniques; and Phase III) selection and implementation of physical traffic calming measures. Each phase requires the participation of the neighborhood residents, the City, and the City Engineering Department.

In the first phase, the residents are responsible for contacting the City, identifying their concerns, and submitting a project application. At this point the City Engineer will make initial contacts with the residents, and conduct informal meetings to better understand the nature of the problem. The City Engineer will then perform preliminary studies to validate the perceived problem, and determine whether or not the process should advance.

During Phase II, the City Engineer will facilitate a neighborhood meeting at which the City will present a range of appropriate educational activities and enforcement alternatives. The City Engineer will work with the neighborhood residents to identify a preferred solution. The residents will then be responsible for circulating a petition and fostering support for the identified solution. Phase III responsibilities will be divided similarly to those in Phase II, although the solutions being discussed at this point will be applicable physical devices. When a permanent solution is selected, the City Engineer will determine the appropriate funding sources based on the nature of the problem. Traffic calming projects will be financed on a case-by-case basis. Residents should expect to pay some portion of the cost of installing permanent traffic calming devices in their neighborhood.

8.12 TRAFFIC CALMING PROGRAM FOR EXISTING STREETS

The following is a sample three-phase procedure for implementing traffic calming measures on existing facilities. In order to accommodate seasonal changes, special events or any other irregular circumstances, the process may be altered or accelerated at the discretion of the City Engineer. The City's traffic calming program for existing streets is intended for application to local streets only.

8.12.1 Phase I

Step 1: A Citizen contacts the City Engineering Department about a traffic problem. The City Engineer responds by sending the Citizen information about the Traffic Calming Program and an Investigation Request Form.

Step 2: The Citizen completes the "Investigation Request Form" and returns it to the City Engineer. The form should include a description of the problem and location, as well as the signatures of 10 other neighborhood residents from separate households who agree that the problem exists. A Neighborhood Contact is also identified on the form. After receipt of the form, the City Engineer contacts neighborhood residents to discuss the nature of the perceived problem. The information gathered in this step helps determine the types of studies needed to be performed in Step 3.

Step 3: The City Engineer conducts a field review of the location, and collects the appropriate data in order to determine whether or not the perceived problem actually exists. In most cases, accident records should be reviewed, and traffic volumes measured. Depending upon the nature of the complaint, a speed study, truck count, or cut-through study may also be appropriate. In order to be considered for a traffic calming project, the location must have traffic volumes of at least 800 vehicles per day. It must meet at least one of the following criteria: three or more accidents in a 12-month period; an 85th percentile speed that is at least five (5) miles per hour over the posted speed limit; or truck volumes exceeding 10 percent of the total traffic volume.

After the field data is collected and reviewed, the City Engineer informs the Neighborhood Contact of the results. If the location does not meet the above criteria, the City Engineer meets with neighborhood residents to review the study results and discuss other options. At this point, the Traffic Calming Program is concluded. If the problem location meets the required criteria, the City Engineer reviews the Phase II process with the Neighborhood Contact.

8.12.2 Phase II

Step 4: The City Engineer determines the boundaries of the affected neighborhood. Neighborhood boundaries will typically follow arterial streets or other natural breaks. The City Engineer schedules a neighborhood meeting to discuss possible Phase II solutions to the problem. The City Engineer gives the Neighborhood Contact a map of the designated boundaries so he/she can inform area residents of the meeting. At the meeting, the City Engineer presents a range of appropriate measures. Potential Phase II measures will emphasize the least intrusive measures, consisting of enforcement, educational activities, and/or minor physical changes (brush trimming, and sign or pavement marking installation).

Step 5: The Neighborhood Contact circulates a Phase II Petition within the defined boundaries. The petition identifies the proposed education and enforcement techniques, and asks residents to indicate their approval. If the petition is not signed by 40 percent of the property owners within the defined neighborhood, the process is terminated. If the petition is signed by at least 40 percent of the property owners, the City and/or Neighborhood will then implement the Phase II measures.

Step 6: Approximately 90 days after implementation of the Phase II measures, the City repeats the data collection efforts. (This 90-day period may be modified by the City to accommodate seasonal conditions and other factors.) If the problem has been resolved, the education and enforcement activities can be tapered off and the process concluded. If the situation arises again at a later date, as confirmed by data, the process can begin again at Step 6.

8.12.3 Phase III

Step 7: If the traffic problem has not been resolved by the Phase II measures, the City Engineer conducts an engineering study to determine a range of appropriate physical improvements to the location. Initially, less restrictive measures such as vertical or horizontal deflection of the roadway are preferable to roadway obstruction techniques.

Step 8: The City Engineer schedules a neighborhood meeting to review the Phase III improvement options. The Neighborhood Contact is responsible for notifying area residents about the meeting. The City Engineer facilitates the neighborhood meeting. Based on resident input, a preferred solution is selected from the range of possible solutions. If a temporary version of this traffic-calming device is not practical, proceed to Step 11.

Step 9: If a temporary traffic-calming device is suitable, the Neighborhood Contact circulates a Phase III Petition for Temporary Measures. The process ends if the petition is not signed by 50 percent of the property owners within the defined boundaries. If at least 50 percent of the property owners sign the petition, the City constructs a temporary version of the preferred traffic-calming device.

Step 10: After one year, the City repeats the data collection process to determine whether or not the temporary device is effective. If it is found to not be effective, the City Engineer notifies the Neighborhood Contact, and the device is removed. The process can then be repeated from Step 7.

Step 11: If the temporary device is effective, the City Engineer develops a preliminary design and cost estimate for a permanent traffic calming device(s), and determines who will finance the permanent solution. The City then provides Neighborhood Contact with this information and indicates that the area property owners are receptive to a Petition for Permanent Measures.

Step 12: The Neighborhood Contact circulates a Phase III Petition for Permanent Measures, which includes a copy of the preliminary design and cost estimate, as well as an explanation of financial responsibility. If the petition is not signed by 70 percent of the area property owners, the process is terminated and any temporary devices removed. If at least 70 percent of the property owners sign the petition, the City Engineer performs a final design, and constructs a permanent traffic-calming device.

There are numerous points at which the traffic calming implementation process can be terminated due to lack of neighborhood support. Should neighborhood sentiment change at a later date, the process may be resumed at the same step where it left off.

8.12.4 Project Costs

Traffic problems on existing streets are usually caused by one of the following situations: poor initial street design; inadequacy of the major street network; or commercial and/or residential development adjacent to the neighborhood. The cost of financing traffic calming projects to resolve such problems should be distributed accordingly. As part of the initial investigation, the nature and cause of the traffic problem will be identified. The City will use this information to determine the appropriate division of project costs and identify who (the City, neighborhood residents, developers, other parties) may be involved in paying for the traffic calming measures.

The costs of Steps 1 through 11 will be borne by the City. Permanent Phase III construction (Step 12) will be financed by some combination of neighborhood contributions, development fees, and funds from other sources.

8.12.5 Removal of Permanent Traffic Calming Devices

Refer to the local policy for removal of a permanent traffic calming device. The neighborhood residents will be responsible for paying the cost of removing traffic calming devices.

9.1 Functional Highway Systems in Urbanized Areas

The discussion in this Chapter relates to the recommended functional classification network for the Greater Bozeman area, not the Federally approved classification system. Bozeman has a local functional classification based on a future network that shows how the street network should develop over time and is intended to be used as a planning tool for planning future developments. The Federally approved functional classification is based on current conditions and reflects how roads currently function within the network and is used to determine federal funding eligibilities and design standards for federal-aid programs.

The roadways that make up the street network within a community can be subdivided into categories based upon the function of the road. Roadway functional classifications include interstate principal arterials; non-interstate principal arterials; minor arterials; collector routes; and local streets, however, there are two classes of collectors, major and minor. **Figure 9-17** shows rural standards. Although volumes may differ on urban and rural sections of a street it is important to maintain coordinated right-of-way standards. A description of these classifications is provided in the following text.

9.1.1 Principal Arterial – Interstate

The sole purpose of the interstate is to provide for regional and interstate travel. Interstate highways are access-controlled facilities with access provided only at a limited number of interchanges. The interstate system has been designed as a high-speed facility with all road intersections being grade separated. Interstate 90, which traverses the study area, is a four-lane divided highway with a posted speed limit of 75 miles per hour (mph) for automobiles, and 65 mph for trucks.

9.1.2 Principal Arterial – Non-Interstate

The purpose of the non-interstate principal arterial is to serve the major centers of activity, the highest traffic volume corridors, and the longest trip distances in an urban area. This group of roads carries a high proportion of the total traffic within the urban area. Most of the vehicles entering and leaving the urban area, as well as most of the through traffic bypassing the central business district, utilize principal arterials. Significant intra-area travel, such as between central business districts and outlying residential areas, and between major suburban centers, are served by principal arterials.

The spacing between non-interstate principal arterials may vary from less than one mile in highly developed areas (e.g., the central business district), to five miles or more on the urban fringes. The major purpose of the non-interstate principal arterial is to provide for the expedient movement of traffic. Service to abutting land is a secondary concern. On-street parking should not be allowed along this type of corridor.

9.1.3 Minor Arterial Street System

The minor arterial street system interconnects with and augments the urban principal arterial system. It accommodates trips of moderate length at a somewhat lower level of travel mobility than principal arterials, and it distributes travel to smaller geographic areas. With an emphasis on traffic mobility, this street network includes all arterials not classified as principal arterials while providing access to adjacent lands.

The spacing of minor arterial streets may vary from several blocks to a half-mile in the highly developed areas of town, to several miles in the suburban fringes. They are not normally spaced more than one mile apart in fully developed areas.

9.1.4 Collector Street System

The urban collector street network serves a joint purpose. It provides equal priority to the movement of traffic, and to the access of residential, business, and industrial areas. This type of roadway differs from those of the arterial system in that the facilities on the collector system may traverse residential neighborhoods. The system distributes trips from the arterials to ultimate destinations. The collector streets also collect traffic from local streets in the residential neighborhoods, channeling it into the arterial system. On-street parking is usually allowed on most collector streets if space is available.

The rural collector street network serves the same access and movement functions as the urban collector street network – a link between the arterial system and local access roads. Collectors penetrate but should not have continuity through residential neighborhoods. Some potential collector locations have been shown in the fringe area. The actual location of collectors should be flexible to best serve developing areas and the public. Several design guidelines should be kept in mind as new subdivisions are designed and reviewed. The most important concept is that long segments of continuous collector streets are not compatible with a good functional classification of streets. Long, continuous collectors will encourage through traffic, essentially turning them into arterials. This, in turn, results in the undesirable interface of local streets with arterials, causing safety problems and increased costs of construction and maintenance. The collector street system should intersect arterial streets at a uniform spacing of one-half to one-quarter mile in order to maintain good progression on the arterial network. Ideally, collectors should be no longer than one to two miles without discontinuities. Opportunities need to be identified through good design and review of subdivisions to create appropriate collector streets in developing areas.

9.1.5 Urban Local Street System

The local street network comprises all facilities not included in the higher systems. Its primary purpose is to permit direct access to abutting lands and connections to higher systems. Usually service to through-traffic movements is intentionally discouraged. On-street parking is usually allowed on the local street system.

9.2 Facility Size Versus Traffic Volume

The size of a roadway is based upon the anticipated traffic demand. It is desirable to size the roadways to comfortably accommodate the traffic demand that is anticipated to occur 20 years from the time it is constructed. The selection of a 20-year design period represents a desire to receive the most benefit from an individual construction project's service life within reasonable planning limits. The design, bidding, mobilization, and repair of affected adjacent properties can consume a significant portion of an individual project's budget. Frequent projects to make minor adjustments to a roadway can therefore be prohibitively expensive. As roadway capacity generally is provided in large increments, a long term horizon is necessary.

There are two measurements of a street's capacity, Annual Average Daily Traffic (AADT) and Peak Hour. AADT measures the average number of vehicles a given street carries over a 24- hour period. Since traffic does not usually flow continuously at the maximum rate, AADT is not a statement of maximum capacity. Peak Hour measures the number of vehicles that a street can physically accommodate during the busiest hour of the day. It is therefore more of a maximum traffic flow rate measurement than AADT. When the Peak Hour is exceeded, the traveling public will often perceive the street as "broken" even though the street's AADT is within the expected volume. Therefore, it is important to consider both elements during design of corridors and intersections.

Physical size of the roadway and the required right-of-way is a function of the land use that will occur along the street corridor. These uses will dictate the vehicular traffic characteristics, travel by pedestrians and bicyclists, and need for on-street parking. The right-of-way required should always be based upon the ultimate facility size.

The actual amount of traffic that can be handled by a roadway is dependent upon the presence of parking, number of driveways and intersections, intersection traffic control, speed of the roadway, and roadway alignment. The data presented in **Table 9-1** indicates the approximate volumes that can be accommodated by a particular roadway. As indicated in the differences between the two tables, the actual traffic that a road can handle will vary based upon a variety of elements including: road grade; alignment; pavement condition; number of intersections and driveways; the amount of turning movements; and the vehicle fleet mix.

Table 9-1
Approximate Volumes for Planning of Future Roadway Improvements

Road Segment	Volumes[1]	Volumes[2]
Two Lane Road	Up to 12,000 VPD	Up to 15,000 VPD*
Three Lane Road	Up to 18,000 VPD	Up to 22,500 VPD*
Four Lane Road	Up to 24,000 VPD	Up to 30,000 VPD*
Five Lane Road	Up to 35,000 VPD	Up to 43,750 VPD*

[1]Historical management conditions
[2]Ideal management conditions
*Additional volumes may be obtained in some locations with adequate road design, access control, and other capacity enhancing methods.

9.3 RECOMMENDED MAJOR STREET NETWORK

The major street network consists of all interstate principal arterial, non-interstate principal arterial, minor arterial, and collector routes. Local streets are not included on the major street network. The major street network recommended in the *Greater Bozeman Area Transportation Plan – 2001 Update* was used as a basis, or starting point, in developing the major street network for this update.

Establishing a plan for a community's future street layout is essential to proper land development and community planning. It is important that planners, landowners, and developers know where the future road network needs to be located. With an approved major street network, everyone will know where the future arterials need to be located. This will assist everyone involved in anticipating right-of-way needs, and appropriate land-uses.

The study area was examined to determine the most appropriate placement for the future arterial network. The principal arterials were set in place first with two-mile spacing. The minor arterials were then inserted on a one-mile spacing to fill in between the principals. Some collector routes were also established. It is assumed that other collector routes would be established when the development patterns in an area are defined.

The recommended existing and future major street networks are shown in **Figure 9-1** and **Figure 9-2**. The future alignments shown are conceptual in nature and may vary based on factors such as topography, wetlands, land ownership, and other unforeseen factors. The purpose of these figures is to illustrate the anticipated network at full build-out. It is likely that many of the route corridors shown will not be developed into roads for many decades to come. On the other hand, if development is proposed in a particular area, the recommended major street network will insure that the arterial corridors will be established in a fashion that produces an efficient and logical future road network. It is important to note that presenting the major street network at this time is not intended to control or influence development. It is presented in an effort to help plan for the future development of the road system in the community.

The acquisition of right-of-ways for these future road corridors should be one of the community's highest priorities. It is essential that these corridors be dedicated for roadway use before an area develops. This action will insure that the roadway corridors remain clear and available for use when the future need arises.

In addition, a final "travel demand model" run of the recommended improvements has been made. **Figure 9-3** thru **Figure 9-6** show the future year (2030) travel demand model estimated traffic volumes and v/c ratios based on the recommended improvements discussed in **Chapter 5** and the Major Street Network.

Interpretation of Map

This map presents the Recommended Major Street Network. It shows how the street network should develop over time and is intended to be used as a planning tool. It will assist in the evaluation of long-term traffic needs when planning future developments. The route alignments shown are conceptual in nature.

The actual alignments may vary based on development patterns, geographic features, and other issues unknown at this time. The community planners will strive to design the roads to fit the character of the landscape and minimize impacts on natural features such as wetlands, mature trees, and riparian corridors.

Most of these routes are not recommended for construction at this time. The development of these conceptual routes will take decades to become reality, and will only become roads if traffic needs materialize as a result of development in the area. Many of the existing roads identified as arterial routes are currently functioning as collectors or local streets and will be upgraded as traffic needs increase.

It is important to note that although this major street network is recommended as part of the Transportation Plan, it does not reflect the federally approved functional classification criteria which is based on current conditions rather than anticipated future conditions.

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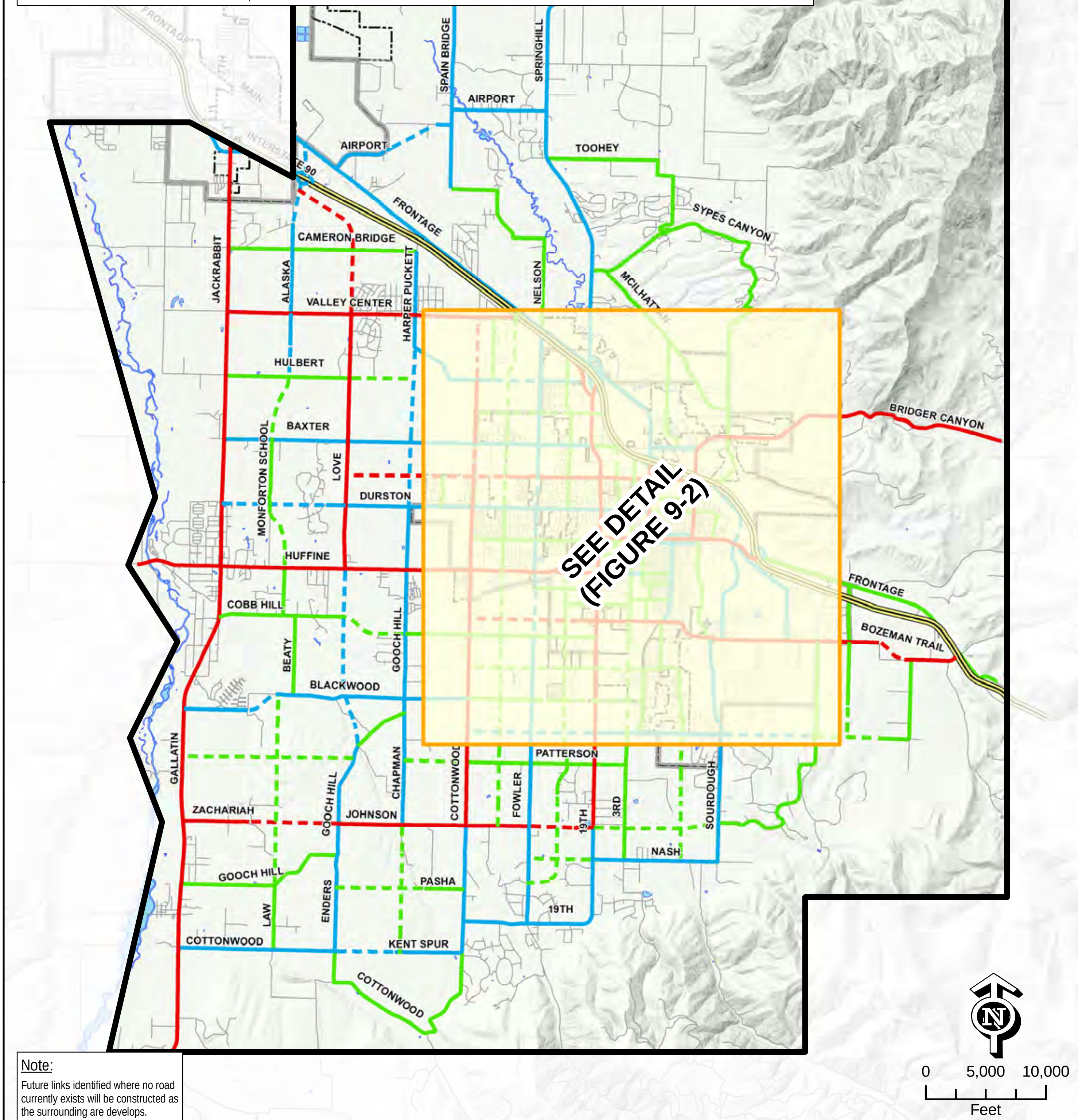

Note:
Future links identified where no road currently exists will be constructed as the surrounding are develops.

Legend

- Interstate
- Principal Arterial
- Minor Arterial
- Collector
- Future Principal Arterial*
- Future Minor Arterial*
- Future Collector*
- Local Roadway
- Study Area Boundary
- Detail Area
- City Boundary
- Urban Boundary

RPA

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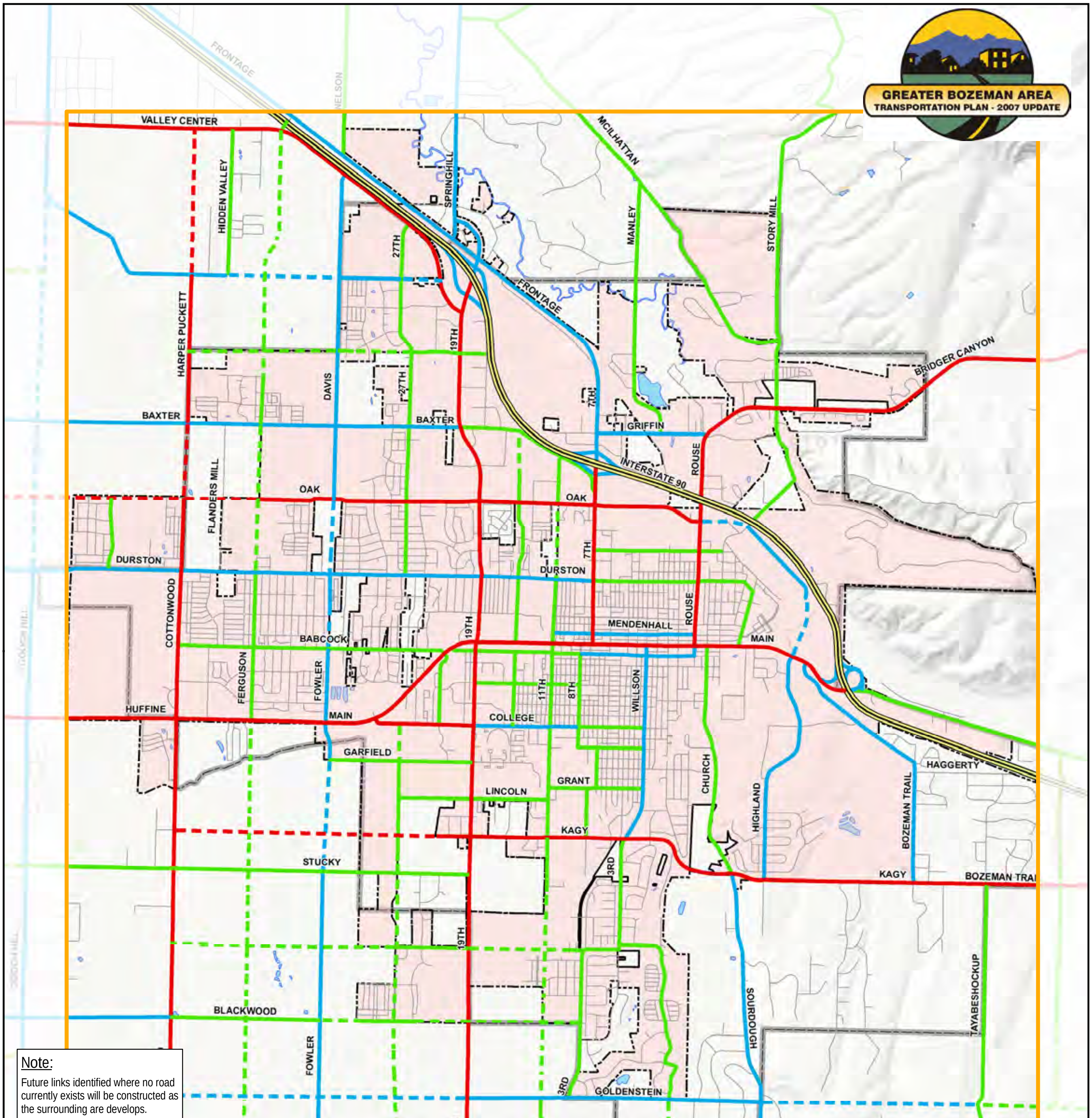
Existing Major Street Network and Future Right-Of-Way Corridor Needs

Figure 9-1



Note:
Future links identified where no road currently exists will be constructed as the surrounding are develops.

Interpretation of Map

This map presents the Recommended Major Street Network. It shows how the street network should develop over time and is intended to be used as a planning tool. It will assist in the evaluation of long-term traffic needs when planning future developments. The route alignments shown are conceptual in nature.

The actual alignments may vary based on development patterns, geographic features, and other issues unknown at this time. The community planners will strive to design the roads to fit the character of the landscape and minimize impacts on natural features such as wetlands, mature trees, and riparian corridors.

Most of these routes are not recommended for construction at this time. The development of these conceptual routes will take decades to become reality, and will only become roads if traffic needs materialize as a result of development in the area. Many of the existing roads identified as arterial routes are currently functioning as collectors or local streets and will be upgraded as traffic needs increase.

It is important to note that although this major street network is recommended as part of the Transportation Plan, it does not reflect the federally approved functional classification criteria which is based on current conditions rather than anticipated future conditions.

Legend

- Interstate
- Principal Arterial
- Minor Arterial
- Collector
- Future Principal Arterial*
- Future Minor Arterial*
- Future Collector*
- Local Roadway
- Detail Area
- City Boundary
- Urban Boundary

RPA

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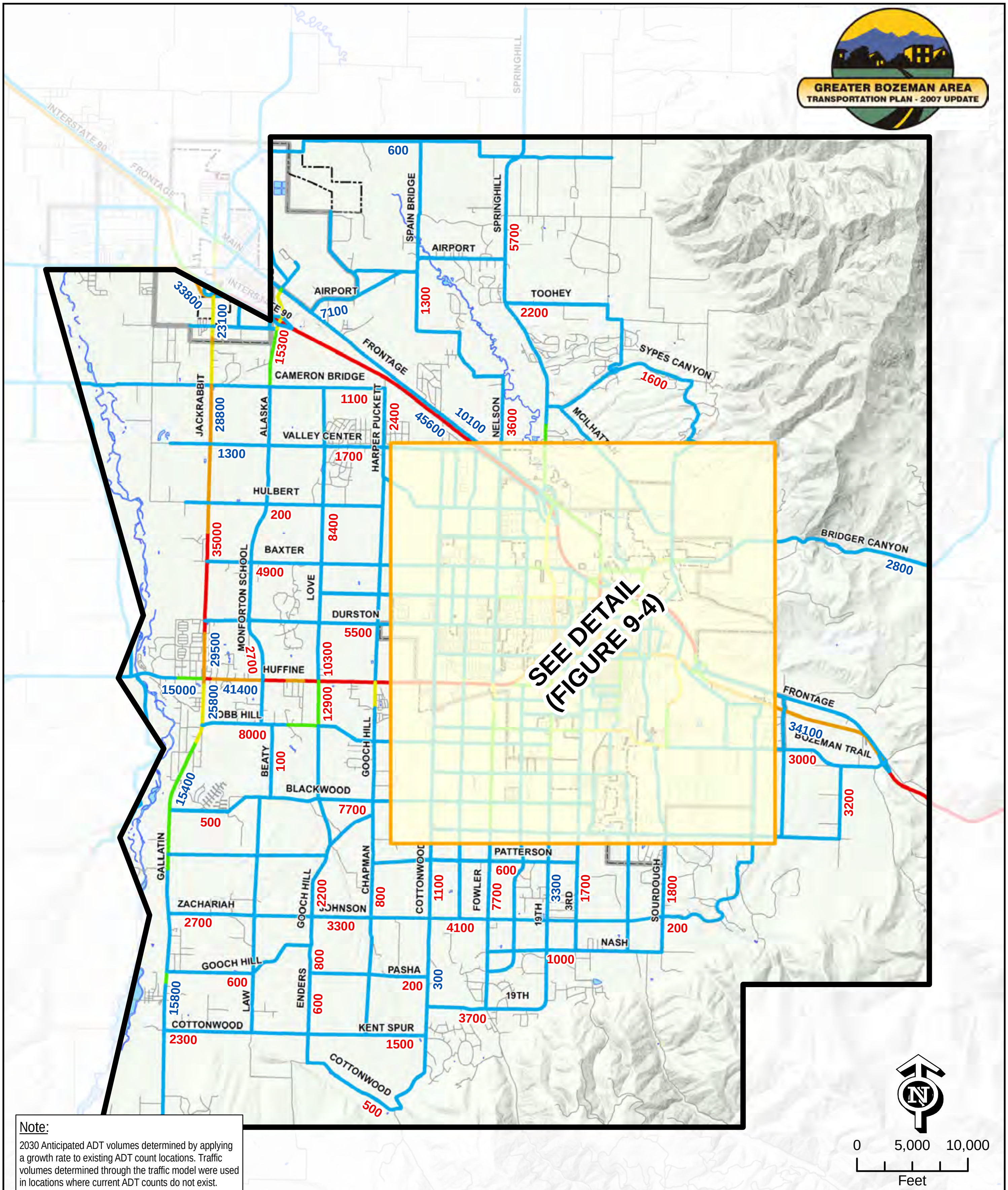
Existing Major Street Network and Future Right-Of-Way Corridor Needs

Figure 9-2



Note:

2030 Anticipated ADT volumes determined by applying a growth rate to existing ADT count locations. Traffic volumes determined through the traffic model were used in locations where current ADT counts do not exist.

Legend

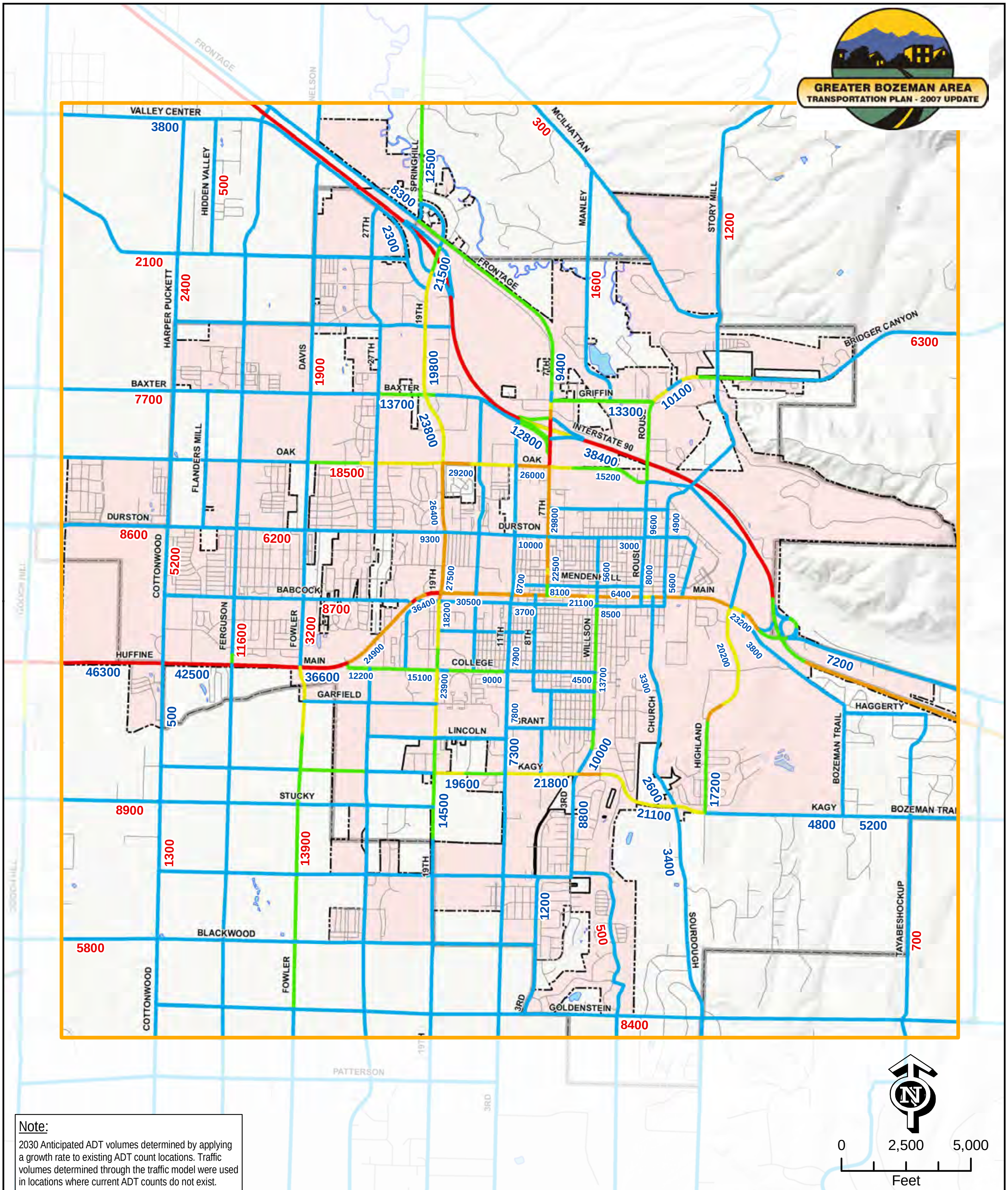
- < 12,000
- 12,000 - 18,000
- 18,000 - 24,000
- 24,000 - 35,000
- \> 35,000
- 1200 2030 Anticipated Average Daily Traffic (ADT)*
- 1200 2030 Model Traffic Volume*
- Study Area Boundary
- Detail Area
- City Boundary
- Urban Boundary

RPA

Greater Bozeman Area Transportation Plan (2007 Update)

Future (2030) MSN ADT Traffic Volumes

Figure 9-3



Note:
2030 Anticipated ADT volumes determined by applying a growth rate to existing ADT count locations. Traffic volumes determined through the traffic model were used in locations where current ADT counts do not exist.

Legend

< 12,000	Detail Area
12,000 - 18,000	City Boundary
18,000 - 24,000	Urban Boundary
24,000 - 35,000	1200 2030 Anticipated Average Daily Traffic (ADT)*
> 35,000	1200 2030 Traffic Model Volume*

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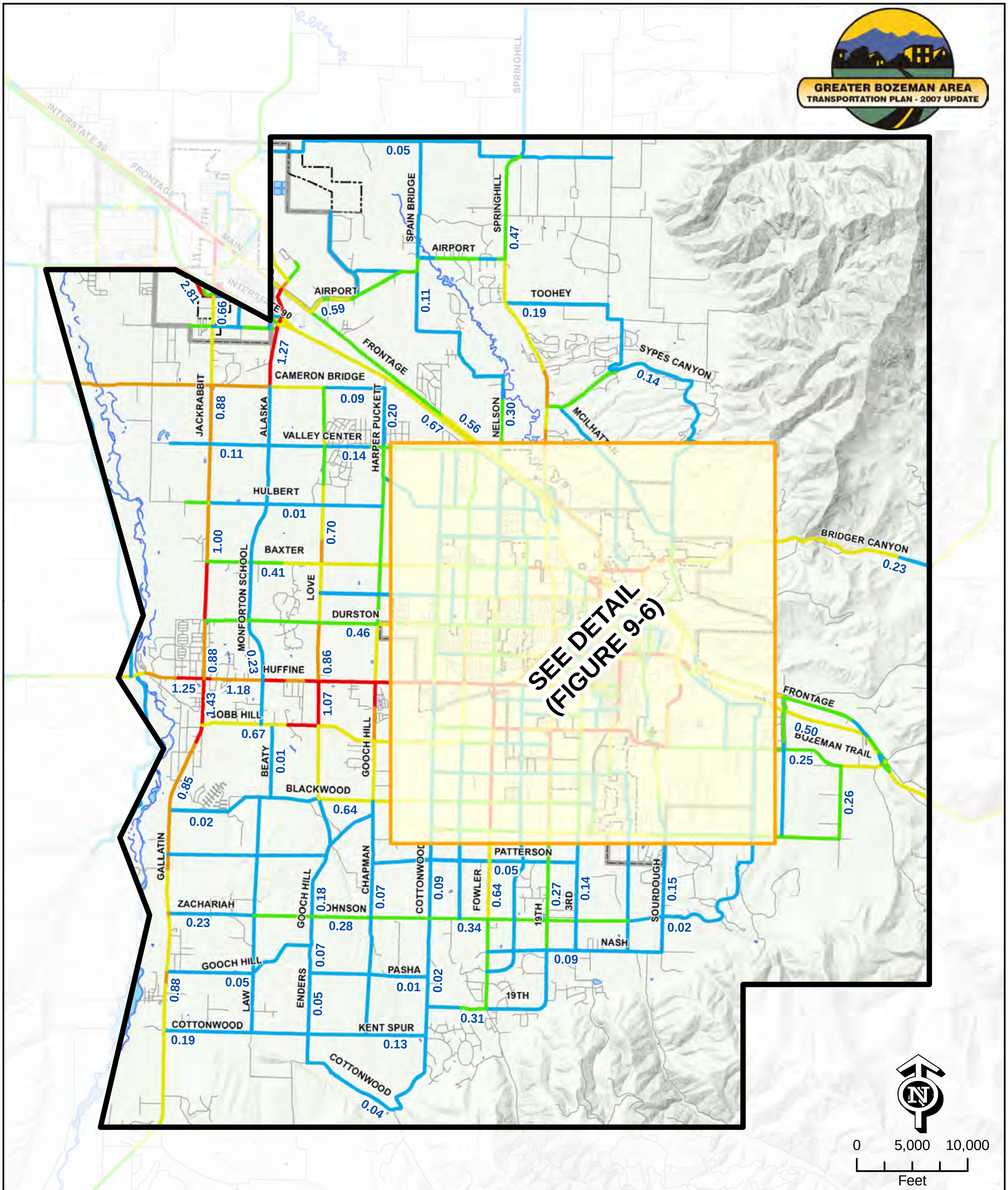
Future (2030) MSN ADT Traffic Volumes

Figure 9-4



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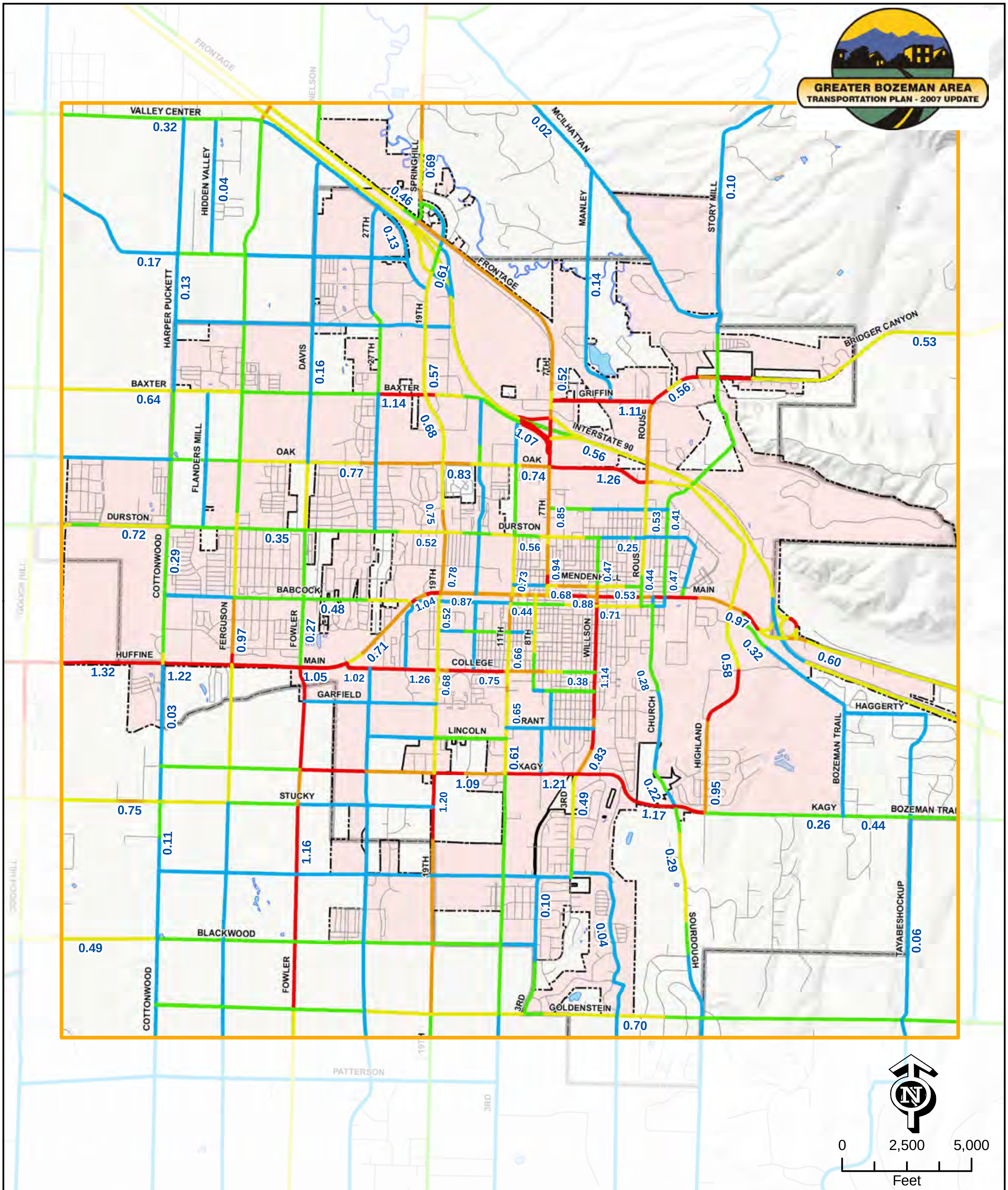
Future (2030) MSN V/C
Volume to Capacity Ratio
Figure 9-5



Legend

Volume to Capacity Ratio (V/C)

- <0.25
- 0.25-0.49
- 0.50-0.74
- 0.75-1.00
- >1.00

- Detail Area
- City Boundary
- Urban Boundary
- 0.25 Volume / Capacity Ratio

RPA

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Future (2030) MSN V/C
Volume to Capacity Ratio
Figure 9-6

9.4 Right-of-Way Needs

The recommended road standards identify the amount of right-of-way that is necessary to accommodate the full build-out of each type of facility. The desired right-of-way for principal arterials is 120 feet, 100 feet for minor arterials, 90 feet for collectors, and 60 feet for local roads.

Many existing roads within the community do not have the necessary right-of-way based on these standards. Apparently there are also public roads within the study area that traverse parcels of private property without any formal right-of-way agreements or easements.

It is recommended that both the city and county establish a policy to review all existing roadways and identify roads that are located within right-of-way corridors that are less than the desirable width. Additional right-of-way should be acquired in these areas where possible. The city and county should attempt to acquire the right-of-way for both existing and future roads where the opportunity exists. It is recommended that the right-of-way necessary for all future road segments be acquired through the development process as undeveloped areas develop. Even though the initial road may only be a two-lane or three-lane facility, providing the full amount of right-of-way will enable the corridor to be expanded at a later date while avoiding an expensive and disruptive land acquisition process at some time in the future.

Nothing in the *Greater Bozeman Area Transportation Plan - 2007 Update* should be read as an encouragement of the use by the County of its power of eminent domain.

9.5 Roundabout Conceptual Designs

The FHWA publication *Roundabouts: An Informational Guide* categorizes roundabouts into six categories according to size, number of lanes, and environment. These categories, along with design features specific to the design type, are listed below:

Mini-roundabouts

- Low-speed urban environments
- Environments with right-of-way constraints
- Maximum recommended entry speed of 15 mph
- Inscribed diameter of 45-80 feet
- 10,000 vpd volume for 4-legged intersection

Urban compact roundabouts

- Pedestrian and bicyclist friendly compared to other types of roundabouts
- Low vehicle speeds with maximum recommended entry speed of 15 mph
- Inscribed diameter of 80-100 feet
- Capacity should not be a critical issue
- 15,000 vpd volume for 4-legged intersection

Urban single-lane roundabouts

- Consistent entering and exiting speeds
- Slightly higher speeds and capacities than urban compact roundabouts
- Less pedestrian friendly than other types of roundabouts due to the higher speeds
- Maximum recommended entry speed of 20 mph
- Inscribed diameter of 100-130 feet
- 20,000 vpd volume for 4-legged intersection

Urban double-lane roundabouts

- At least one entry with two lanes
- Require wider circulatory roadways with inscribed diameter of about 150-180 feet
- Similar speeds to urban single-lane roundabouts with maximum recommended entry speed of 25 mph
- May need special design considerations for high volumes of bikes and pedestrians
- Volume varies with design

Rural single-lane roundabouts

- Higher approach speeds require additional attention
- May have larger diameters than urban roundabouts to allow for higher speeds
- Inscribed diameter of 115-130 feet with maximum recommended entry speed of 25 mph
- 20,000 vpd for 4-legged intersection

Rural double-lane roundabouts

- Higher entry speeds and larger diameters than urban double-lane roundabouts

- Inscribed diameter of 180-200 feet with maximum recommended entry speed of 30 mph
- Recommended supplementary approach treatments
- Volume varies with design

The FHWA guide does not discuss roundabouts with more than two lanes; however, they are possible and have been constructed in numerous locations. The guide does discuss each of the roundabout categories listed above and gives design principles and concepts that relate to each category.

Conceptual plan view graphics for each of these design categories can be found in **Figures 9-7** thru **9-12**.

9.5.1 Pedestrian Challenges

Roundabouts can present difficult challenges for blind and visually impaired pedestrians. The design of the roundabout needs to go to great length to minimize the hazard to those pedestrians. That includes having the roundabout itself and the approached to the roundabout well lit both to enable the pedestrian to see as much as possible and so motorists approaching a crosswalk can see the pedestrian.

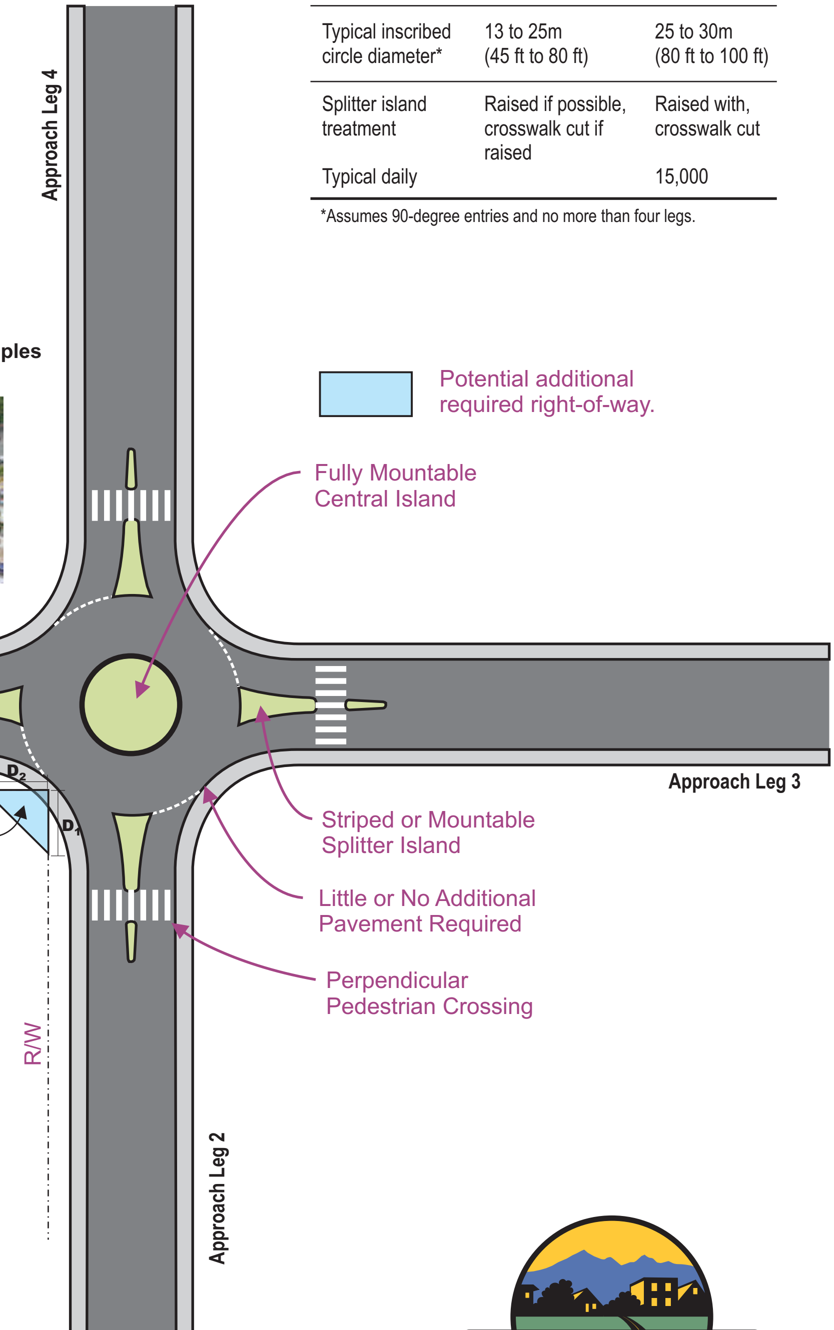
Particularly for roundabouts in locations where relatively large numbers of teenage and/or college-age pedestrians are anticipated, special care should be taken to incorporate design features that discourage pedestrians from taking a shorter route right across the traffic lanes instead of circling around the traffic lanes on the sidewalk.

It is critical that the width of the refuge islands in the middle of the pedestrian crosswalks be wide enough to adequately protect both the front and rear ends of persons pushing long, multi-child baby carriages, persons pushing wheelchairs, and cyclists walking their bicycle.

Mini-Roundabout Examples

Design Element	Mini Roundabout	Urban Compact
Recommended maximum entry design speed	25 km/h (15 mph)	25 km/h (15 mph)
Maximum number of entering lanes per approach	1	1
Typical inscribed circle diameter*	13 to 25m (45 ft to 80 ft)	25 to 30m (80 ft to 100 ft)
Splitter island treatment	Raised if possible, crosswalk cut if raised	Raised with, crosswalk cut
Typical daily		15,000

*Assumes 90-degree entries and no more than four legs.



Additional Right-of-Way Distance ($D_{1,2}$) Required

Functional Classification	Mini Roundabout	Urban Compact
Local	55’	90’
Collector	–	40’

Additional Right-of-Way Area (A) = ½ D_1 D_2
D_1 = additional R/W distance required for approach leg 1
D_2 = additional R/W distance required for approach leg 2

Notes:

- The additional right-of-way required for a roundabout located along a local or collector roadway should be determined by the largest potential roundabout at that location.
- These values assume a single unit truck/bus as the typical design vehicle.
- This table applies to all 4 corners of the roundabout.

Example:
If approach leg 1 is defined as a Collector roadway and approach leg 2 is defined as a Local roadway and the largest potential roundabout at that location is an Urban Compact roundabout, then D_1= 40’ and D_2= 90’.

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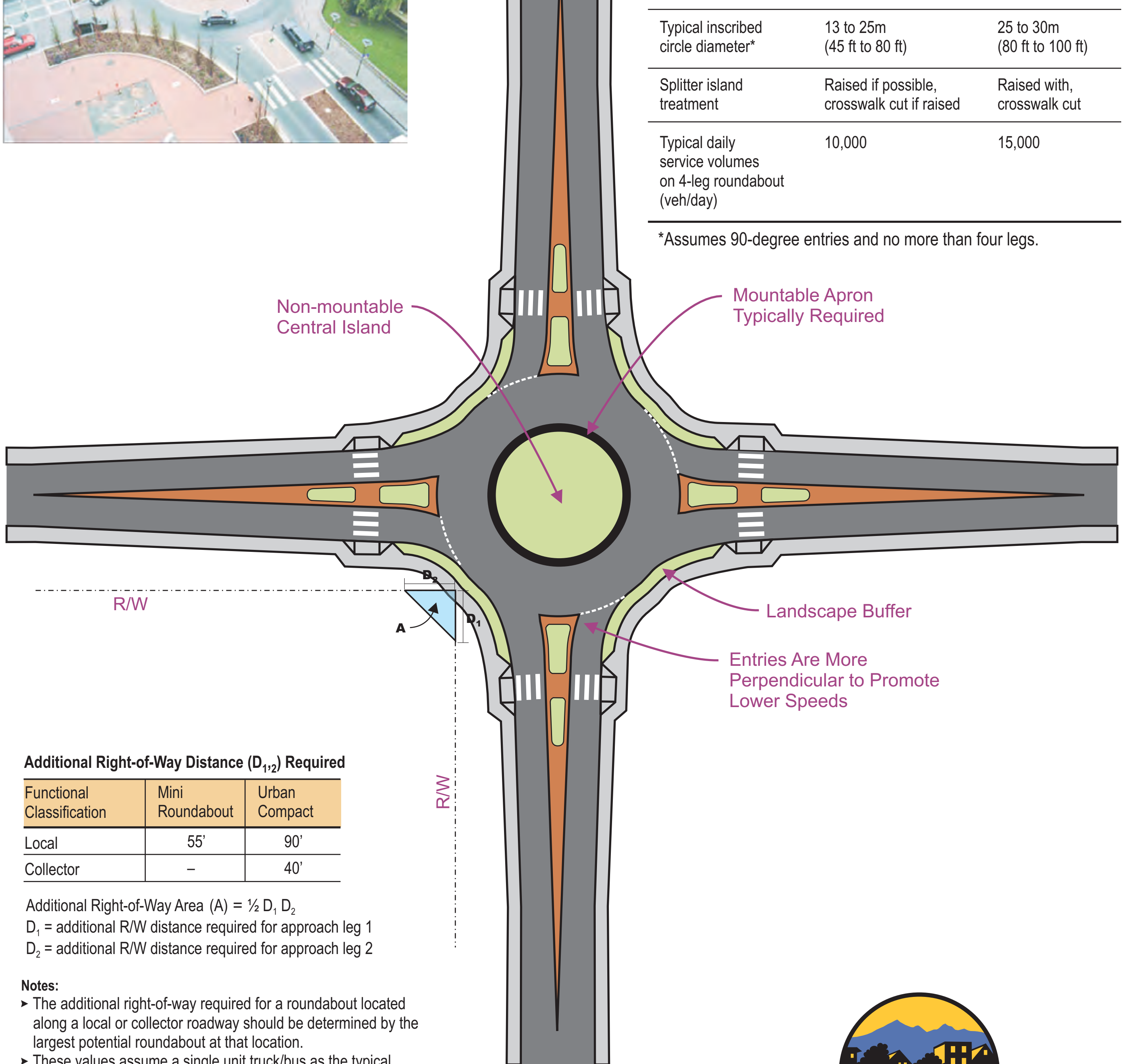
Mini-Roundabout
Conceptual Plan View
Figure 9-7

drawing1b_small.cdr

Urban Compact Roundabout Example

Design Element	Mini Roundabout	Urban Compact
Recommended maximum entry design speed	25 km/h (15 mph)	25 km/h (15 mph)
Maximum number of entering lanes per approach	1	1
Typical inscribed circle diameter*	13 to 25m (45 ft to 80 ft)	25 to 30m (80 ft to 100 ft)
Splitter island treatment	Raised if possible, crosswalk cut if raised	Raised with, crosswalk cut
Typical daily service volumes on 4-leg roundabout (veh/day)	10,000	15,000

*Assumes 90-degree entries and no more than four legs.



Additional Right-of-Way Distance ($D_{1,2}$) Required

Functional Classification	Mini Roundabout	Urban Compact
Local	55’	90’
Collector	–	40’

Additional Right-of-Way Area (A) = ½ D_1 D_2
D_1 = additional R/W distance required for approach leg 1
D_2 = additional R/W distance required for approach leg 2

Notes:
- The additional right-of-way required for a roundabout located along a local or collector roadway should be determined by the largest potential roundabout at that location.
- These values assume a single unit truck/bus as the typical design vehicle.
- This table applies to all 4 corners of the roundabout.

Example:
If approach leg 1 is defined as a Collector roadway and approach leg 2 is defined as a Local roadway and the largest potential roundabout at that location is an Urban Compact roundabout, then D_1= 40’ and D_2= 90’.

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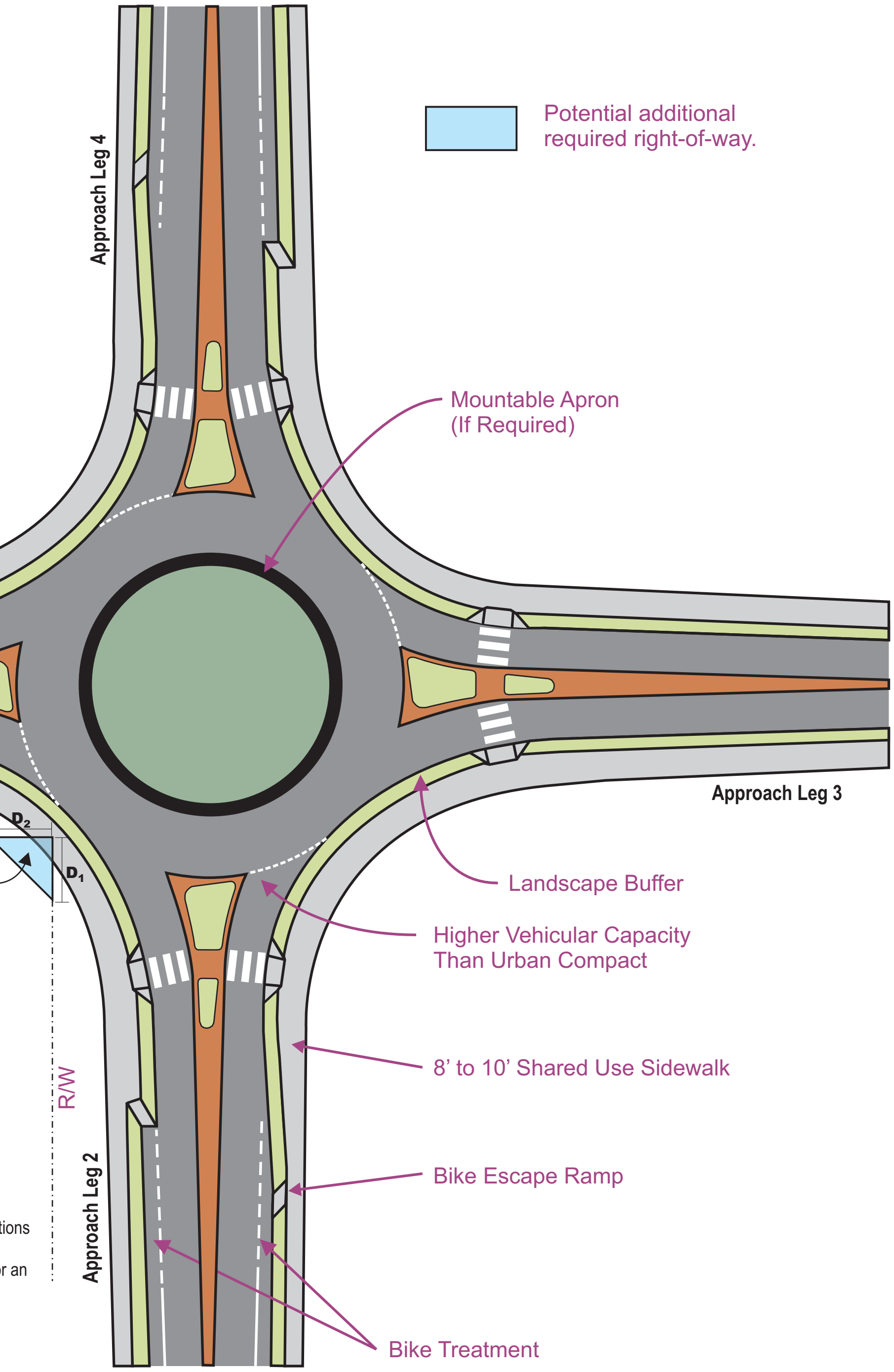
Urban Compact Roundabout
Conceptual Plan View
Figure 9-8

Drawing1_small.cdr

drawing2b_small.cdr

Urban Single-Lane Roundabout Example



Additional Right-of-Way Distance ($D_{1,2}$) Required

Functional Classification	Urban Single-Lane	Urban Double-Lane
Collector	75'	140'
Minor Arterial	60'	120'
Principal Arterial	–	85'

Additional Right-of-Way Area (A) = ½ D_1 D_2
D_1 = additional R/W distance required for approach leg 1
D_2 = additional R/W distance required for approach leg 2

Notes:
- For Collector and Minor Arterial roadways, the additional right-of-way required for an urban double-lane roundabout should be used in locations where the potential for an urban double-lane roundabout exists.
- For Principal Arterial roadways, the additional right-of-way required for an urban double-lane roundabout should always be used.
- These values assume a WB-67 typical design vehicle.
- This table applies to all 4 corners of the roundabout.

Example:
If approach leg 1 is defined as a Collector roadway and approach leg 2 is defined as a Minor Arterial roadway and the potential exists for an urban double-lane roundabout, then D_1= 140' and D_2= 120'.

Design Element	Urban Single-Lane	Urban Double-Lane
Recommended maximum entry design speed	35 km/h (20 mph)	40 km/h (25 mph)
Maximum number of entering lanes per approach	1	2
Typical inscribed circle diameter*	30 to 40m (100 ft to 130 ft)	45 to 55m (150 ft to 180 ft)
Splitter island treatment	Raised with crosswalk cut	Raised with, crosswalk cut
Typical daily service volumes on 4-leg roundabout (veh/day)	20,000	Based on design template used

**Assumes 90-degree entries and no more than four legs.*

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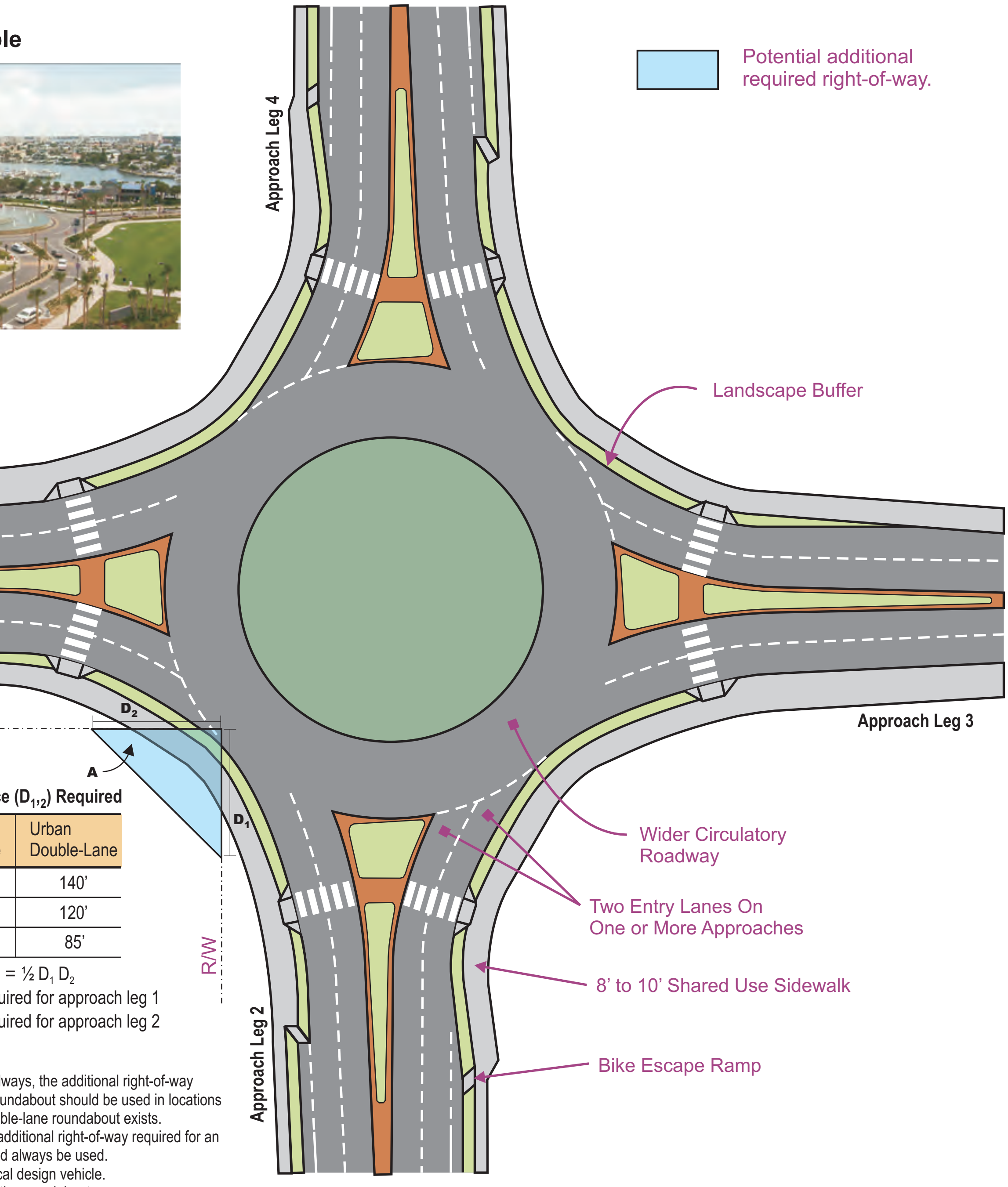
Urban Single-Lane Roundabout
Conceptual Plan View
Figure 9-9

drawing2_small.cdr

Urban Double-Lane Roundabout Example



Additional Right-of-Way Distance ($D_{1,2}$) Required

Functional Classification	Urban Single-Lane	Urban Double-Lane
Collector	75'	140'
Minor Arterial	60'	120'
Principal Arterial	–	85'

Additional Right-of-Way Area (A) = ½ D_1 D_2
D_1 = additional R/W distance required for approach leg 1
D_2 = additional R/W distance required for approach leg 2

Notes:
- For Collector and Minor Arterial roadways, the additional right-of-way required for an urban double-lane roundabout should be used in locations where the potential for an urban double-lane roundabout exists.
- For Principal Arterial roadways, the additional right-of-way required for an urban double-lane roundabout should always be used.
- These values assume a WB-67 typical design vehicle.
- This table applies to all 4 corners of the roundabout.

Example:
If approach leg 1 is defined as a Collector roadway and approach leg 2 is defined as a Minor Arterial roadway and the potential exists for an urban double-lane roundabout, then D_1= 140' and D_2= 120'.

Design Element	Urban Single-Lane	Urban Double-Lane
Recommended maximum entry design speed	35 km/h (20 mph)	40 km/h (25 mph)
Maximum number of entering lanes per approach	1	2
Typical inscribed circle diameter*	30 to 40m (100 ft to 130 ft)	45 to 55m (150 ft to 180 ft)
Splitter island treatment	Raised with crosswalk cut	Raised with, crosswalk cut
Typical daily service volumes on 4-leg roundabout (veh/day)	20,000	Based on design template used

**Assumes 90-degree entries and no more than four legs.*

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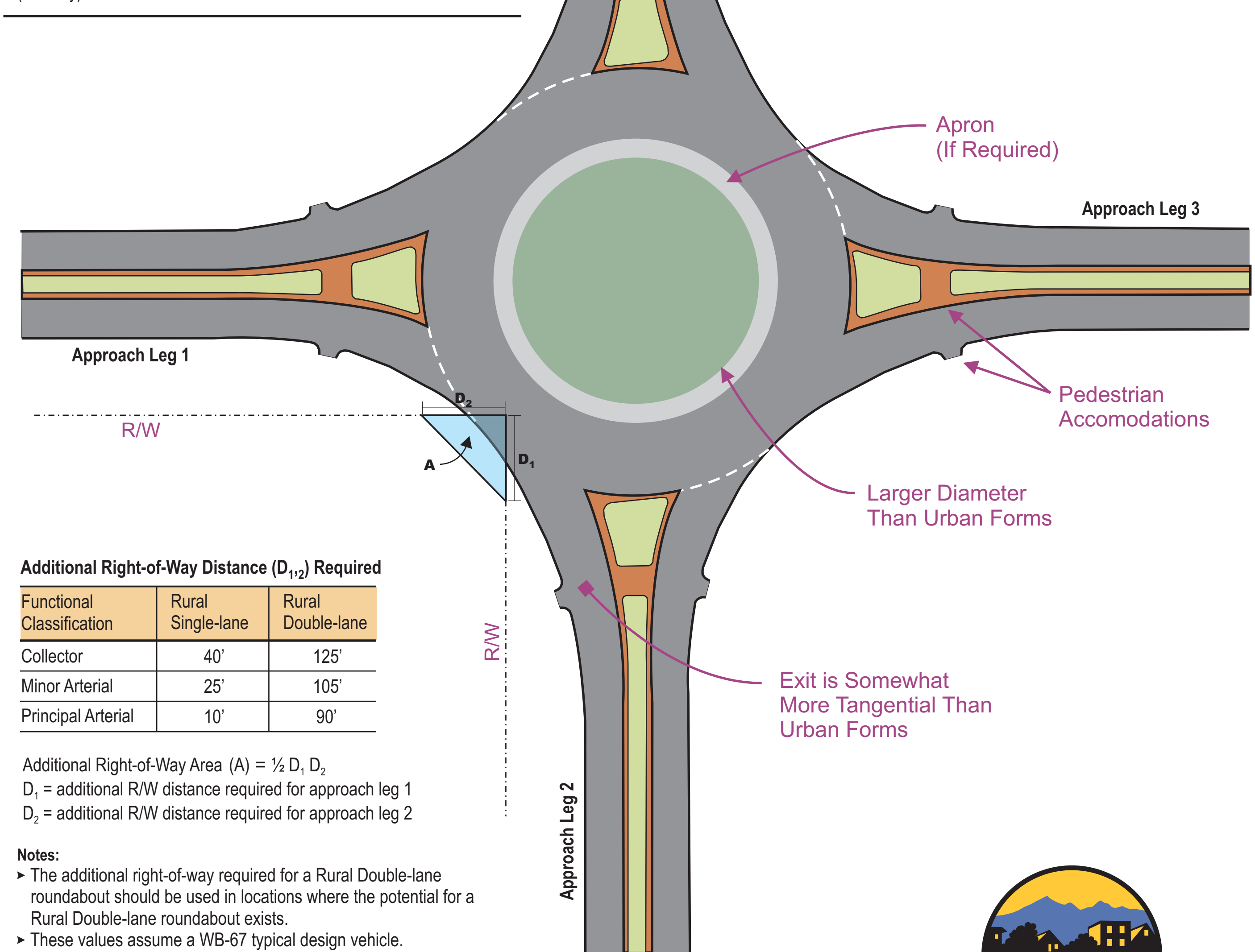
Urban Double-Lane Roundabout
Conceptual Plan View
Figure 9-10

Design Element	Rural Single-Lane	Rural Double-Lane
Recommended maximum entry design speed	40 km/h (25 mph)	50 km/h (30 mph)
Maximum number of entering lanes per approach	1	2
Typical inscribed circle diameter	35 to 40m (115 ft to 130 ft)	55 to 60m (180 ft to 200 ft)
Splitter island treatment	Raised and extended with crosswalk cut	Raised and extended with crosswalk cut
Typical daily service volumes on 4-leg roundabout (veh/day)	20,000	Based on design template used

Rural Single-Lane Roundabout Example



Additional Right-of-Way Distance ($D_{1,2}$) Required

Functional Classification	Rural Single-lane	Rural Double-lane
Collector	40’	125’
Minor Arterial	25’	105’
Principal Arterial	10’	90’

Additional Right-of-Way Area (A) = $\frac{1}{2} D_1 D_2$

D_1 = additional R/W distance required for approach leg 1

D_2 = additional R/W distance required for approach leg 2

Notes:

- The additional right-of-way required for a Rural Double-lane roundabout should be used in locations where the potential for a Rural Double-lane roundabout exists.
- These values assume a WB-67 typical design vehicle.
- This table applies to all 4 corners of the roundabout.

Example:

If approach leg 1 is defined as a Collector roadway and approach leg 2 is defined as a Minor Arterial roadway and the largest potential roundabout at that location is an Rural double-lane roundabout, then D_1= 125’ and D_2= 105’.

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Rural Single-Lane Roundabout

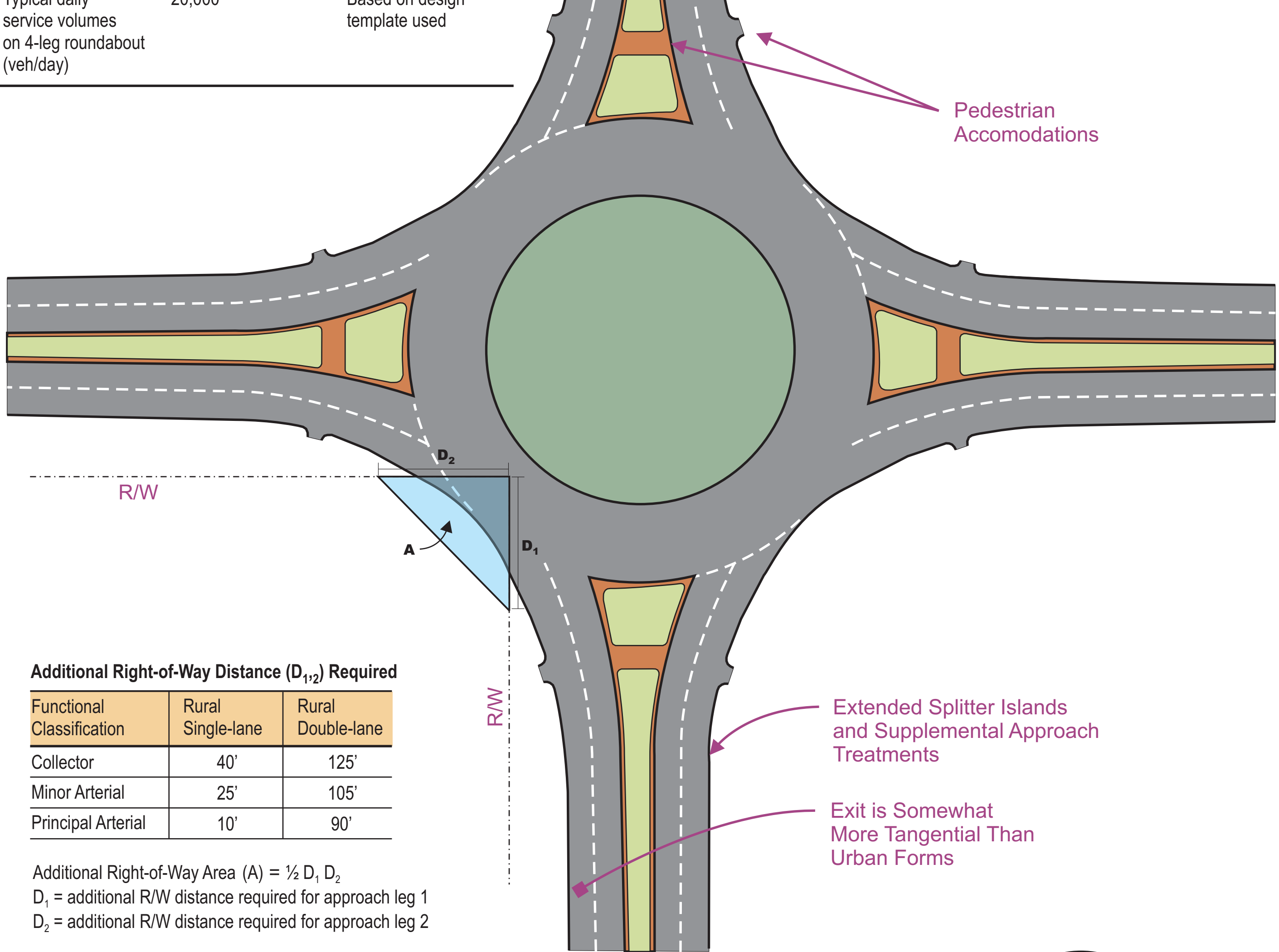
Conceptual Plan View

Figure 9-11

drawing3_small.cdr

Design Element	Rural Single-Lane	Rural Double-Lane
Recommended maximum entry design speed	40 km/h (25 mph)	50 km/h (30 mph)
Maximum number of entering lanes per approach	1	2
Typical inscribed circle diameter	35 to 40m (115 ft to 130 ft)	55 to 60m (180 ft to 200 ft)
Splitter island treatment	Raised and extended with crosswalk cut	Raised and extended with crosswalk cut
Typical daily service volumes on 4-leg roundabout (veh/day)	20,000	Based on design template used

Rural Double-Lane Roundabout Example



Additional Right-of-Way Distance ($D_{1,2}$) Required

Functional Classification	Rural Single-lane	Rural Double-lane
Collector	40’	125’
Minor Arterial	25’	105’
Principal Arterial	10’	90’

Additional Right-of-Way Area (A) = ½ D_1 D_2
D_1 = additional R/W distance required for approach leg 1
D_2 = additional R/W distance required for approach leg 2

Notes:
- The additional right-of-way required for a Rural Double-lane roundabout should be used in locations where the potential for a Rural Double-lane roundabout exists.
- These values assume a WB-67 typical design vehicle.
- This table applies to all 4 corners of the roundabout.

Example:
If approach leg 1 is defined as a Collector roadway and approach leg 2 is defined as a Minor Arterial roadway and the largest potential roundabout at that location is an Rural double-lane roundabout, then D_1= 125’ and D_2= 105’.

GREATER BOZEMAN AREA
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Greater Bozeman Area Transportation Plan (2007 Update)

Rural Double-Lane Roundabout
Conceptual Plan View
Figure 9-12

drawing3b_small.cdr

9.6 Recommended Roadway Typical Sections

It is important to have established standards that identify the overall character of various roads within a community. These standards should identify the anticipated amount of right-of-way necessary at full build-out. They should also include all of the design elements necessary such as sidewalks, bicycle facilities, landscaping, and space for utilities and snow storage. The standards should reflect the uses for each type of road, and the applicable traffic volumes anticipated.

There should be standards for both urban and rural street designs. Standards have been developed for all of the categories of roads that are found within the Bozeman area including local and collector roads, as well as minor and principal arterials. A variety of lane widths have been included in the suggested road standards. Lane widths vary based on the volume and expected type of traffic on each street. Generally, streets which will carry larger numbers of vehicles and vehicles of larger sizes have been given wider travel lanes. Please see **Figures 9-13** thru **9-17.**

Note that landscaped boulevards and sidewalks are required on both sides of all roads. Boulevards are necessary throughout the community to provide space for snow storage and separation of pedestrians and vehicles. The boulevards also provide space for trees and other forms of corridor landscaping, which are considered an essential ingredient to producing a livable community.

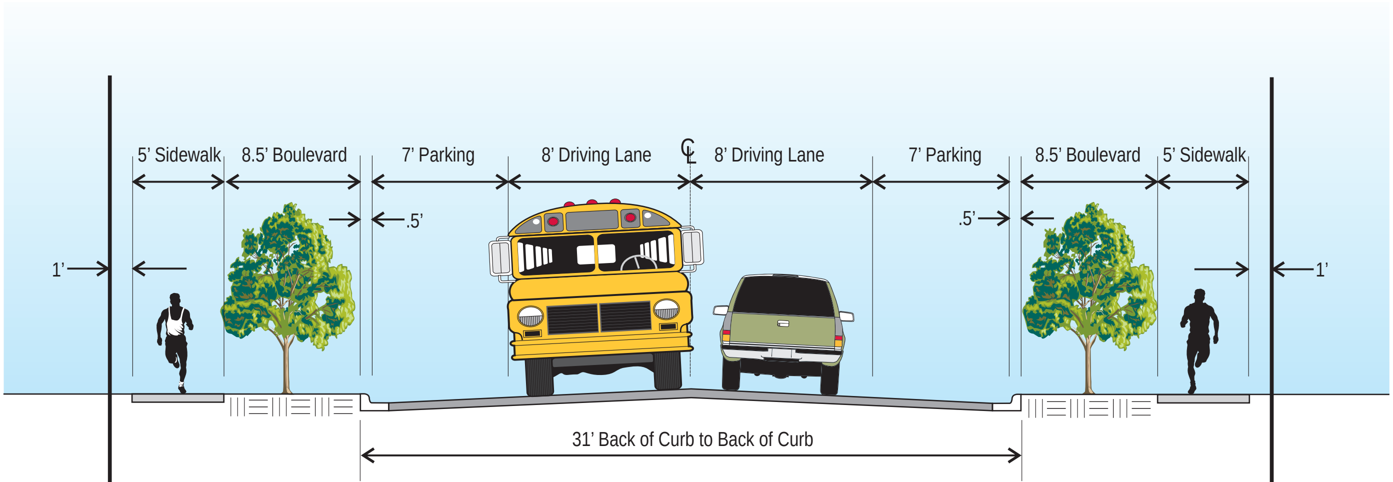
Bicycle facilities are required in all but the local road standards. Bicycle facilities are not necessary on local streets due to the relatively low traffic volumes and low vehicle speeds. In all other cases, five or six-foot-wide bicycle lanes are required on both sides of the street. A ten-foot-wide combined ped/bike trail option is allowed if the necessary right-of-way is available or provided for the primary arterial typical sections. The use of bicycle facilities that are not in the roadway are a safety concern at cross-street intersections, therefore, this option may be proposed only in cases where there are few minor intersections along the corridor.

This plan has taken a multi-modal approach to the provision of transportation services. Therefore, it is important that the pedestrian and bicycle facilities depicted on the street standards illustrated in this chapter be constructed as a basic component of the initial facility rather than being considered as an optional add-on.

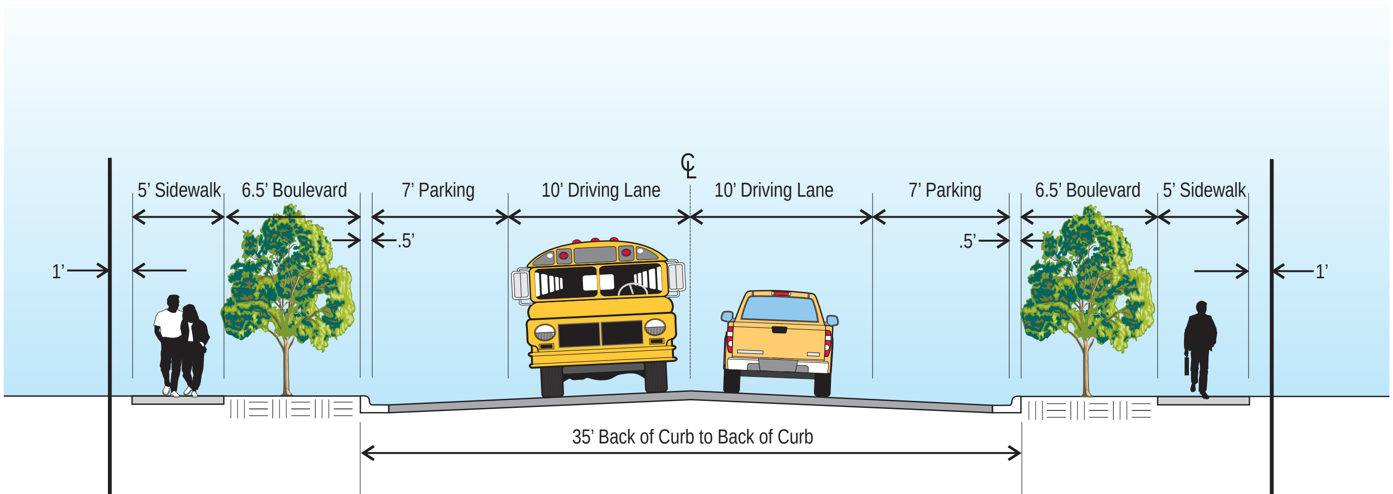
Both flush and raised center medians are included in various road standards. The use of raised versus flush medians will be determined on a case by case basis and depends on the number of driveways. The recommended road standards are presented graphically in **Figures 9-13** thru **9-17**.

The principal focus of this plan is the arterial and collector street network. A wide variety of acceptable local street alternatives exist and may integrate well with the larger scale street depicted in this Plan. For full information on local streets, interested parties are referred to the City of Bozeman and Gallatin County subdivision regulations.

It is appropriate to note that there will always be special circumstances that must be considered as roadway improvements are contemplated. Context sensitive solutions and designs, as initially described in **Chapter 6**, suggests that roadway improvements can be done in harmony with local community objectives and public interest. The potential does exist that deviation to the proposed typical sections may be warranted via reduced lane widths, on-street parking, building placement and orientation and access control features. These should be evaluated on a case by case basis by community leaders.



2 Lanes
Sidewalks/Parking/Boulevard Both Sides



2 Lanes
Sidewalks/Parking/Boulevard Both Sides [3]

R/W Requirements = 60'

Not To Scale

NOTES:

[1] Narrower or wider local street configurations may be acceptable depending on the character of the neighborhood. Please examine the City of Bozeman's Subdivision and Zoning Regulations for details.

[2] Local streets are not on the official "Urban Aid System" and therefore jurisdiction for the geometric layout falls exclusively under the City of Bozeman regulations.

[3] Use this street section as local road *if* adjacent to park.

[4] Sidewalks adjacent to parks on local streets are required to be 6-feet in width. This additional foot of width should be taken out of the boulevard section.

Minimum Features:
- Two Driving Lanes
- Sidewalks - Both Sides
- Bike Lanes - Not Required
- Boulevards - Both Sides
- Parking - Both Sides
  (Where Parking is Provided)

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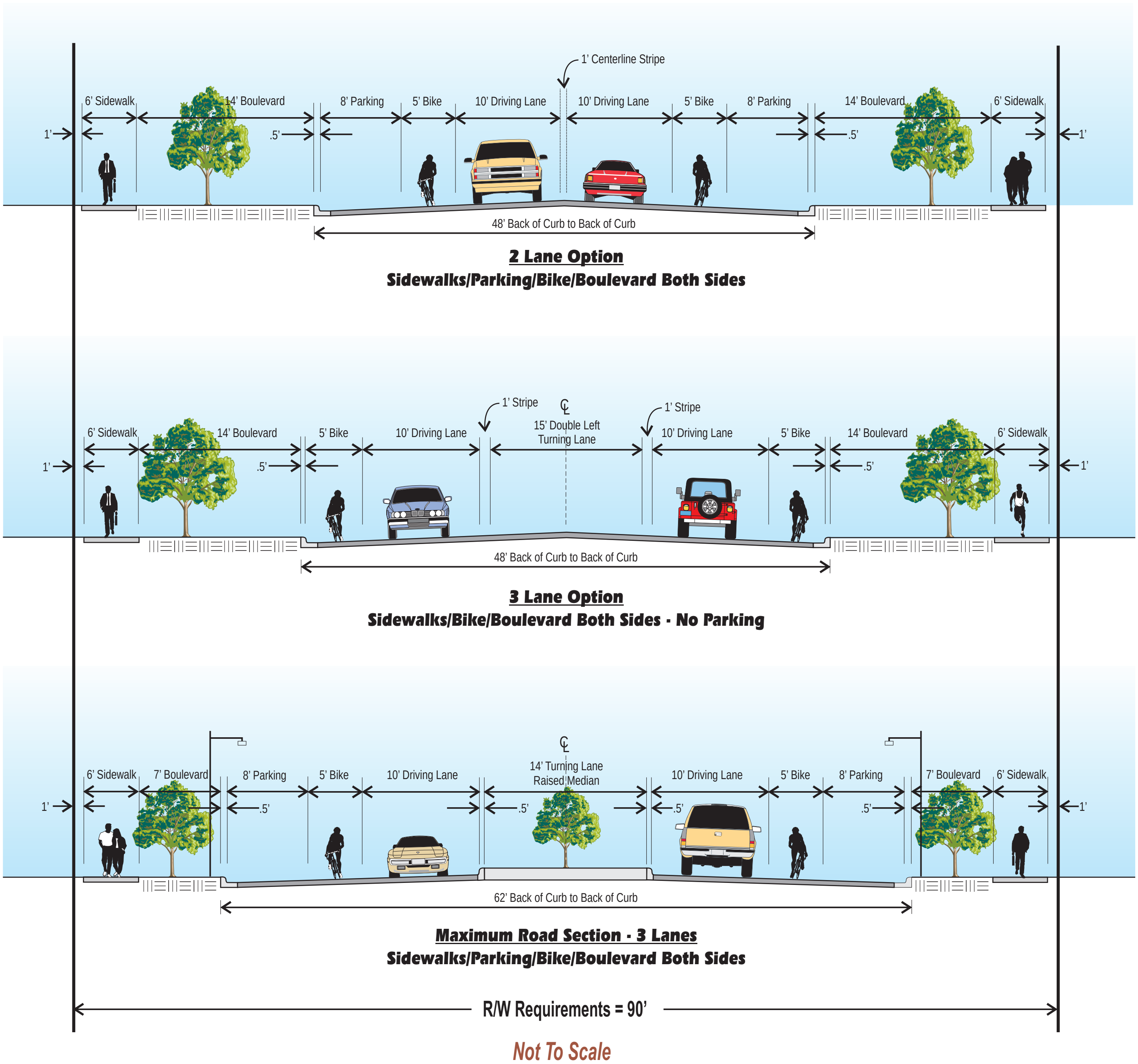
Suggested Local Street Standards
Figure 9-13



NOTES:

- Pedestrian crossing safety enhancement is required for roads wider than 2-lanes.
- Corridor lighting is required wherever raised medians are used.
- Grade separated ped/bike facilities should be considered at major ped/bike crossings.
- MDT routes will need to meet MDT Urban Design Standards which may not be represented in this graphic.

Minimum Features:

- Two Driving Lanes
- Sidewalks - Both Sides
- Bike Lanes - Both Sides
- Boulevards - Both Sides
- Parking - Both Sides (Where Parking is Provided)

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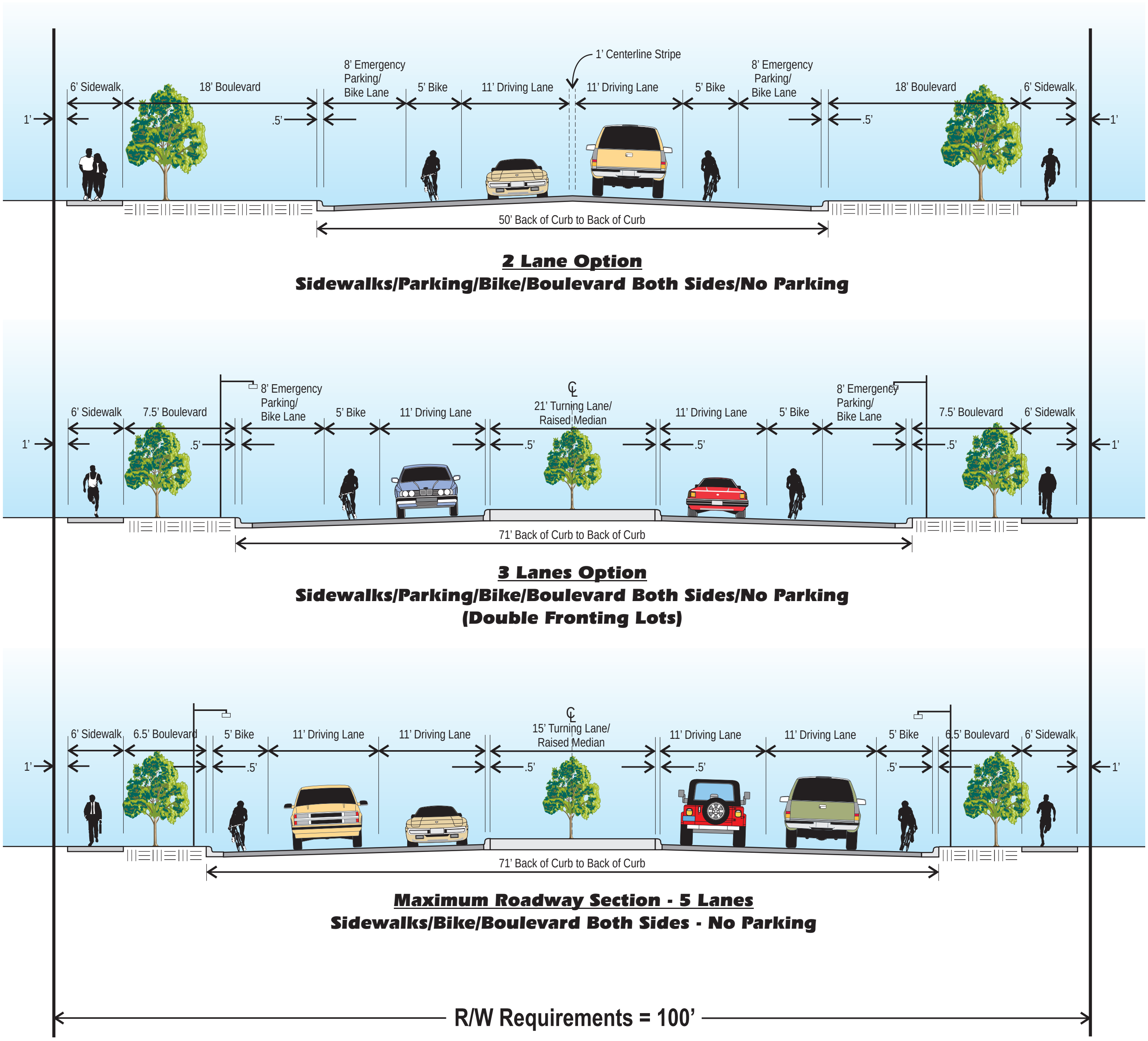
Recommended Collector Street Standards
Figure 9-14



Not To Scale

NOTES:

- Pedestrian crossing safety enhancement is required for roads wider than 2-lanes.
- Corridor lighting is required wherever raised medians are used.
- Grade separated ped/bike facilities should be considered at major ped/bike crossings.
- MDT routes will need to meet MDT Urban Design Standards which may not be represented in this graphic.

Minimum Features:
- Two Driving Lanes
- Sidewalks - Both Sides
- Bike Lanes - Both Sides
- Boulevards - Both Sides
- Emergency Parking/ Bike Lane - Both Sides

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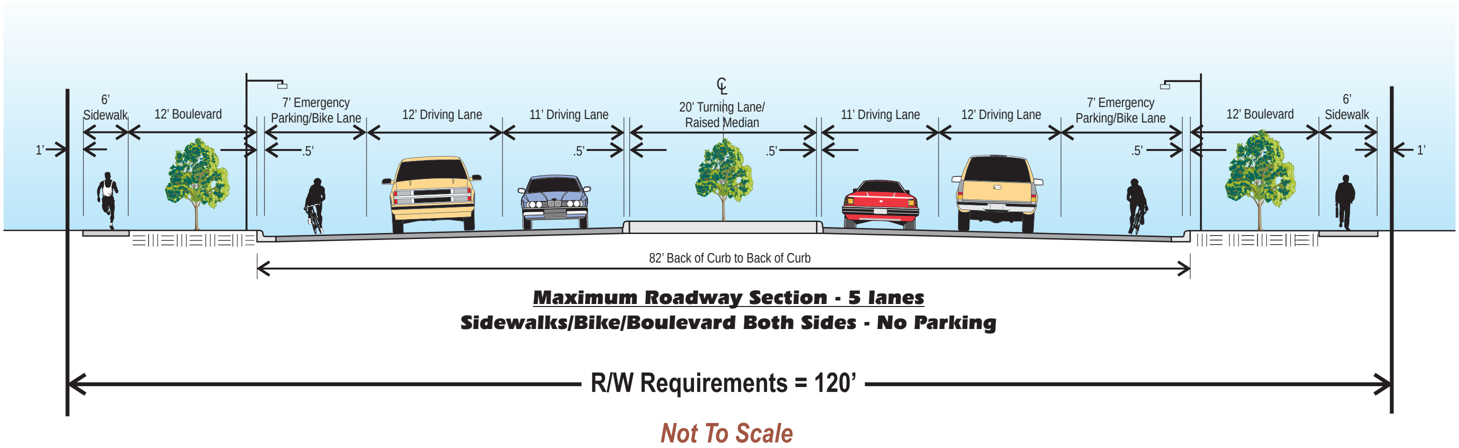
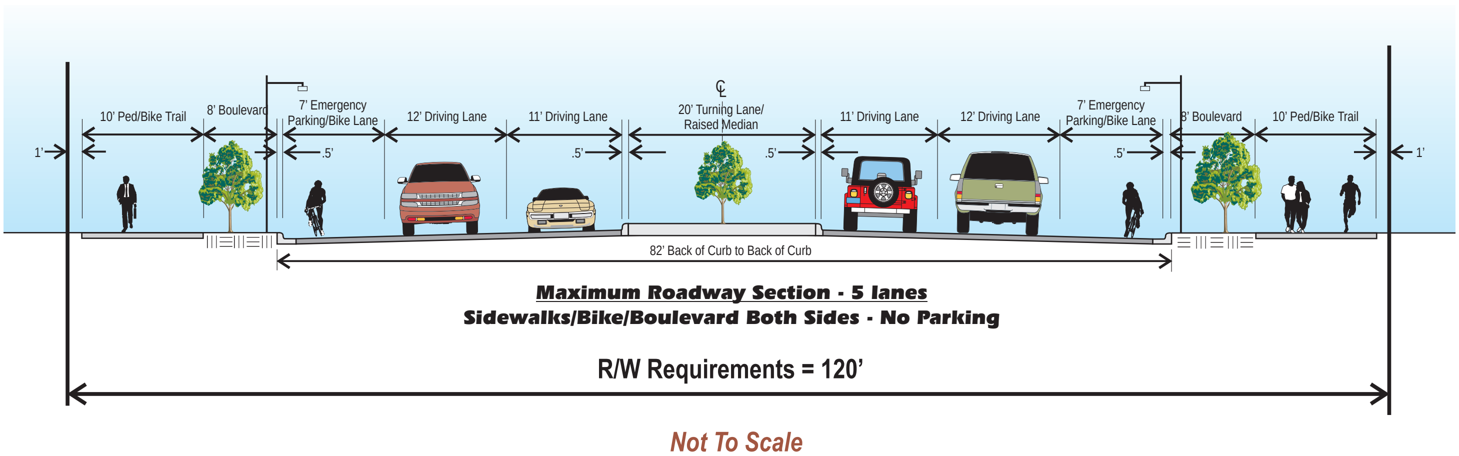
Recommended Minor Arterial Street Standards
Figure 9-15





Minimum Features:
- Two Driving Lanes
- Sidewalks - Both Sides
- Bike Lanes - Both Sides
- Boulevards - Both Sides
- Emergency Parking/Bike Lanes - Both Sides

NOTES:
- Pedestrian crossing safety enhancement is required for roads wider than 2-lanes.
- Corridor lighting is required wherever raised medians are used.
- Grade separated ped/bike facilities should be considered at major ped/bike crossings.
- MDT routes will need to meet MDT Urban Design Standards which may not be represented in this graphic.

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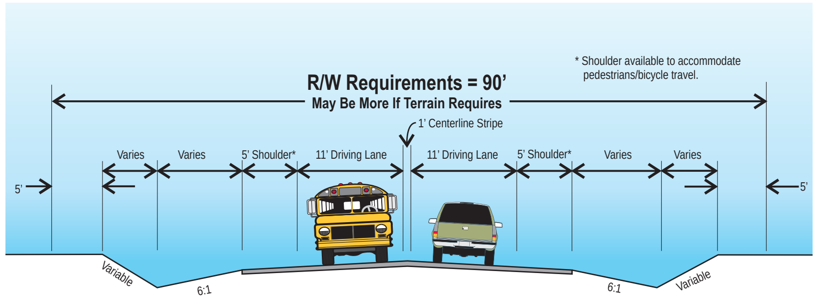
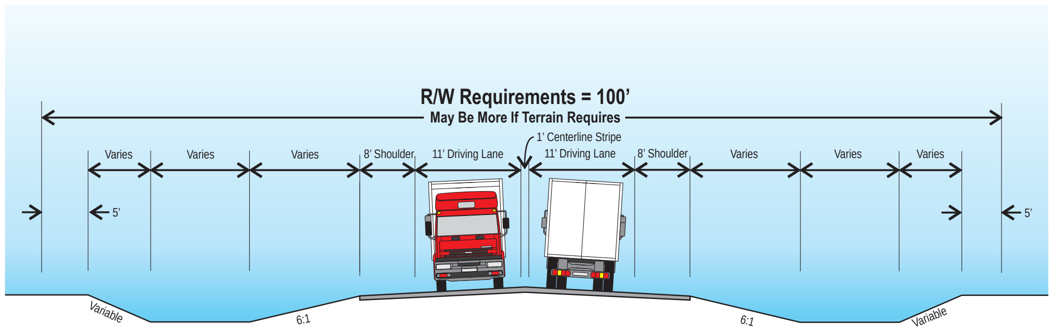
Greater Bozeman Area Transportation Plan (2007 Update)

Recommended Principal Arterial Street Standards
Figure 9-16

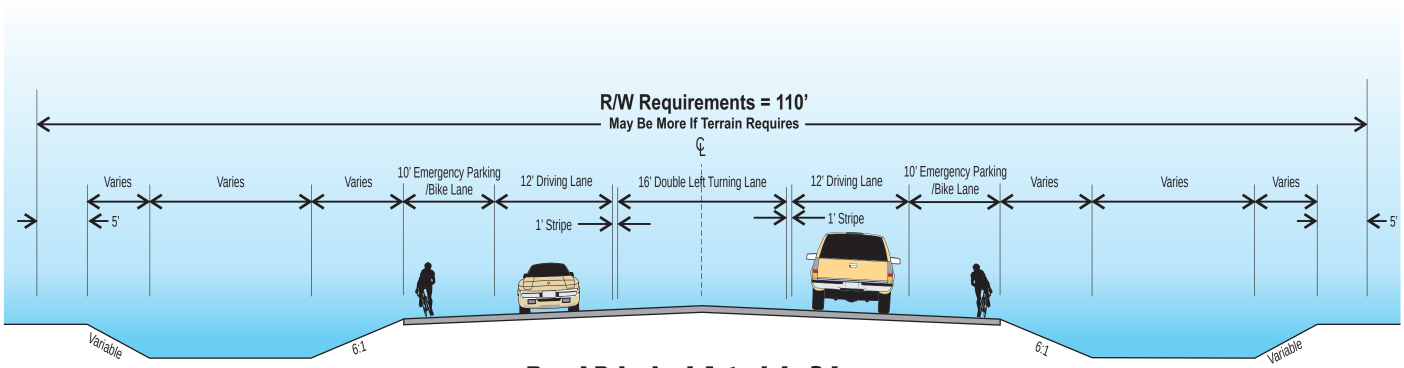
NOTE: Recommended Rural Street Standards are future visions for the County's rural roadway system. They do not match the currently utilized roadway geometrics as per the Gallatin County Subdivision Regulations.



Rural Collector - 2 Lanes



Rural Minor Arterial - 2 Lanes



Rural Principal Arterial - 3 Lanes

Not To Scale

Minimum Paving & Street Width Standards *		
ADT	Finished Gravel Width	Minimum Paving Width
Non-Mountainous Terrain		
8	24'	22'
16	24'	22'
24	24'	22'
32-99	26'	24'
100+	26'	24'
Major Collectors & Arterials	30'	28'
Mountainous Terrain		
8-40	24'	22'
41-99	26'	24'
100+	24'	24'
Major Collectors & Arterials	30'	28'

* As per Gallatin County Subdivision Regulations

NOTES:

- Pedestrian crossing safety enhancement is required for roads wider than 2-lanes.
- Corridor lighting is required wherever raised medians are used.
- Grade separated ped/bike facilities should be considered at major ped/bike crossings.

GREATER BOZEMAN AREA
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Greater Bozeman Area Transportation Plan (2007 Update)

Recommended Rural Street Standards Figure 9-17

9.7 PEDESTRIAN AND BICYCLE DESIGN GUIDELINES

The design of pedestrian and bicycle infrastructure is governed by many local, state, and federal standard documents. In the Bozeman area, these documents include the Montana Public Works Standard Specifications, the Bozeman Modifications to the Montana Public Works Standard Specifications, the Manual of Uniform Traffic Control Devices, the AASHTO Guide for the Development of Bicycle and Pedestrian Facilities, the City of Bozeman Design Standards and Specification Policy, and the Americans with Disabilities Act Access Board (ADAAG) Guidelines. This section provides additional guidance that could benefit the Bozeman area with some found in the above standards, and some experimental.

9.7.1 Pedestrian Facilities

The design of the pedestrian environment will directly affect the degree to which people enjoy the walking experience. If designed appropriately, the walking environment will not only serve the people who currently walk, but also be inviting for those who may consider walking in the future. Therefore, when considering the appropriate design of a certain location, designers should not just consider existing pedestrian use, but how the design will influence and increase walking in the future. Additionally, designers must consider the various levels of walking abilities and local, state, and federal accessibility requirements. Although these types of requirements were specifically developed for people with walking challenges, their use will result in pedestrian facilities that benefit all people.

Crosswalks

Crosswalks are a critical element of the pedestrian network. It is of little use to have a complete sidewalk system if pedestrians cannot safely and conveniently cross intersecting streets. Safe crosswalks support other transportation modes as well. Transit riders, motorists, and bicyclists all may need to cross the street as pedestrians at some point in their trip.

Frequency

In general, whatever their mode, people will not travel out of direction unless it is necessary. This behavior is observed in pedestrians, who will cross the street wherever they feel it is convenient. The distance between comfortable opportunities to cross a street should be related to the frequency of uses along the street that generate crossings (shops, high pedestrian use areas, etc.). In areas with many such generators, like high pedestrian use areas, opportunities to cross should be very frequent. In areas where generators are less frequent, good crossing opportunities may also be provided with less frequency.

Where	Generally not further apart than	Generally not closer together than
High Pedestrian Use Areas	200 – 300 feet (60-90 m) Where blocks are longer than 400 feet (120 m)	150 feet (45 m)
Local Street Walkways and Low Pedestrian Use Areas	Varies, based on adjacent uses. Do not prohibit crossing for more than 400 feet (120 m)	150 feet (45 m)

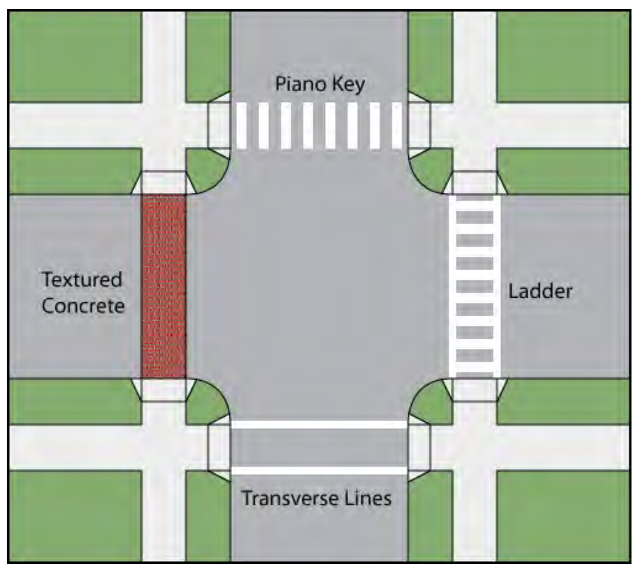
Crosswalk Pavement Markings

Marked crosswalks indicate to pedestrians the appropriate route across traffic, facilitate crossing by the visually impaired, and remind turning drivers of potential conflicts with pedestrians. Crosswalk pavement markings should generally be located to align with the through pedestrian zone of the sidewalk corridor.

Marked crosswalks should be used:

- At **signalized intersections**, all crosswalks should be marked.
- At **unsignalized intersections**, crosswalks should be marked when they
  - o help orient pedestrians in finding their way across a complex intersection, or
  - o help show pedestrians the shortest route across traffic with the least exposure to vehicular traffic and traffic conflicts, or
  - o help position pedestrians where they can best be seen by oncoming traffic.

There are three common types of crosswalk striping currently used in the United States including the Piano Key, the Ladder, and the standard Transverse crosswalk. Of these, the Piano Key and the Transverse Lines crossings are typically used in Montana. Other types of textured or colored concrete surfacing may be used in appropriate locations where it helps establish a sense of place such as shopping centers and downtown Bozeman.



Ladder or piano key crosswalk markings are considered 'high-visibility' markings and are recommended for most crosswalks in the Bozeman area where heavy pedestrian traffic exists, including school crossings, across arterial streets at pedestrian-only signals, at mid-block crosswalks, and where the crosswalk crosses a street not controlled by signals or stop signs. A piano key pavement marking consists of 2-ft (610 mm) wide bars spaced 2-ft apart and should be located such that the wheels of vehicles pass between the white stripes. A ladder pavement marking consists of 2-ft (610 mm) wide bars spaced 2-ft apart and located between 1-ft wide parallel stripes that are 10-ft apart.

Curb Extensions

Curb extensions (sometimes called curb bulbs or bulb-outs) have many benefits for pedestrians. They shorten the crossing distance, provide additional space at the corner (simplifying the placement of elements like curb ramps), and allow pedestrians to see and be seen before entering the crosswalk. Curb extensions can also provide an area for accessible transit stops and other pedestrian amenities and street furnishings.

Curb extensions may be useful for local or collector roadways and may be used at any corner location, or at any mid-block location where there is a marked crosswalk, provided there is a parking lane into which the curb may be extended. Curb extensions are not generally used where there is no parking lane because of the potential hazard to bicycle travel. Under no circumstances should a curb extension block a bike lane if one exists.

In high pedestrian use areas such as downtown Bozeman, curb extensions are a preferred element for corner reconstruction except where there are extenuating design considerations such as the turning radius of the design vehicle, or transit and on-street parking factors.

Curb extensions can be compatible with snow removal operations provided that they are visibly marked for crews. Where drainage is an issue, curb extensions can be designed with storm drain inlets, or pass through channels for water.

Refuge Islands

Refuge islands allow pedestrians to cross one segment of the street to a relatively safe location out of the travel lanes, and then continue across the next segment in a separate gap. At unsignalized crosswalks on a two-way street, a median refuge island allows the crossing pedestrian to tackle each direction of traffic separately. This can significantly reduce the time a pedestrian must wait for an adequate gap in the traffic stream.

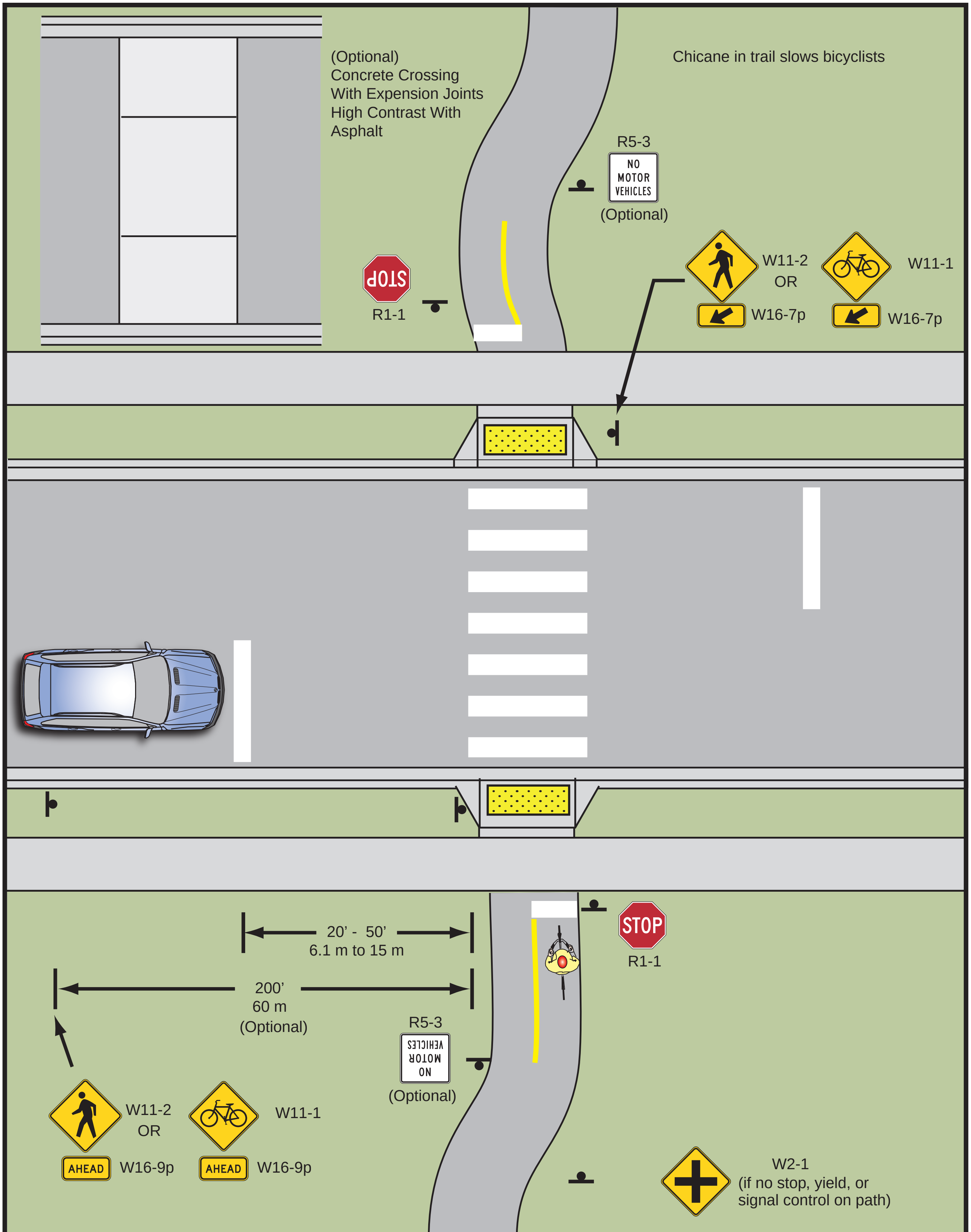
Mid-Block Crossings

Mid-block crossings are installed where there is a significant demand for crossing and no nearby existing crosswalks. Within the Study Area there are numerous stream corridors traveling mainly south to north. These corridors have been well utilized by developers and support numerous trail systems, which nearly always require mid-block crossings to be continuous. Currently, the treatments employed for the existing crossings vary street to street with varying levels of accommodation and visibility. This section will dictate design of future mid-block crossings in the Bozeman area for consistency. In general, because these crossings are not at existing intersections they should be designed for a high level of visibility through appropriate signage, lighting, and high-contrast pavement markings and treatments.

Local Streets

Local roadways are the most common location for midblock crossings currently found in the Bozeman area. Mid-block crossings should use high visibility crosswalk markings either as a concrete pad contrasting with the asphalt or as a ladder or piano key crossing using thermoplastic markings for durability. Six-inch vehicle stop lines should be placed 20 feet in advance of the crossing with MUTCD W11-2 signage at the crossing. Higher volume local streets may need a second warning sign in advance of the crossing. On-street parking should be prohibited within 40 feet of the crossing, and if being constructed as part of a new roadway, curb extensions should be considered where parking is allowed to shorten the crossing distance.

Mid-block crossings of collector and arterial streets are strongly discouraged, but may be considered in unique situations where adequate warning and protection are provided.



Mid-Block Trail Crossing - Local Streets
Figure 9-18

9.7.2 Bicycle Facilities

Similar to pedestrian facilities, the overall safety and usability of the bicycle network lies in the details of design. The following guidelines provide useful design considerations that fill in the gaps from the standard manuals such as the MUTCD and the AASHTO Guide for the Development of Bicycle Facilities.

Shared-Use Paths / Bike Paths

Facilitates two-way off-street bicycle and pedestrian traffic, which also may be used by skaters, wheelchair users, joggers and other non-motorized users. These facilities are frequently found in parks, and in greenbelts, or along rivers, railroads, or utility corridors where there are few conflicts with motorized vehicles. Shared use facilities can also include amenities such as lighting, signage, and fencing (where appropriate). In Montana, design of Shared use facilities should follow guidance in the AASHTO Guide for the Development of Bicycle Facilities. For non-paved shared-use facilities, see trail standards in the Bozeman Parks, Recreation, Open Space and Trails Plan (PROST) or the Gallatin Valley Trails Plan.

General Design Practices:

Shared-use paths can provide a good facility, particularly for novice riders, recreational trips, and cyclists of all skill levels preferring separation from traffic. Shared-use paths should generally provide directional travel opportunities not provided by existing roadways. Some of the elements that enhance off-street path design include:

- Implementing frequent access points from the local road network; if access points are spaced too far apart, users will have to travel out of direction to enter or exit the path, which will discourage use;
- Placing adequate signage for cyclists including stop signs at trail crossings and directional signs to direct users to and from the path;
- Building to a standard high enough to allow heavy maintenance equipment to use the path without causing it to deteriorate;
- Limiting the number of at-grade crossings with streets or driveways;
- Terminating the path where it is easily accessible to and from the street system, preferably at a controlled intersection or at the beginning of a dead-end street. Poorly designed paths can put pedestrians and cyclists in a position where motor vehicle drivers do not expect them when the path joins the street system.

Both the Federal Highway Administration and the AASHTO Guide for the Development of Bicycle Facilities generally recommend against the development of shared-use paths directly adjacent to roadways. Also, known as “sidepaths” these facilities create a situation where a portion of the bicycle traffic rides against the normal flow of motor vehicle traffic and can result in bicyclists going against traffic when either entering or exiting the path. This can also result in an unsafe situation where motorists entering or crossing the roadway at intersections and driveways do not notice bicyclists coming from their right, as they are not expecting traffic coming from that direction. Stopped cross-street motor vehicle traffic or vehicles exiting side streets or driveways may frequently block path crossings. Even bicyclists coming from the left may also go unnoticed, especially when sight distances are poor. Because of these operational challenges, sidepaths should be provided on both sides of the roadway to reduce the numbers of bicyclists travelling against vehicle traffic.

Shared-use paths may be considered along roadways under the following conditions:

- The path will generally be separated from all motor vehicle traffic.
- Bicycle and pedestrian use is anticipated to be high.
- In order to provide continue an existing path through a roadway corridor.
- The path can be terminated at each end onto streets with good bicycle and pedestrian facilities, or onto another safe, well-designed path.
- There is adequate access to local cross-streets and other facilities along the route.
- Any needed grade separation structures do not add substantial out-of-direction travel.
- The total cost of providing the proposed path is proportionate to the need.
- The paths are provided on both sides of the roadway.

As bicyclists gain experience and realize some of the advantages of riding on the roadway, many stop riding on paths placed adjacent to roadways. Bicyclists may also tend to prefer the roadway a pedestrian traffic on the Multi-use path increases due to its location next to an urban roadway. When designing a bikeway network, the presence of a nearby or parallel path should not be used as a reason to not provide adequate shoulder or bicycle lane width on the roadway, as the on-street bicycle facility will generally be superior to the “sidepath” for experienced cyclists and those who are cycling for transportation purposes. In fact, bicycle lanes should be provided as an alternate (more transportation-oriented) facility whenever possible.

At Grade Crossings
When a grade-separated crossing cannot be provided, the optimum at-grade crossing has either light traffic or a traffic signal that trail users can activate. If a signal is provided, signal loop detectors may be placed in the shared-use path pavement to detect bicycles. This feature can be combined with or replaced by a pedestrian-actuated button provided (placed such that cyclists can press it without dismounting.) At unsignalized crossings, a trail sized stop sign (R1-1) or yield sign (R1-2) should be placed about 5 feet before the intersection with an accompanying stop line. Direction flow should be treated either with physical separation or a centerline approaching the intersection for the last 100 feet. Additional design considerations can slow bicyclists as they approach the crossing include chicanes, bollards, and pavement markings.

If the street is above four or more lanes or two/three lanes without adequate gaps, a median refuge should be considered in the middle of the street crossed. The refuge should be 8 feet at a minimum, 10 feet is desired. Another potential design option for street crossings is to slow motor vehicle traffic approaching the crossing through such techniques as speed bumps in advance of the crossing, or a painted or textured crosswalk.

Grade Separated Crossings
When the decision to construct an off-street multi-use path has been made, grade separation should be considered for all crossings of major thoroughfares. At-grade crossings introduce

conflict points. The greatest conflicts occur where paths cross roadway driveways or entrance and exit ramps. Motor vehicle drivers using these ramps are seeking opportunities to merge with other motor vehicles; they are not expecting bicyclists and pedestrians to appear at these locations. However, grade-separated crossings should minimize the burden for the user, and not, for example, require a steep uphill and/or winding climb.

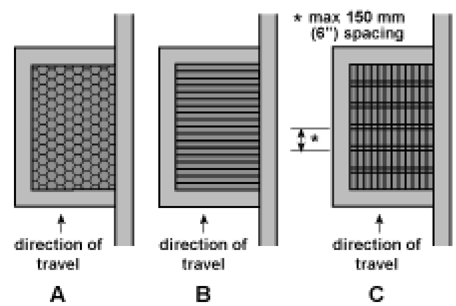
In the Bozeman Area, the preferred type of grade-separated crossing is an undercrossing due to weather and visual considerations. Several currently exist in the area in Four Corners and Gallatin Gateway. Undercrossings should be lighted if in high use areas or if longer than 75 feet in length. Groundwater infiltration may be a significant issue and should be considered early in the decision making process when any undercrossing is considered.

Bike Lanes

Bike lanes are defined as a portion of the roadway that has been designated by striping, signage, and pavement markings for the preferential or exclusive use of bicyclists. Bicycle lanes are generally found on major arterial and collector roadways and are 4-6 feet wide. Bike lanes should be constructed in accordance with the recommended roadway typical sections in this chapter and should be designed following AASHTO guidelines.

Additional Considerations

Drainage grates located within bike lanes can often be hazardous to bicyclists. Drainage grates with large slits can catch bicycle tires and cause a crash. Poorly placed drainage grates may also be hazardous, and can cause bicyclists to veer into the auto travel lane to avoid them. Sometimes, resurfacing projects result in a vertical lip surrounding a drainage grate. Such abrupt changes can jar a cyclist and cause a crash. Resurfacing projects should taper the pavement to the drainage grate or other relevant utility access point.

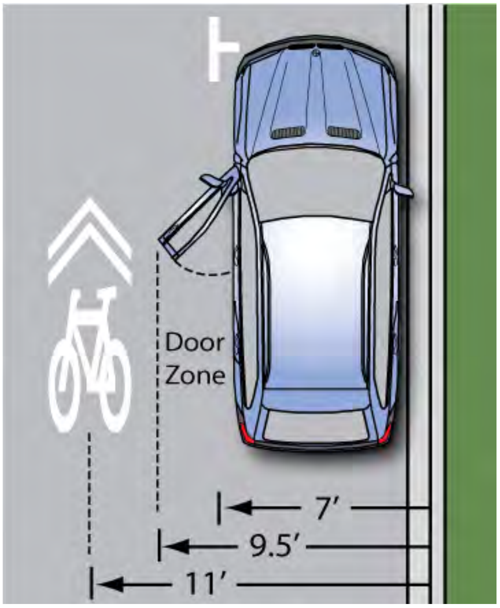


Bicycle-Friendly Drainage Grates

Bicycle Friendly Rumble Strips

Rumble Strips can hamper bicycling by presenting obstacles through trapped debris on the far right of the road shoulder and the rumble strip to the left. Consequently, special care needs to be exercised for bicyclists when this treatment for motorist safety is planned and built, with a robust maintenance schedule put into place. The rumble strip design and placement are also important; placing the rumble strip as close to the fog line as possible leave the maximum shoulder area available for cyclists. Certain rumble strip designs are safer for bicyclists to cross, and still provide the desired warning effect for motorists.

The Federal Highway Administration performed a study on the design of rumble strips in 2000 reviewing different techniques of installation and studies performed by ten state DOTs from the point of view of motorists and bicyclists. Based on the information provided in the FHWA study, the recommended design for a rumble strip should be of a milled design rather than rolled that is 1 foot (300mm) wide with 5/16 ± 1/16 in (8 ± 1.5 mm) in depth. Rumble strips are recommended to be installed only on roadways with shoulders in excess of 5 feet (1.5 m). A shallow depth of the milled portions of the rumble strips are preferred by bicyclists. Since the roadway shoulder can become cluttered with debris it is recommended to include a skip (or gap) in the rumble strip to allow bicyclists to cross from the shoulder to the travel lane when encountering debris. This skip pattern is recommended to be 12 feet (3.7 m) in length with intervals of 40 or 60 feet (12.2 or 18.3 m) between skips.



Recommended SLM placement.

Shared Lane Markings (SLMs)

Recently, Shared Lane Marking stencils (also called "Sharrows") have been introduced for use in the United States as an additional treatment for shared roadway facilities. The stencil can serve a number of purposes, such as making motorists aware of bicycles potentially in their lane, showing bicyclists the direction of travel, and, with proper placement, reminding bicyclists to ride further from parked cars to reduce the risk of "dooring" collisions. Shared Lane Markings are expected to be included in the 2009 MUTCD and would be valuable additions to the proposed bicycle boulevards in **Chapter 5**.

10.1 URBAN AND SECONDARY HIGHWAY DESIGNATIONS

It is appropriate when completing a regional Transportation Plan to discuss the state system in place in the community. The formal system in place in the Greater Bozeman area consists of both urban roadways and secondary roadways. These roadways are designated through existing Montana statute, the Montana Transportation Commission, and MDT guidelines. Because these roads are Montana systems, the Federal government has no direct involvement in the designations.

Urban and secondary routes are designated by the Montana Transportation Commission, in cooperation with local governing authorities. When revisions to the system are proposed, the Transportation Commission may require when adding mileage that a reasonably equal amount of mileage be removed. This is not an absolute, and situations do exist where mileage is added without a corresponding reduction. With that in mind, to meet eligibility requirements for placement on a system of urban and secondary highways, the following criteria must be met:

Urban Highways

The route must be within a designated urban area and must be functionally classified by the Transportation Commission and Federal Highway Administration as either an urban arterial or collector. The route must also meet urban design standards in order to qualify as an urban route. A list of the urban routes located in the Greater Bozeman area can be found in **Table 10-1**.

Table 10-1
Urban Routes in the Greater Bozeman Area

Urban Route ID	Roadway Common Designation
U-1201	19th Avenue
U-1202	Oak Street
U-1203	S. 11th Avenue
U-1204	Durston Road
U-1205	8th Street
U-1206	Mendenhall Street
U-1207	Frontage Road / N. 7th Avenue
U-1208	Babcock Street
U-1209	3rd Street / Graff Street / Willson Avenue
U-1210	College Street
U-1211	Valley Center Road
U-1212	Kagy Boulevard / Bozeman Trail
U-1213	Church Street
U-1215	Highland Boulevard
U-1216	S. 19th Avenue
U-1217	Griffin Drive
U-1218	Baxter Lane

Secondary Highways

The route must be outside a designated urban area and must be functionally classified as either a rural minor arterial or major collector. A list of the secondary routes located in the Greater Bozeman area can be found in **Table 10-2**.

Table 10-2
Secondary Routes in the Greater Bozeman Area

Secondary Route ID	Roadway Common Designation
S-235	Valley Center Road
S-205	Frontage Road
S-411	Springhill Road
S-412	N. 19th Avenue
S-345	S. 19th Avenue / Cottonwood Road

As conditions change in the community, driven by outlying growth and travel characteristic shifts, it is advisable to revisit the urban and secondary highway classifications from time to time. To add, or delete, a route from the system, a very specific "six-step" process is in place and must be adhered to. This process is as follows:

Step 1 – Requests for new route designations or changes in existing designations are initiated by the local government. Requests must have the support of local elected officials and local transportation committees (if applicable).

Step 2 – MDT staff reviews the requests to determine whether the routes meet eligibility requirements.

Step 3 – If a route does not meet functional classification eligibility requirements, MDT staff advises the local government about the process for requesting a formal review of the routes functional classification.

Step 4 – If necessary, MDT staff advises the local government about the Montana Transportation Commission policy that requires no significant net changes in secondary and urban highway mileage within the affected county or urban area as a result of designation changes. Local governments may have to adjust their original request to comply with this requirement.

Step 5 – If the proposal meets all eligibility requirements and complies with Transportation Commission policy, MDT staff asks the Transportation Commission to approve the request.

Step 6 – If the Transportation Commission approves the request, MDT staff notifies the affected local governments and makes appropriate changes in MDT records.

10.2 CORRIDOR PRESERVATION MEASURES

Corridor preservation is the application of measures to prevent or minimize development within the right-of-way of a planned transportation facility or improvement within a defined corridor. That includes corridors, both existing and future, in which a wide array of transportation improvements may be constructed including roadways, bikeways, multi-use trails, equestrian paths, high occupancy vehicle lanes, fixed-rail lines and more.

Corridor preservation is important because it helps to ensure that a transportation system will effectively and efficiently serve existing and future development within a local community, region or state, and prevent costly and difficult acquisitions after the fact. Corridor preservation policies, programs and practices provide numerous benefits to communities, taxpayers and the public at large. These include, but are not limited to, the following:

- **Reducing transportation costs by preservation of future corridors in an undeveloped state.** By acquiring or setting aside right-of-way well in advance of construction, the high cost to remove or relocate private homes or businesses is eliminated or reduced.

- **Enhancing economic development by minimizing traffic congestion and improving traffic flow, saving time and money.** Low cost, efficient transportation helps businesses contain final costs to customers and makes them more competitive in the marketplace. Freight costs, for instance, accounts for ten percent of the value of agricultural products, the highest for any industry.

- **Increasing information sharing so landowners, developers, engineers, utility providers, and planners understand the future needs for developing corridors.** An effective corridor preservation program ensures that all involved parties understand the future needs within a corridor and that state, local and private plans are coordinated.

- **Preserving arterial capacity and right-of-way in growing corridors.** Corridor preservation includes the use of access management techniques to preserve the existing capacity of corridors. When it is necessary, arterial capacity can be added before it becomes cost prohibited by preserving right-of-way along growing transportation corridors.

- **Minimizing disruption of private utilities and public works.** Corridor preservation planning allows utilities and public works providers to know future plans for their transportation corridor and make their decisions accordingly.

- **Promoting urban and rural development compatible with local plans and regulations.** The state and local agencies must work closely together to coordinate their efforts. Effective corridor preservation will result in development along a transportation corridor that is consistent with local policies.

To effectively achieve the policies and goals listed above, corridor management techniques can be utilized. These techniques can involve the systematic application of actions that:

- Preserve the safety and efficiency of transportation facilities through **access management**; and,
- Ensure that new development along planned transportation corridors is located and designed to accommodate future transportation facilities (**corridor preservation measures**).

10.3 ACCESS MANAGEMENT GUIDELINES

Access management techniques are increasingly fundamental to preserving the safety and efficiency of a transportation facility. Access control can extend the carrying capacity of a roadway, reducing potential conflicts. There are six basic principles of access management that are used to achieve the desired outcome of safer and efficient roadways. These principles are:

- Limit the number of conflict points.
- Separate the different conflict points.
- Separate turning volumes from through movements.
- Locate traffic signals to facilitate traffic movement.
- Maintain a hierarchy of roadways by function.
- Limit direct access on higher speed roads.

It is recommended that local government adopt a set of Access Management Regulations through which the need for access management principles can be evaluated on a case-by-case basis. For roadways on the State system and under the jurisdiction of the Montana Department of Transportation (MDT), access control guidelines are available which define minimum access point spacing, access geometrics, etc., for different roadway facilities. For other roadways (non-State), the adoption of an access classification system based upon the functional classification of the roadway (principal arterial, minor arterial or major collector) is desirable. These local regulations should serve to govern minimum spacing of drive approaches/connections and median openings along a given roadway in an effort to fit the given roadway into the context of the adjacent land uses and the roadway purpose. The preparation and adoption of a local Access Management Ordinance should be pursued that can adequately document the local government's desire for standard approach spacing, widths, slopes and type for a given roadway classification.

Different types of treatment that can assist in access control techniques are:

- Non-traversable raised medians.
- Frontage roads
- Consolidation and/or closure of existing accesses to the roadway.
- Directional raised medians.

- Left-turn bay islands.
- Redefinition of previously uncontrolled access.
- Raised channelization islands to discourage turns.
- Regulate number of driveways per property.

10.3.1 Corridor Preservation Measures

Another tool used to fulfill the policies and goals listed earlier in this chapter is that of specific corridor preservation measures. As was stated earlier regarding developing a local Access Management Ordinance, it is desirable to develop a Corridor Preservation Ordinance as well. Such an ordinance would serve to accomplish the following:

- Establish criteria for new corridor preservation policies to protect future transportation corridors from development encroachment by structures, parking areas, or drainage facilities (except as may be allowed on an interim basis). Some possible criteria could include the on-site transfer of development rights and the clustering of structures.

- Establish criteria for providing right-of-way dedication and acquisition while mitigating adverse impacts on affected property owners.

10.4 TRANSPORTATION DEMAND MANAGEMENT

10.4.1 Role of TDM in the Transportation Plan

Transportation Demand Management (TDM) measures came into being during the 1970s and 1980s in response to a desire to save energy, improve air quality, and reduce peak-period congestion. TDM strategies focused on identifying alternates to single occupant vehicle use during commuting hours. Therefore, such things as carpooling, vanpooling, transit use, walking and bicycling for work purposes are most often associated with TDM. Many of these methods were not well received by the commuting public and therefore, provided limited improvement to the peak-period congestion problem. Due to the experiences with these traditional TDM measures over the past few decades, it became clear that the whole TDM concept needed to be changed. TDM measures that have been well received by the commuting public include flextime, a compressed workweek and telecommuting. In addition to addressing commute trip issues, managing demand on the transportation system includes addressing traffic congestion associated with special events, such as the Sweet Pea Festival, Christmas Stroll, Music on Main, and other large cultural or sporting events. A definition of TDM follows:

> *TDM programs are designed to maximize the people-moving capability of the transportation system by increasing the number of persons in a vehicle, or by influencing the time of, or need to, travel. (FHWA, 1994)*

Since 1994, TDM has been expanded to also include route choice. A parallel arterial with excess capacity near a congested arterial can be used to manage the transportation system to decrease congestion for all transportation users. In Montana, an excellent model for TDM strategies can be found by examining the Missoula Ravalli Transportation Management Association (MRTMA).

The Bozeman area is projected to grow. The accompanying expansion of transportation infrastructure is expensive and usually lags behind growth. Proper management of demand now will maximize the existing infrastructure and delay the need to build more expensive additional infrastructure. TDM is an important and useful tool to extend the useful life of a transportation system. It must be recognized that TDM strategies aren't always appropriate for certain situations and may be difficult to implement.

As communities such as Bozeman grow, the growth in number of vehicles and travel demand should be accommodated by a combination of road improvements; transit service improvements; bicycle and pedestrian improvements; and a program to reduce travel (vehicle trips and the vehicle miles traveled) via transportation demand management in conjunction with appropriate land use planning. This section of the Transportation Plan describes which TDM measures are appropriate and acceptable for the Bozeman community.

TDM strategies are an important part of the Transportation Plan due to their inherent ability to provide the following benefits to the commuting public:

- Better transportation accessibility;
- Better transportation predictability;
- More, and timelier, information;
- A range of commute choices; and
- Enhanced transportation system performance.

TDM measures can also be applied to non-commuter traffic and are especially easy to adapt to tourism, special events, emergencies and construction. The benefits to these traffic users are similar to those for commuters, and are listed as follows:

- Better transportation accessibility;
- More transportation reliability;
- More, and timelier, information;
- A range of route choices; and
- Enhanced transportation system performance.

These changes allow the same amount of transportation infrastructure to effectively serve more people. They acknowledge and work within the mode and route choices which motorists are willing to make, and can encourage a sense of community. Certain measures can also increase the physical activity of people getting from one place to another.

Such things as alerting the traveling public to disruptions in the transportation system caused by construction or vehicle crashes can manage demand and provide a valuable service to the traveling public.

Overall, congestion can be avoided or managed on a long-term basis through the use of an integrated system of TDM strategies.

10.4.2 List of TDM Strategies

TDM strategies, which are or have been used by other communities in the United States, include:

Flextime
When provided by employers, flextime allows workers to adjust their commuting time away from the peak periods. This means that employees are allowed some flexibility in their daily work schedules. For example, rather than all employees working 8:00 to 4:30, some might work 7:30 to 4:00, and others 9:00 to 5:30. This provides the workers with a less stressful commute, allows flexibility for family activities and lowers the number of vehicles using the transportation system during peak times. This in turn can translate into reduced traffic congestion, support for ridesharing and public transit use, and benefits to employees. Flextime allows commuters to match their work schedules with transit and rideshare schedules, which can significantly increase the feasibility of using these modes. Costs for implementing this type of TDM strategy can include increased administrative and management responsibilities for the employer, and more difficulty in evaluating an employee's productivity.

Alternate Work Schedule
A related but more expansive strategy is to provide an alternate work schedule. This strategy involves using alternate work hours for all employees. It would entail having the beginning of the normal workday start at a time other than 8:00 a.m. For example, starting the workday at 7:30 a.m. would allow all employees to reach the work site in advance of the peak commute time. Additionally, since they will be leaving work at 4:30 p.m., they will be home before the peak commute time, and have more time in the evening to participate in family or community activities. This can be a very desirable side benefit for the employees. This has a similar effect on traffic as flextime, but does not give individual employees as much control over their schedules.

Compressed Work Week
A compressed work week is different from offering "flextime" or the "alternate work schedule" in that the work week is actually reduced from the standard "five-days-a-week" work schedule. A good example would be employers giving their workers the opportunity to work four (4) ten-hour days a week. A compressed work week reduces commute travel (although this reduction may be modest if employees take additional car trips during non-work days or move farther from worksites). Costs for implementing this type of TDM strategy may be a reduction in productivity (employees become less productive at the end of a long day), a reduction in total hours worked, and it may be perceived as wasteful by the public (for example, if staffing at public agencies is low on Fridays).

Telecommuting

Telecommuting in the work place offers a good chance to reduce the dependence to travel to work via car or bus. This is especially true in technical positions and some fields in the medical industry (such as medical transcription). Additionally, opportunities for distance learning, shopping via computers, basic health care services and recreation also exist and can serve to reduce vehicular travel on the transportation system. Telecommuting is usually implemented in response to an employee request, more so than instigated by the employer. Since telecommuting reduces commute trips, it can significantly reduce congestion and parking costs. It is highly valued by many employees and tends to increase their productivity and job satisfaction. Costs associated with this TDM strategy include increased administrative and management responsibilities, and more difficult evaluation of employee productivity. Some employees find telecommuting difficult and isolating. Telecommuting also may reduce staff coverage and interaction, and make meetings difficult to schedule. Many employers in Montana have tried and currently allow some form of telecommuting.

Ride Sharing (carpooling)

Carpooling is traditionally one of the most widely considered TDM strategies. The idea is to consolidate drivers of single occupancy vehicles (SOV's) into fewer vehicles, with the result being a reduction in congestion. Carpooling is generally limited to those persons whose schedules are rigid and not flexible in nature. Studies have shown that carpooling is most effective for longer trips greater than ten miles in each direction. Aside for the initial administrative cost of set-up and marketing, ridesharing also may encourage urban sprawl by making longer-distance commutes more affordable.

Transit agencies sometimes consider rideshare as competition that reduces transit ridership. Ridesharing is a strategy that would work within the Bozeman area, especially if set up through the larger employers. An extensive public awareness campaign describing the benefits of this program would help in selling it to the general public.

Vanpooling

Vanpooling is a strategy that encourages employees to utilize a larger vehicle than the traditional standard automobile to arrive at work. Vans typically hold twelve or more persons. Vanpooling generally does not require high levels of subsidy usually associated with a fixed-route or demand-responsive transit service. They can often times be designed to be self-sufficient. The van is typically provided by the employer, or a vanpool brokerage agency, which provides the insurance. The costs of a vanpooling program are very similar to those of ridesharing.

Bicycling

Bicycling can substitute directly for automobile trips. Communities that improve cycling conditions often experience significant increases in bicycle travel and related reductions in vehicle travel. Even a one percent shift in travel modes from vehicle trips to bicycle trips can be viewed as a positive step in the Bozeman community.

Although this may not be a measurable statistic pertinent to reducing congesting, providing increased bicycling opportunities can help and can also contribute to quality of life issues. Bicycling characteristics within the Bozeman area is primarily recreational in nature, and by implementing the bikeway network improvements as described in **Chapter 5**, a gradual shift to bicycling as a commuter mode of travel should be realized. Incentives to increase bicycle usage as a TDM strategy include: construction improvements to bike paths and bike lanes; correcting specific roadway hazards (potholes, cracks, narrow lanes, etc.); development of a more connected bikeway street network; development of safety education, law enforcement and encouragement programs; and the solicitation and addressing of bicycling security/safety concerns. Potential costs of this TDM strategy are expenses associated with creating and maintaining the bikeway network, potential liability and accident risks (in some cases), and increased stress to drivers.

Walking

Walking as a TDM strategy has the ability to substitute directly for automobile trips. A relatively short non-motorized trip often substitutes for a longer car trip. For example, a shopper might choose between walking to a small local store versus driving a longer distance to shop at a supermarket. Incentives to encourage walking in a community can include: making improvements to sidewalks, crosswalks and paths by designing transportation systems that accommodate special needs (including people using wheelchairs, walkers, strollers and hand carts); providing covered walkways, loading and waiting areas; improving pedestrian accessibility by creating location-efficient, clustered, mixed land use patterns; and soliciting and addressing pedestrian security/safety concerns. Costs are similar to that of bicycling and are generally associated with program expenses and facility improvements.

Park & Ride Lots

Park and ride lots are effective for communities with substantial suburb to downtown commute patterns. Park and ride consists of parking facilities at transit stations, bus stops and highway on ramps, particularly at the urban fringe, to facilitate transit and rideshare use. Parking is generally free or significantly less expensive than in urban centers. Costs are primarily associated with facility construction and operation.

Car Sharing

Car sharing is a demand reducing technique that allows families within a neighborhood to reduce the number of cars they own and share a vehicle for the limited times when an additional vehicle is absolutely essential. Costs are primarily related to creation, startup and administrative costs of a car sharing organization.

Traditional Transit

Traditional transit service is an effective TDM strategy, especially in a highly urban environment. Several methods to increase transit usage within the community are to improve overall transit service (including more service, faster service and more comfortable service), reduce fares and offer discounts (such as lower rates for off-peak travel times, or for certain groups), and improved rider information and marketing programs. The costs of providing transit depend on many factors, including the type of transit service, traffic conditions and ridership. Transit service is generally subsidized, but these subsidies decline with increased ridership because transit services tend to experience economies of scale (a 10% increase in capacity generally increases costs by less than 10%). TDM strategies that encourage increased ridership can be very cost effective. These strategies may include offering bicycle carrying components on the transit vehicle, changing schedules to complement adjacent industries, etc.

Express Bus Service

Express bus service as a TDM strategy has been used by larger cities in the nation as a means to change driver vehicle characteristics. The use of an express bus service is founded on the idea that service between two points of travel can either be done faster or equal to the private automobile (or a conventional bus service that is not "express").

Installing/Increasing Intelligent Transportation Systems (ITS)

The use of ITS (Intelligent Transportation System) methods to alert motorists of disruptions to the transportation system will be well received by the transportation users, and are highly effective tools for managing transportation demands.

Ramp Metering

Ramp metering has been used by some communities and consists of providing a modified traffic signal at on ramps to interstate highway facilities. The use of this TDM strategy would not be applicable to the Bozeman area.

Traffic Calming

Traffic Calming (also called Traffic Management) refers to various design features and strategies intended to reduce vehicle traffic speeds and volumes on a particular roadway. Traffic Calming projects can range from minor modifications of an individual street to comprehensive redesign of a road network. Traffic Calming can be an effective TDM strategy in that its use can alter and/or deter driver characteristics by forcing the driver to either use a different route or to use an alternative type of transportation (such as transit, bicycling, walking, etc.). Costs of this TDM strategy include construction expenses, problems for emergency and service vehicles, potential increase in drivers' effort and frustration, and potential problems for bicyclists and visually impaired pedestrians. Refer to **Chapter 8** for a discussion on traffic calming measures.

Identifying and Using Special Routes and Detours for Emergencies or Special Events

This type of TDM strategy centers around modifications to driver patterns during special events or emergencies. They can typically be completed with intensive temporary signing or traffic control personnel. Temporary traffic control via signs and flaggers could be implemented to provide a swift and safe exit after applicable events.

Linked Trips

This strategy entails combining trips into a logical sequence that reduces the total miles driven on the surrounding transportation system. These trips are generated by associated facilities within a mixed-use development or within an area of the community where adjacent land uses are varied and offer services that would limit the need to travel large distances on the transportation system.

Pay for Parking at Work Sites (outside the downtown area)

TDM measures involving "paying for parking" outside the downtown area or at employers or paying more for single occupant vehicles can be regarded by those impacted as Draconian.

Higher Parking Costs for Single Occupant Vehicles (SOV)

Intuitively, free parking provided by employers is a tremendous incentive for driving alone. If the driver of a SOV is not penalized in some form, there is no perceived reason not to drive to the workplace. One way to counter this reality is to charge a higher price for parking for the SOV user. This implementation is not likely to have much of an impact to the frequency of SOV users on the transportation system.

Preferential Parking for Rideshare/Carpool/Vanpools

This concept ties into the discussion above regarding parking of the SOV user. Preferential parking, such as delineating spaces closer to an office for riders sharing their commute or reduced/free parking, can be an effective TDM strategy.

Subsidized Transit by Employers

A subsidized transit program, typically offered by employers to their employees, consists of the employer either reimbursing or paying for transit services in full as a benefit to the employee. This usually comes in the form of a monthly or annual transit pass. Studies show that once a pass is received by an employee, the tendency to use the system rises dramatically.

Guaranteed Ride Home (GRH) Programs for Transit Riders

The guaranteeing of a ride home for transit users is a wise choice for all transit systems, since it gives the users a measure of calm knowing that they will be able to get home. A GRH program provides an occasional subsidized ride to commuters who use alternative modes, for example, if a bus rider must return home in an emergency, or a car pooler must stay at work later than expected. This addresses a common objection to the use of alternative modes. GRH programs may use taxies, company vehicles or rental cars. GRH trips may be free or they may require a modest co-payment. The cost of offering this service tends to be low because it is seldom actually used.

Mandatory TDM Measures for Large Employers

Some communities encourage large employers (typically with at least 50 to 100 employees) to mandate TDM strategies for their employees. This is a control that can be required by local governments on developers, employers, or building managers.

The regulatory agencies often times provide incentives for large employers to make TDM strategies more appealing, such as reduced transit fares, preferred parking, etc.

Required Densification / Mixed Use Elements for New Developments

Requiring new developments to be dense and contain mixed-use elements will ensure that these developments are urban in character and have some services that can be reached by biking, walking or using other non-automobile methods. This also relates to the concept of "linked" or "shared" trips presented later in this chapter. As new developments are proposed, local and regional planners have the opportunity to dictate responsible and effective land use to encourage "shared" trips and reduce impacts to the surrounding transportation system.

Transit Oriented Development (TOD)

Transit Oriented Development (TOD) refers to residential and commercial areas designed to maximize access by transit and non-motorized transportation, and with other features to encourage transit ridership. A TOD usually consists of a neighborhood with a rail or bus station, surrounded by relatively high-density development, with progressively lower-density spreading outwards. Transit Oriented Development generally requires about seven residential units per acre in residential areas and twenty-five employees per acre in commercial centers to adequately justify transit ridership. Transit ridership is also affected by factors such as employment density and clustering, demographic mix (students, seniors and lower-income people tend to be heavy transit users), transit pricing and rider subsidies, and the quality of transit service. This type of development could potentially work well within Bozeman and its outlying areas as development occurs. Features could be built into a given development to encourage transit use from the start, and at the same time could be incorporated into the funding source available to Streamline to help offset costs associated with new service.

Alternating Directions of Travel Lanes

This method of TDM is similar to that of Traffic Calming in that it strives to change driver characteristics and possibly enable users of the system to try different modes of travel. It also can serve to relieve a corridor during particularly heavy times of the day.

By capitalizing on the use of these options, the existing vehicular infrastructure can be made to function at acceptable levels of service for a longer period of time. Ultimately, this will result in lower per year costs for infrastructure replacement and expansion projects, not to mention less disruption to the users of the transportation system.

While some of these options may work well in the Bozeman area, it is clear that some may be inappropriate. Additionally, some of these options are more effective than others. To provide a TDM system that is effective in managing demand, a combination of these methods will be necessary.

10.4.3 Effectiveness of TDM Strategies

The measure of effectiveness of TDM strategies can be done using several different methods such as cost, usage, or those listed below:

- Reduced traffic during commute times;
- Reduced or stable peak hour traffic volumes;
- Increased commuter traffic at off peak times;
- Increased use of modes other than single occupant vehicles;
- Increased use of designated routes during emergencies or special events;
- Eased use of the transportation system by tourists or others unfamiliar with the system;
- Reduced travel time during peak hours; and/or
- Fewer crashes during peak hours.

In order to provide a TDM system that will address the needs of the Bozeman area, the elements of the system must be acceptable to the general population. If elements are proposed which are not acceptable, the TDM system goals will not be reached. However, it is also important to keep in mind the cost of implementing TDM measures.

Table 10-3 presents available TDM measures and ranks them by the likeliness of being accepted and implemented within the Bozeman area. A rank of "3" indicates that the measure has a high likelihood of being successfully implemented, a rank of "2" indicates that the measure would have more difficulty being accepted or implemented and a rank of "1" indicates that this measure would either be difficult to implement, or is inappropriate for the community at this time. This ranking system is based on input from public meetings, as well as consultant knowledge and experience. It is not survey based.

The measures which could best be adopted and accepted by area residents are those which allow greater flexibility in work hours, changing modes of transportation, or address specific, time-limited situations. Note that is envisioned that the most successful programs are "employer based", which necessitates a great deal of cooperation amongst the area employers most affected by modified work schedules and other potential TDM programs.

Those measures that would not be used in the planning area generally address issues not present in our community, such as significant commuting from a suburb. If such a problem existed, park and ride lots could be installed to address it. Travel characteristics in Montana are heavily dependent on population densities, distances to services (retail, medical, etc.), and locations of major employment centers. Often times travel distances are longer than what would be encountered in a larger urban area. Due to this nature of travel in Montana, private automobiles are unlikely to be replaced by other modes of travel until a change in technology occurs which allows travel by a mode that has the same flexibility of the automobile.

TDM strategies can be applied to specific events. If an event occurs on a regular basis which can be planned for, steps can be taken to manage the demands made on the transportation system.

Table 10-3
TDM Measures Ranked by Anticipated Usability

Strategy	Rank
Alternating directions of travel lanes	1
Alternate work schedule	3
Bicycling	2
Car sharing	1
Compressed work week	3
Express bus service	1
Flextime	3
Guaranteed ride home program	2
Higher parking costs for single occupant vehicles	1
Identifying routes for emergencies or special events	3
Installing / increasing Intelligent Transportation Systems (ITS)	2
Linked trips	3
Mandatory TDM measures for large employers	1
Park & Ride Lots	1
Pay for parking at work sites (outside the downtown area)	1
Preferential parking for rideshare/carpool/vanpools	1
Ramp metering	1
Required densification / mixed use elements for new developments	2
Ride sharing (carpooling)	2
Subsidized transit by employers	2
Telecommuting	2
Traffic Calming	3
Transit Oriented Development	2
Use of Streamline (Transit)	2
Vanpooling	1
Walking	2

A combination of methods is the most effective in reducing demand. The next step in the process is to prioritize these strategies to determine community preferences, and begin to develop packages of TDM strategies. These preferences and strategies can be analyzed to determine their impact on reducing trips. In order to prioritize the strategies, several questions must be answered relating to applicability, cost effectiveness, and community support. Using national experience as a basis, the strategies are classified according to their cost effectiveness as follows:

<u>The Most Cost Effective TDM Strategies</u>

- Financial Incentives (commuter subsidies for not driving alone)
- Financial Disincentives (e.g., parking tax or charges)
- Bicycle and Walking Programs, Facilities and Subsidies
- Parking Management (i.e., reducing the supply of available parking)

Thus, pricing, parking and provision of non-motorized options are among the most cost effective (greatest trip reduction impact at the lowest cost) alternatives. Taxes and/or charges for parking are among the least popular strategies, but most effective and cost-effective because they can immediately change travel behavior, and can be revenue neutral or even generate revenue to fund improved travel alternatives.

Moderately Cost Effective TDM Strategies

- Compressed Work Weeks (e.g., 4/40 schedules)
- Telecommuting
- Car Pool and Van Pool Programs

Compressed workweeks and telecommuting are among the most popular strategies with commuters because they offer employees more time at home. However, these strategies can be costly to employers because they involve a change in the basic operating policies of the work site. Car pool and van pool programs are also less cost effective because they generally only involve improved information on these travel alternatives (e.g., ride-matching computer systems, marketing campaigns, etc.). These programs can be expensive to manage and produce limited impact without supportive incentives or disincentives.

Cost Ineffective TDM Strategies

- TDM Marketing Programs (without incentives)
- Shuttles (for commuters, lunchtime travelers, etc.)
- Transit Service Improvements (without incentives)

Shuttles that connect employment sites to retail areas are often cited as necessary to allow ride sharers to get around midday without their cars. However, most shuttle programs of this type exhibit very low ridership and very high per rider cost. That is not to say all shuttles, such as student/campus shuttles, are ineffective. Likewise, transit service improvements can be very expensive and ineffective if incentives are not in place.

Cost Effectiveness Unknown

- TDM Friendly Land Use Policies
- TDM Strategies Applied to Non-Commute Travel

While some early evidence suggests that transit-oriented, bicycle-oriented, and pedestrian-oriented developments are effective in increasing the use of these modes at new residential, commercial and office sites, the cost effectiveness of these strategies is still somewhat unknown. One study in southern California showed that employers who combined financial incentives with an aesthetically pleasing work site exhibited trip reduction results 10 percent higher than those without these two critical strategies.

Finally, the application of TDM strategies to non-commute trips is somewhat problematic. In the Bozeman area, commute (home-base work) trips account for most all of the travel in the region. On the one hand, school, shopping, recreational and other trips most likely exhibit higher auto occupancy rates. This makes sense when one considers the amount of natural car pooling that occurs to schools, to the store, to restaurants, etc. However, many TDM strategies cannot be applied to these other travel markets. For example, one cannot really telecommute to the store. Other TDM strategies, such as parking taxes and bicycle improvements, can influence all travel markets.

Employer and Area-wide TDM Strategies - A range of employer-based and area-wide strategies can be considered. These strategies include the following:

- **Minimal Voluntary Ride-sharing Program**: assuming voluntary participation among employers (a low proportion of whom are implementing programs), this program includes support of car pools, van pools and transit, as well as preferential parking for car pools and van pools.

- **Maximum Voluntary Ride-sharing Program**: still assuming low participation among employers, this program includes additional support, such as significant alternative work arrangements (compressed workweeks and telecommuting), preferential parking, and direct financial subsidies to car poolers, van poolers, and transit riders ($0.50 per day).

- **Voluntary Alternative Work Arrangement Program**: again assuming voluntary participation among the region's employers, this program involves offering 30 percent of all employees compressed work weeks and giving another 25 percent the option of telecommuting (acknowledging that only about 20 percent of eligible employees will choose to do so).

- **Trip Reduction Ordinance**: this type of employer-based program would mandate all employers to implement the maximum ride-sharing program outlined above.

- **Voluntary Ride-sharing plus Transit Service Improvements**: a voluntary ride-sharing program for employers with area-wide improvements to transit service such as frequency and coverage increases, and preferential treatment to expedite bus run times.

- **Voluntary Ride-sharing plus Transit Improvements and a Parking Tax**: a voluntary employer program and transit service improvements with a $1 per day parking tax on all public and private parking spaces (non-residential).

- **Developer-based Ride-sharing Requirements**: new developments would be required to implement a moderate ride-sharing program (moderate support, preferential parking, alternative work arrangements, and subsidies), and site design improvements that are conducive to TDM (such as transit shelters, bicycle storage, etc.).

10.4.4 Conclusions Based on Preliminary TDM evaluation for the Bozeman Area

The object of this analysis is to provide the planners and policy-makers in the greater Bozeman area with a range of TDM programs, strategies and estimated impacts in terms of reducing traffic. The intent of the information provided is to assist in facilitating a consensus on the preferred TDM program to be included in the Plan update. The following overall conclusions are offered:

- **Employer-based programs will have limited long-term impacts.** Alone, these programs do not sufficiently reduce regional traffic volumes. This is because the Bozeman area is comprised of relatively small employers that are generally less effective in facilitating commute alternatives. The exception to this is MSU, which would likely realize a greater impact from employer-based strategies given its control over key travel variables, notably parking.

- **Employer programs should be considered as an interim step.** Even though employer programs are less effective due to the employment composition of the Bozeman area, a voluntary program, focused on the downtown and MSU should be considered. A demonstration program would provide local planners and policy-makers with valuable information on the specific strategies and marketing techniques to encourage commute alternatives. Unlike efforts aimed at the general population, the program should target large employers and work through appointed and dedicated coordinators. The program should be launched by local government (City and County) employers, and might involve the formation of a Transportation Management Association (TMA). Flextime among large employers and MSU should also be tested.

- **Transit service improvements would have limited impacts.** The transit service improvements (increased coverage and frequency, faster running times, etc.), will not likely yield significant trip reduction impacts on a regional basis. However, when applied to the downtown and MSU areas, with heavier concentrations of commuter and student trips, the results may be more encouraging.

- **Land use and non-motorized TDM strategies can be effective.** The implementation of land use policies that are TDM-friendly, combined with improvements to bicycle and pedestrian facilities, can impact all types of travel. The potential impact of these strategies may be greater in the long run than traditional employer-based TDM measures. These measures, considered alone, could reduce vehicle trips and vehicle miles traveled (VMT), although the impacts may be somewhat weather-dependent.

- **Area-wide pricing strategies are the most effective strategy.** While politically among the least popular measures, the fact remains that financial incentives and disincentives, especially area-wide parking pricing strategies, are the most effective techniques for reducing trips and encouraging travelers to use alternative modes of transportation and times of day. A regional parking tax could significantly reduce trips and VMT.

- **A range of regional impacts is possible from TDM.** The impacts presented here range from a low reduction in trips (for a voluntary ride-sharing program), to a theoretical maximum trip reduction of 25 percent (for a combination of all strategies). However, the results possible in the Bozeman area are highly dependent on the community support for changing travel behavior. The maximum impact is based on a combination of programs that has not, to date, been implemented anywhere in the U.S.

The steps in incorporating TDM into the Transportation Plan involve the selection of a preferred set of TDM strategies, and then the specification of a recommended short- and long- run TDM program for the Bozeman area. The choices for the preferred TDM program generally involved the following elements, alone or in combination:

- developer requirements (new employment);
- trip reduction ordinance (all employers);
- transit service improvements;
- voluntary employer program;
- parking fees or taxes;
- TDM-friendly land use policies; and
- bicycle and pedestrian facility and program improvements.

It is recommended that the preferred TDM program consists of four principle TDM program elements:

1) a voluntary employer program;
2) an enhanced bicycle and pedestrian program;
3) an improved transit system; and
4) modified land use policies to encourage TDM.

Each is discussed in more detail in the next subsection. It is believed that the non-motorized strategies offer the potential for reducing a significant number of trips in a cost-effective manner, and that a voluntary employer program is a good short-term objective. The belief is that the land use policy initiative would address necessary long-term measures.

It is also believed that several TDM strategies should be rejected outright as being infeasible or unacceptable. These include parking pricing and any type of mandatory requirements on employers and developers. The Montana Department of Transportation has developed a Montana specific "TDM Toolbox". In evaluating local options for TDM it is suggested to look for programs and alternatives that have been successfully implemented in Montana.

10.4.5 Recommended TDM Program

Based on the preferred TDM strategies described above, a short- and long-range TDM program can be outlined for the Bozeman area. This program description is not intended as a fully articulated plan for implementing TDM strategies over the next 20 years; rather it is intended as a framework from which to develop such a plan. As mentioned above, the plan should have at least two distinct time frames, or perhaps three: a short-range plan (1 to 3 years); a medium-range plan (5 to 10 years); and possibly a long-range plan (10 to 20 years).

Short-Range TDM Program: Maximize Volunteerism (1 to 3 years)

A program could be developed with the following components:

- **Voluntary Employer Cooperative Program**: With the assistance of the City, County, MSU, and a select group of other major employers, form a business cooperative to explore the implementation of TDM programs within each organization. This might involve a pilot program, whereby the City would work with several existing and new employer programs to test and evaluate employee acceptance and the effectiveness of various TDM strategies. The impetus for business involvement should not only be traffic congestion and air quality; rather TDM should be sold as a good business practice that benefits participants by solving site access problems, assisting with employee recruitment or retention, and providing additional employee benefits.

- **Small Employer TDM Program**: The Bozeman area has a very large proportion of employers with less than 50 employees, most of which with less than ten employees. This clearly affects the ability to group employees into car pools, but does not preclude the use of transit, bicycling, walking, or even alternative work arrangements (e.g., 4/40 schedules and telecommuting). While the small employer market has been a difficult one for the TDM profession to tackle, some techniques, including multi-tenant-building campaigns, can be effective.

- **Education on Smart Trip-making**: Since the employer elements of the program only effect commute trips and some student trips, an aggressive educational campaign to combine or avoid other types of trips could be implemented. This would be designed to reduce VMT and cold starts by encouraging residents to combine trips (e.g., to drop off school children and shop at the grocery store), or to avoid trips by using the telephone, computer or televisions to access information and services.

- **Flex-time and Staggered Shifts at Largest Employment Sites**: Changing the arrival and departure times of commuters and students can be a very effective way to alleviate peak period, localized traffic congestion. While these strategies do not reduce trips or VMT (and therefore, do not have an air quality benefit), they tend to be very effective in University communities. While many employers in the greater Bozeman area already have informal flexible schedules, the formalization of flex-time and staggered hours among employers, at places like MSU, and the City and County, could go a long way to reduce congestion around these sites and on heavily congested corridors.

- **Enhanced Bicycle/Pedestrian Program**: Given that the greatest TDM impacts are anticipated to be derived from the enhanced non-motorized program, implementation of three related program elements should be initiated. First, a bicycle and pedestrian system improvement program should be implemented on an aggressive schedule. Second, non-motorized information should be produced and distributed to reflect these new facilities on an ongoing basis. As the bicycle and pedestrian systems are improved and connectivity enhanced, marketing of the program should reflect the ease at which travelers can get around on foot or by pedal. Finally, as part of the employer pilot programs, financial subsidies for non-motorized modes should be encouraged.

Medium-Range TDM Program: Land Use and Non-Motorized (5 to 10 years)

The TDM program for the medium-range future--five to ten years from now--should build upon the short-range program, and initiate strategies that have a longer-range impact, such as land use policies. These strategies include:

- **Expansion of Employer Cooperative Program into TMA**: Based on the experience of the trial period of the business cooperative program, additional employers and organizations should be recruited to participate in the program. If the cooperative program is successful (demonstrating the interest and commitment of the involved organizations), the effort could be expanded into a Transportation Management Association (TMA). The TMA could relieve the City from the day-to-day responsibilities of operating the program, and provide additional focus and resolve to the efforts.

- **Continued Implementation of the Bicycle/Pedestrian/Transit Program**: Those projects programmed for implementation in five to ten years should be completed. Then the supporting information and incentive elements, as developed, could be continued to assure that maximum use and benefits are derived from the capital investment.

- **Land Use Policies and Practices Supportive of TDM**: The relationship between land use policies and travel behavior cannot be overstated. Modifying existing land use policies and practices, to be more TDM-friendly, could be very effective as a long-term solution. Supportive land use policies include:

    - **Parking maximums** - reduced parking requirements to encourage the implementation of TDM measures and parking supply management.
    - **Shared parking** - allowing two different and adjacent land uses (e.g., office building and movie theaters), to build and manage shared parking that is less than that required of each site.
    - **Density bonuses** - in certain areas, densification and mixed uses can reduce overall trip generation rates, and make shared ride and transit options more effective.
    - **In-filling** - by allowing residential development close to downtown and major employment areas, the ability of residents to bicycle, walk,

or use transit to commute is enhanced. Other growth management techniques, as suggested in the new growth management plan, could also be supportive of TDM.

- **Site design guidelines** - as described below, a number of TDM-friendly site design practices can be incorporated into the development review process, as either a comprehensive policy or on a case-by-case basis for zoning variances.

- **TDM-friendly Site Design Features**: As mentioned above, site design features that are supportive of TDM programs can be incorporated into site plans, and required or negotiated as part of the review process. This is a very common practice throughout the U.S. and has already been used on a limited basis in Montana. Such features should be considered for growing areas. An illustrative list of some site design features includes:

  - provision for bus shelters and information kiosks;
  - allowance for van pools in any downtown or MSU parking lots;
  - secure and safe bicycle storage at employment, school and retail locations;
  - showers and lockers for bicyclist and walkers at large employment sites; and
  - pedestrian system connectivity with adjacent sites and other paths.

Long-Range TDM Program: Contingency Measures (10 to 20 years)

The final element of the Bozeman area TDM program should be long-range contingency measures to address traffic problems (e.g., congestion, accessibility, mobility or air quality), become untenable. Should air quality or traffic congestion levels reach intolerable levels, the Bozeman area could revisit the analyses made as part of the 20-year plan. This would include investigating the need to implement more stringent, but less popular measures, such as parking pricing and mandatory TDM programs. While not a recommendation of this Plan, the possibility of needing more aggressive TDM measures, should the short- and medium-range programs fall short of expectations, should not be totally ignored.

Clearly TDM has an important place in the *Greater Bozeman Area Transportation Plan (2007 Update)*. However, the voluntary employer programs, bicycle/pedestrian improvements, transit system development and land use strategies are insufficient to completely avoid the need for key roadway capacity expansion projects, but may help defer the need for construction for a period of time. The highest priority should be the implementation of the non-motorized improvements; but even a modest reduction in vehicle trips during certain times of the year would avoid the need for certain capacity enhancements. Supportive of congestion relief, air quality improvement and regional mobility goals, TDM should be implemented on an incremental basis to test and evaluate the effectiveness and acceptability of the strategies analyzed in this Plan. Several short-term TDM program elements have been suggested that are relatively low-cost and readily available. The Bozeman area should strive to build more local experience with TDM programs by developing a detailed short-range plan and pilot program, and then revisiting that plan in three to five years.

10.5 TRAFFIC IMPACT STUDY (TIS) PREPARATION GUIDELINES

The following guidelines describe the elements required (at a minimum) for preparing a Traffic Impact Study and provide for the consistent preparation of these studies throughout the community. The purpose of a Traffic Impact Study is to: ensure that the proposed developments do not adversely affect the transportation network; identify any traffic problems related to the development; to develop solutions to the potential problems; and present improvements to be included in the proposed development.

1.0 INTRODUCTION

This section of the Traffic Impact Study should include the location of the development site and a detailed description of the proposed development. The description should include the existing and proposed uses of the site, size of the proposed development, general terrain features, access to the site, and anticipated completion date of the development (including phasing). This will include the square footage of each use or number of units proposed.

2.0 EXISTING CONDITIONS

This section of the Traffic Impact Study should include discussion about the existing roadways, traffic data collected for the development, and a level of service analysis.

2.1 EXISTING TRANSPORTATION SYSTEM

The Traffic Impact Study must identify existing conditions in the vicinity of the proposed development. This should include the geometric data (number of lanes, intersection configurations, etc.), traffic controls, and traffic volumes for the impacted roadways. The study area should include all roadways that are expected to be impacted by the development.

2.2 TRAFFIC DATA COLLECTION

In order to determine the existing traffic demands within the study area, average daily traffic count data and manual turning movement count data should be collected. If possible, speed data and vehicle classification data should be collected as well.

Manual turning movement counts should be collected at the study area intersections during peak hours (7:00 a.m. – 9:00 a.m. and 4:00 p.m. – 6:00 p.m.) on a Tuesday, Wednesday, or Thursday during weeks which have no holidays. Off-peak time periods may be analyzed based on the proposed development type (school, shopping centers, theaters, etc.).

2.3 EXISTING LEVEL OF SERVICE ANALYSIS

Based on the traffic data collected, the level of service for these intersections should be determined according to the procedures outlined in the Transportation Research Boards' Highway Capacity Manual (HCM) and the Highway Capacity Software (HCS). Level of Service provides a means for identifying intersections that are experiencing operational difficulties, as well as providing a scale to compare intersections with each other. The level of service scale represents the full range of operating conditions. The scale is based on the ability of an intersection to accommodate the amount of traffic using it. The scale ranges from "A" which indicates little, if any, vehicle delay, to "F" which indicates significant vehicle delay and traffic congestion.

This section should analyze the current traffic conditions in the study area and should identify any mitigation measures necessary prior to the development to achieve proper LOS and function of the transportation system.

Figures to be included in this section include:

- Vicinity Map
- Existing AM peak hour volumes
- Existing PM peak hour volumes
- Existing AADT traffic volumes

3.0 FUTURE CONDITIONS

An analysis of the study area should be conducted using anticipated (future) traffic volumes without the proposed development. Future daily and peak hour traffic volumes should be developed for the study area. The method and assumptions should be documented clearly so calculations are easy to follow and replicated if necessary. Any known future developments expected to affect the study area should also be addressed in this section.

Figures to be included in this section include:

- Development site plan
- Future AM peak hour volumes (without development)
- Future PM peak hour volumes (without development)
- Future AADT traffic volumes (without development)

4.0 PROPOSED DEVELOPMENT

This section discusses the proposed development characteristics and determines the number of additional trips and distribution that are expected to occur as a result of the development.

4.1 TRIP GENERATION CHARACTERISTICS

A trip generation analysis should be performed to determine future traffic volumes attributable to the proposed development in the study area using the Institute of

Transportation Engineers (ITE) Trip Generation Manual. This analysis establishes the number of trip rates generated by the proposed development.

4.2 Trip Distribution and Assignment

Traffic generated by the proposed development must be distributed and assigned to the roadway network. This distribution will determine the extent of the development's impacts on the surrounding roadways.

Figures to be included in this section include:

- Trip distribution percentages on the surrounding network
- Estimated AM peak hour volumes generated by the development
- Estimated PM peak hour volumes generated by the development

5.0 TRAFFIC IMPACTS WITH DEVELOPMENT

This section looks at the potential impact that the development will have on the transportation system. Using the trip generation and distribution rates determined in **Section 4.0** and applying those trips to the future network discussed in **Section 3.0**, the future conditions of the transportation system can be analyzed. An intersection and corridor analysis should be completed to determine the future LOS and to determine if any mitigation measure are necessary.

Any mitigation measures that may be required due to the additional trips from development should be discussed. An analysis of the mitigated transportation system should then be completed to show how the system is expected to perform after the mitigation measures have been put in place.

Figures to be included in this section include:

- Future AM peak hour volumes (with development)
- Future PM peak hour volumes (with development)
- Future AADT traffic volumes (with development)

6.0 RECOMMENDATIONS

Recommendations for improvements needed to remedy deficiencies in the network caused by the proposed development should be discussed in detail. These recommendations should be provided to help ensure that the proposed development functions with the surrounding area.

7.0 CONCLUSIONS

The conclusion of a Traffic Impact Study should be a clear description of the study findings including a reiteration of any recommendations being made as part of the study.

11.1 BACKGROUND

The previous chapters of this Plan identified problems with the transportation system and recommended appropriate corrective measures. This chapter focuses on the financial mechanisms that are traditionally used to finance transportation improvements. Transportation improvements can be implemented using federal, state, local and private funding sources. Considering the current funding limits of these traditional programs, and the anticipated road development needs of the community, it is apparent that a greater amount of the financing will be required from local and private sources if these needs are to be met.

Much of the following information concerning the federal and state funding programs was assembled with the assistance of the Statewide and Urban Planning Section of the Montana Department of Transportation (MDT). The intent is to identify the traditional federal, state and local sources of funds available for funding transportation related projects and programs in the Greater Bozeman Area. A narrative description of each potential funding source is provided including: the source of revenue; required match; purpose for which funds are intended; means by which the funds are distributed; and the agency or jurisdiction responsible for establishing priorities for the use of the funds.

11.2 FUNDING SOURCES

The following list includes federal and state funding sources developed for the distribution of Federal and State transportation funding. This includes Federal funds the State receives under Federal Transportation Legislation and State law.

Federal Funding Sources

- Interstate Maintenance (IM)
- National Highway System (NHS)
- Surface Transportation Program (STP)
    - *Primary Highway System (STPP)**
    - *Secondary Highway System (STPS)**
    - *Urban Highway System (STPU)**
    - *Community Transportation Enhancement Program (CTEP)**
- Highway Safety Improvement Program (HSIP)
    - *High Risk Rural Roads Program (HRRR)*
- Highway – Railway Crossing Program (RRX)
- Highway Bridge Replacement and Rehabilitation Program (HBRRP)
    - *On-System Bridge Replacement and Rehabilitation Program*
    - *Off-System Bridge Replacement and Rehabilitation Program*
- Congestion Mitigation & Air Quality Improvement Program (CMAQ)
    - *CMAQ (formula)*
    - *Montana Air & Congestion Initiative (MACI)–Guaranteed Program (flexible)**
    - *Montana Air & Congestion Initiative (MACI)–Discretionary Program (flexible)**
    - *Urban High Growth Adjustment (flexible)**

- Urban Highway Preservation (UHP) (Equity Bonus)*
- Safe Routes To School (SRTS)
- Federal Lands Highway Program (FLHP)
  - *Public Lands Highways (PLH)*
  - *Parkways and Park Roads*
  - *Indian Reservation Roads (IRR)*
  - *Refuge Roads*
- Congressionally Directed Funds
  - *High Priority Projects (HPP)*
  - *Transportation Improvements Projects*
- Transit Capital & Operating Assistance Funding
  - *Discretionary Grants (Section 5309)*
  - *Capital Assistance for the Elderly and Persons with Disabilities (Section 5310)*
  - *Financial Assistance for Rural General Public Providers (Section 5311)*
  - *New Freedoms Program (5317)*
  - *Job Access Reverse Commute (JARC) (5316)*

State Funding Sources

- State Funded Construction (SFC)
- TransADE

11.3 FEDERAL AID FUNDING SOURCES

The following summary of major Federal transportation funding categories received by the State through the Federal Transportation Legislation and State law includes state developed implementation/sub-programs. In order to receive project funding under these programs, projects must be included in the State Transportation Improvement Program (STIP).

- **Interstate Maintenance (IM)**

Interstate Maintenance (IM) funds are Federally apportioned to Montana and allocated based on system performance by the Montana Transportation Commission. The Commission approves and awards projects for improvements on the Interstate Highway System which are let through a competitive bidding process. The Federal share for IM projects is 91.24% and the State is responsible for 8.76%.

- **National Highway System (NHS)**

The purpose of the National Highway System (NHS) is to provide an interconnected system of principal arterial routes which will serve major population centers, international border crossings, intermodal transportation facilities and other major travel destinations; meet national defense requirements; and serve interstate and interregional travel. The National Highway System includes all Interstate routes, a large percentage of urban and rural principal arterials, the defense strategic highway network, and strategic highway connectors.

Allocations and Matching Requirements
NHS funds are Federally apportioned to Montana and allocated based on system performance by the Montana Transportation Commission. The Federal share for NHS projects is 86.58% and the State is responsible for the remaining 13.42%. The State share is funded through the Highway State Special Revenue Account.

Eligibility and Planning Considerations
Activities eligible for the National Highway System funding include construction, reconstruction, resurfacing, restoration, and rehabilitation of segments of the NHS. Operational improvements as well as highway safety improvements are also eligible. Other miscellaneous activities that may qualify for NHS funding include research, planning, carpool projects, bikeways, and pedestrian walkways. The Transportation Commission establishes priorities for the use of National Highway System funds and projects are let through a competitive bidding process.

- **Surface Transportation Program (STP)**

Surface Transportation Program (STP) funds are Federally apportioned to Montana and allocated by the Montana Transportation Commission to various programs including the Surface Transportation Program Primary Highways (STPP), Surface Transportation Program Secondary Highways (STPS), and the Surface Transportation Program Urban Highways (STPU).

  - *Primary Highway System (STPP)**

The Federal and State funds available under this program are used to finance transportation projects on the state-designated Primary Highway System. The Primary Highway System includes highways that have been functionally classified by the MDT as either principal or minor arterials and that have been selected by the Transportation Commission to be placed on the Primary Highway System [MCA 60-2-125(3)].

Allocations and Matching Requirements
Primary funds are distributed statewide [MCA 60-3-205] to each of five financial districts, including the Butte District. The Commission distributes STPP funding based on system performance. Of the total received, 86.58% is Federal and 13.42% is State funds from the Highway State Special Revenue Account.

Eligibility and Planning Considerations
Eligible activities include construction, reconstruction, rehabilitation, resurfacing, restoration and operational improvements. The Transportation Commission establishes priorities for the use of Primary funds and projects are let through a competitive bidding process.

- *Secondary Highway System (STPS)**

The Federal and State funds available under this program are used to finance transportation projects on the state-designated Secondary Highway System. The Secondary Highway System highways that have been functionally classified by the MDT as either rural minor arterials or rural major collectors and that have been selected by the Montana Transportation Commission in cooperation with the boards of county commissioners, to be placed on the secondary highway system [MCA 60-2-125(4)].

Allocations and Matching Requirements
Secondary funds are distributed statewide (MCA 60-3-206) to each of five financial districts, including the Butte District, based on a formula, which takes into account the land area, population, road mileage and bridge square footage. Federal funds for secondary highways must be matched by non-federal funds. Of the total received 86.58% is Federal and 13.42 % is non-federal match. Normally, the match on these funds is from the Highway State Special Revenue Account.

Eligibility and Planning Considerations
Eligible activities for the use of Secondary funds fall under three major types of improvements: Reconstruction, Rehabilitation, and Pavement Preservation. The Reconstruction and Rehabilitation categories are allocated a minimum of 65% of the program funds with the remaining 35% dedicated to Pavement Preservation. Secondary funds can also be used for any project that is eligible for STP under Title 23, U.S.C.

MDT and county commissions determine Secondary capital construction priorities for each district with final project approval by the Transportation Commission. By state law the individual counties in a district and the state vote on Secondary funding priorities presented to the Commission. The Counties and MDT take the input from citizens, small cities, and tribal governments during the annual priorities process. Projects are let through a competitive bidding process.

- *Urban Highway System (STPU)**

The Federal and State funds available under this program are used to finance transportation projects on the state-designated Urban Highway System. The Urban Highway System is described under MCA 60-2-125(6), as those highways and streets that are in and near incorporated cities with populations of over 5,000 and within urban boundaries established by the MDT, that have been functionally classified as either urban arterials or collectors, and that have been selected by the Montana Transportation Commission, in cooperation with local government authorities, to be placed on the Urban Highway System.

Allocations and Matching Requirements
State law [MCA 60-3-211] guides the allocation of Urban funds to projects on the Urban Highway System in the fifteen urban areas through a statutory formula based

on each area's population compared to the total population in all urban areas. Of the total received, 86.58% is Federal and 13.42% is non-federal match typically provided from the Special State Revenue Account for highway projects.

Eligibility and Planning Considerations
Urban funds are used primarily for major street construction, reconstruction, and traffic operation projects on the 390 miles on the State-designated Urban Highway System, but can also be used for any project that is eligible for STP under Title 23, U.S. C. Priorities for the use of Urban funds are established at the local level through local planning processes with final approval by the Transportation Commission.

Because the Urban Highway System includes transportation infrastructure that crosses the line between incorporated and unincorporated areas, it is important that city and county governments work together to identify and address urban highway needs. Consideration of cooperative efforts between city and county governments to address urban highways (roads and bridges) should be incorporated into the planning and implementation of the county CIP as appropriate.

Bozeman's FFY 2008 urban funding balance is currently $3,336,806. The annual allocation of urban funds for Bozeman is $805,177(total dollars, Federal plus State match). It is anticipated the City of Bozeman will have a positive Urban funding balance and be able to program a new project in 2009.

- *Community Transportation Enhancement Program (CTEP)**

Federal law requires that at least 10% of STP funds must be spent on transportation enhancement projects. The Montana Transportation Commission created the Community Transportation Enhancement Program in cooperation with the Montana Association of Counties (MACO) and the League of Cities and Towns to comply with this Federal requirement.

Allocations and Matching Requirements
CTEP is a unique program that distributes funding to local and tribal governments based on a population formula and provides project selection authority to local and tribal governments. The Transportation Commission provides final approval to CTEP projects within the State's right-of-way. The Federal share for CTEP projects is 86.58% and the Local and tribal governments are responsible for the remaining 13.42%.

Eligibility and Planning Considerations
Eligible CTEP categories include:

- Pedestrian and bicycle facilities
- Historic preservation
- Acquisition of scenic easements and historic or scenic sites
- Archeological planning and research
- Mitigation of water pollution due to highway runoff or reduce vehicle-caused

- Wildlife mortality while maintaining habitat connectivity
- Scenic or historic highway programs including provisions of tourist and welcome center facilities
- Landscaping and other scenic beautification
- Preservation of abandoned railway corridors (including the conversion and use for bicycle or pedestrian trails)
- Control and removal of outdoor advertising
- Establishment of transportation museums
- Provisions of safety and educational activities for pedestrians and bicyclists

Projects addressing these categories and that are linked to the transportation system by proximity, function or impact, and where required, meet the "historic" criteria, may be eligible for enhancement funding.

Projects must be submitted by the local government to the MDT, even when the project has been developed by another organization or interest group. Project proposals must include evidence of public involvement in the identification and ranking of enhancement projects. Local governments are encouraged to use their planning boards, where they exist, for the facilitation of public participation; or a special enhancement committee. The MDT staff reviews each project proposal for completeness and eligibility and submits them to the Transportation Commission and the federal Highway Administration for approval.

The City of Bozeman has a current balance $128,780 and the estimated 2008 allocation is $136,165 (Federal). Gallatin County is allocated approximately $162,681 annually (Federal). There is currently a balance of $170,499 for this program. The balances represent funds not obligated towards a selected project.

**State funding programs developed to distribute Federal funding within Montana*

- **Highway Safety Improvement Program (HSIP)**

Allocations and Matching Requirements

HSIP is a new core funding program established by SAFETEA-LU. HSIP funds are Federally apportioned to Montana and allocated to safety improvement projects identified in the strategic highway safety improvement plan by the Commission. Projects described in the State strategic highway safety plan must correct or improve a hazardous road location or feature, or address a highway safety problem. The Commission approves and awards the projects which are let through a competitive bidding process. Generally, the Federal share for the HSIP projects is 91.24% and the State is responsible for 8.76%.

Eligibility and Planning Considerations

There are two set aside programs that receive HSIP funding: the Highway – Railway Crossing Program and the High Risk Rural Roads Program.

- **High Risk Rural Roads Program (HRRR)**

Funds are set aside from the Highway Safety Improvement Program funds apportioned to Montana for construction and operational improvements on high-risk rural roads. These funds are allocated to HRRRP projects by the Commission. If Montana certifies that it has met all of the needs on high risk rural roads, these set aside funds may be used on any safety improvement project under the HSIP. Montana's set aside requirement for HRRRP is approximately $700,000 per year.

- **Highway – Railway Crossing Program (RRX)**

Funds are Federally apportioned to Montana and allocated by the Commission for projects that will reduce the number of fatalities and injuries at public highway-rail grade crossings; through the elimination of hazards and/or the installation/upgrade of protective devices.

- **Highway Bridge Replacement and Rehabilitation Program (HBRRP)**

Allocations and Matching Requirements
HBRRP funds are Federally apportioned to Montana and allocated to two programs by the Montana Transportation Commission. In general, projects are funded with 86.58% Federal and the State is responsible for the remaining 13.42%. The State share is funded through the Highway State Special Revenue Account. The Montana Transportation Commission approves projects which are then let to contract through a competitive bidding process.

  - *On-System Bridge Replacement and Rehabilitation Program*

The On-System Bridge Program receives 65% percent of the Federal HBRRP funds. Projects eligible for funding under the On-System Bridge Program include all highway bridges on the State system. The bridges are eligible for rehabilitation or replacement. In addition, painting and seismic retrofitting are also eligible under this program. MDT's Bridge Bureau assigns a priority for replacement or rehabilitation of structurally deficient and functionally obsolete structures based upon sufficiency ratings assigned to each bridge. A structurally deficient bridge is eligible for rehabilitating or replacement; a functionally obsolete bridge is eligible only for rehabilitation; and a bridge rated as sufficient is not eligible for funding under this program.

  - *Off-System Bridge Replacement and Rehabilitation Program*

The Off-System Bridge Program receives 35% percent of the Federal HBRRP funds. Projects eligible for funding under the Off-System Bridge Program include all highway bridges not on the State system. Procedures for selecting bridges for inclusion into this program are based on a ranking system that weighs various elements of a structures condition and considers local priorities. MDT Bridge Bureau personnel conduct a field inventory of off-system bridges on a two-year cycle. The field inventory provides information used to calculate the Sufficiency Rating (SR).

- **<u>Congestion Mitigation & Air Quality Improvement Program (CMAQ)</u>**

Federal funds available under this program are used to finance transportation projects and programs to help improve air quality and meet the requirements of the Clean Air Act. Montana's air pollution problems are attributed to carbon monoxide (CO) and particulate matter (PM10 and PM2.5).

<u>Allocations and Matching Requirements</u>
CMAQ funds are Federally apportioned to Montana and allocated to various eligible programs by formula and by the Commission. As a minimum apportionment state a Federally required distribution of CMAQ funds goes to projects in Missoula since it is Montana's only designated and classified air quality non-attainment area. The remaining, non-formula funds, referred to as "flexible CMAQ" is directed to areas of the state with emerging air quality issues through various state programs. The Transportation Commission approves and awards both formula and non-formula projects on MDT right-of-way. Infrastructure and capital equipment projects are let through a competitive bidding process. Of the total funding received, 86.58% is Federal and 13.42% is non-federal match provided by the state for projects on state highways and local governments for local projects.

<u>Eligibility and Planning Considerations</u>
In general, eligible activities include transit improvements, traffic signal synchronization, bicycle pedestrian projects, intersection improvements, travel demand management strategies, traffic flow improvements, and public fleet conversions to cleaner fuels. At the project level, the use of CMAQ funds is not constrained to a particular system (i.e. Primary, Urban, and NHS). A requirement for the use of these funds is the estimation of the reduction in pollutants resulting from implementing the program/project. These estimates are reported yearly to FHWA.

- *CMAQ (formula)*

Mandatory CMAQ funds that come to Montana based on a Federal formula and are directed to Missoula, Montana's only classified, moderate CO non-attainment area. Not applicable to Whitefish.

- *Montana Air & Congestion Initiative (MACI)–Guaranteed Program (flexible)**

This is state program funded with flexible CMAQ funds that the Commission allocates annually to Billings and Great Falls to address carbon monoxide issues in these designated, but "not classified", CO non-attainment areas. The air quality in these cities is roughly equivalent to Missoula, however, since these cities are "not classified" so they do not get direct funding through the Federal formula.

- *Montana Air & Congestion Initiative (MACI)–Discretionary Program (flexible)**

The MACI – Discretionary Program provides funding for projects in areas designated non-attainment or recognized as being "high-risk" for becoming non-attainment. Since 1998, MDT has used MACI-Discretionary funds to get ahead of the curve for

CO and PM10 problems in non-attainment and high-risk communities across Montana. District Administrators and local governments nominate projects cooperatively. Projects are prioritized and selected based on air quality benefits and other factors. The most beneficial projects to address these pollutants have been sweepers and flushers, intersection improvements and signal synchronization projects.

- *Urban High Growth Adjustment (flexible)**

Urban High Growth Adjustment funds are distributed to urban areas in Montana where population increased by more than 15% between the 1990 and 2000 censuses. Kalispell, Bozeman, and Missoula are the areas currently eligible for funding through this source. The intent of this funding is to address backlogged needs in these very rapidly growing cities. Nominations for the use of these funds are established at the local level similar to STPU funds. These funds may be spent on the Urban Highway System for projects eligible for either STPU or CMAQ funds.

**State funding programs developed to distribute Federal funding within Montana*

- **Urban Pavement Preservation (UPP) (Equity Bonus)***

The Urban Pavement Preservation Program is a state program that addresses urban highway system preservation needs. The program is funded from federal Equity Bonus funds that are appropriated to each State to ensure that each State receives a specific share of the aggregate funding for major highway programs. The program funds cost-effective treatments for the preservation of the existing Urban Highway System to prevent deterioration while maintaining or improving the functional condition of the system without increasing structural capacity.

Allocations and Matching Requirements
The Transportation Commission determines the annual funding level for this program for preservation projects in the fifteen urban areas. Projects are funded with 86.58% Federal and the State is responsible for the remaining 13.42%. The State share is funded through the Highway State Special Revenue Account. The Montana Transportation Commission approves projects which are then let to contract through a competitive bidding process.

Eligibility and Planning Considerations
Activities eligible for this funding include pavement preservation treatments on the Urban Highway System based on needs identified through a locally developed and maintained pavement management system. Priorities are developed by MDT Districts based on the local pavement management system outputs and consideration of local government nominations with final approval by the Transportation Commission. Projects are let through a competitive bidding process.

**State funding programs developed to distribute Federal funding within Montana*

- **Safe Routes To School (SRTS)**

Allocations and Matching Requirements
Safe Routes To School funds are Federally apportioned to Montana for programs to develop and promote a safe environment that will encourage children to walk and bicycle to school. Montana is a minimum apportionment state, and will receive $1-million per year, subject to the obligation limitation. The Federal share of this program is 100%.

Eligibility and Planning Considerations
Eligible activities for the use of SRTS funds fall under two major categories with 70% directed to infrastructure improvements, and the remaining 30% for behavioral (education) programs. Funding may be used within a two mile radius of K-8 schools for improvements or programs that make it safer for kids to walk or bike to school. SRTS is a reimbursable grant program and project selection is done through an annual application process. Eligible applicants for infrastructure improvements include local governments and school districts. Eligible applicants for behavioral programs include state, local and regional agencies, school districts, private schools, non-profit organizations. Recipients of the funds will front the cost of the project and will be reimbursed during the course of the project. For grant cycle information visit: http://www.mdt.mt.gov/pubinvolve/saferoutes/

- **Federal Lands Highway Program (FLHP)**

FLHP is a coordinated Federal program that includes several funding categories; Bozeman is eligible for some of these categories.

  - *Public Lands Highways (PLH)*

Discretionary
The PLH Discretionary Program provides funding for projects on highways that are within, adjacent to, or provide access to Federal public lands. As a discretionary program, the project selection authority rests with the Secretary of Transportation. However, this program has been earmarked by Congress under SAFETEA-LU. There are no matching fund requirements.

Forest Highway
The Forest Highway Program provides funding to projects on routes that have been officially designated as Forest Highways. Projects are selected through a cooperative process involving FHWA, the US Forest Service and MDT. Projects are developed by FHWA's Western Federal Lands Office. There are no matching fund requirements.

  - *Parkways and Park Roads*

Parkways and Park Roads funding is for National Park transportation planning activities and projects involving highways under the jurisdiction of the National Park Service. Projects are prioritized by the National Park Service and approved and developed by FHWA's Western Federal Lands Office. There are no matching fund requirements.

- *Indian Reservation Roads (IRR)*

IRR funding is eligible for multiple activities including transportation planning and projects on roads or highways designated as Indian Reservation Roads. Funds are distributed to Bureau of Indian Affairs (BIA) area offices in accordance with a Federal formula and are then distributed to projects on individual reservations. Projects are usually constructed by BIA forces. There are no matching fund requirements. Any public road within or leading to a reservation is eligible for the Indian Reservation Road funding. In practice, IRR funds are only rarely expended on state designated roads. MDT staff is aware of only two secondary routes that have received IRR funding support. These are S-418, Pryor Road, in the Crow Reservation; and S-234, Taylor Hill Road, that leads to the Rocky Boy's Reservation.

- *Refuge Roads*

Refuge Roads funding is eligible for maintenance and improvements of refuge roads, rest areas, and bicycle and pedestrian facilities. Allocations are based on a long-range transportation improvement program developed by the US Fish and Wildlife Service. There are no matching fund requirements.

- **Congressionally Directed Funds**

- *High Priority Projects (HPP)*

High Priority Projects are specific projects named to receive Federal funding in SAFETEA-LU Section 1702. HPP funding authority is available until expended and projects named in this section are included in Montana's percent share of the Federal highway funding program. The Montana Transportation Commission approves projects which are then let to contract through a competitive bidding process. In Montana, the Federal share payable for these projects is 86.58% Federal and 13.42% non-Federal. Montana receives 20% of the total project funding named in each year 2006 thru 2009. These funds are subject to the obligation limitation.

- *Transportation Improvements Projects*

Transportation Improvement Projects are specific projects named to receive Federal funding in SAFETEA-LU Section 1934. Transportation Improvement Project funding authority is available until expended and projects named in this section are not included in Montana's percent share of the Federal highway funding program. The Montana Transportation Commission approves projects which are then let to contract through a competitive bidding process. In Montana, the Federal share payable on these projects is 86.58% Federal and 13.42% non-Federal. Montana receives a directed percent of the total project funding named in each year as follows: 2005 – 10%, 2006-20%, 2007-25%, 2008-25%, 2009-20%. These funds are subject to the obligation limitation.

- **Transit Capital & Operating Assistance Funding**

The MDT Transit Section provides federal and state funding to eligible recipients through federal and state programs. Federal funding is provided through the Section 5310 and Section 5311 transit programs and state funding is provided through the TransADE program. The new highway bill SAFETEA-LU brought new programs for transit "New Freedoms and Job Access Reverse Commute (JARC). All projects funded must be derived from a locally developed, coordinated public transit-human services transportation plan (a "coordinated plan").

The coordinated plan must be developed through a process that includes representatives of public, private, and nonprofit transportation and human service providers and participation from the public.

- *Discretionary Grants (Section 5309)*

Provides capital assistance for fixed guide-way modernization, construction and extension of new fixed guide-way systems, bus and bus-related equipment and construction projects. Eligible applicants for these funds are state and local public bodies.

- *Capital Assistance for the Elderly and Persons with Disabilities (Section 5310)*

The Section 5310 Program provides capital assistance to providers that serve elderly persons and persons with disabilities. Eligible recipients must have a locally developed coordination plan. Federal funds provide 86% of the capital costs for purchase of buses, vans, wheelchair lifts, communication, and computer equipment. The remaining 14% is provided by the local recipient. Application for funding is made on an annual basis.

- *Financial Assistance for Rural General Public Providers (Section 5311)*

The purpose of the Section 5311 Program is to assist in the maintenance, development, improvement, and use of public transportation systems in rural areas (areas under 50,000 population). Eligible recipients are local public bodies, incorporated cities, towns, counties, private non-profit organizations, Indian Tribes, and operators of public transportation services. A locally developed coordinate plan is needed to receive funding assistance. Funding is available for operating and capital assistance. Federal funds pay for 86% of capital costs, 54% for operating costs, 80% for administrative costs, and 80% for maintenance costs. The remainder, or required match, (14% for capital, 46% for operating, 20% for administrative, and maintenance) is provided by the local recipient. Application for funding is made on an annual basis.

- *New Freedoms Program (5317)*

The purpose of the New Freedom Program is to provide improved public transportation services, and alternatives to public transportation, for people with disabilities, beyond those required by the Americans with Disabilities Act of 1990 (ADA). The program will provide additional tools to overcome barriers facing Americans with disabilities who want to participate fully in society. Funds may be used for capital expenses with Federal funds provided for up to 80 percent of the cost of the project, or operating expenses with Federal funds provided for up to 50 percent of the cost of the project. All projects funded must be derived from a locally developed, coordinated public transit-human services transportation plan (a "coordinated plan").

- *Job Access Reverse Commute (JARC) (5316)*

The purpose of this grant program is to develop transportation services designed to transport welfare recipients and low income individuals to and from jobs and to develop transportation services for residents of urban centers and rural and suburban areas to suburban employment opportunities. Funds may be used for capital and operating expenses with Federal funds provided for up to 50 percent of the cost of the project.

11.4 STATE FUNDING SOURCES

- **State Funded Construction (SFC)**

Allocations and Matching Requirements
The State Funded Construction Program, which is funded entirely with state funds from the Highway State Special Revenue Account, provides funding for projects that are not eligible for Federal funds. This program is totally State funded, requiring no match.

Eligibility and Planning Considerations
This program funds projects to preserve the condition and extend the service life of highways. Eligibility requirements are that the highways be maintained by the State. MDT staff nominates the projects based on pavement preservation needs. The District's establish priorities and the Transportation Commission approves the program.

- **TransADE**

The TransADE grant program offers operating assistance to eligible organizations providing transportation to the elderly and persons with disabilities.

Allocations and Matching Requirements
This is a state funding program within Montana statute. State funds pay 50 percent of the operating costs and the remaining 50 percent must come from the local recipient.

Eligibility and Planning Considerations
Eligible recipients of this funding are counties, incorporated cities and towns, transportation districts, or non-profit organizations. Applications are due to the MDT Transit Section by the first working day of February each year. To receive this funding the applicant is required by state law (MCA 7-14-112) to develop a strong, coordinated system in their community and/or service area.

11.5 LOCAL FUNDING SOURCES

Local governments generate revenue through a variety of funding mechanisms. Typically, several local programs related to transportation exist for budgeting purposes and to disperse revenues. These programs are tailored to fulfill specific transportation functions or provide particular services.

The following text summarizes programs that relate to transportation financing through the city and county.

- **City of Bozeman**

  - *General Fund*

This fund provides revenue for most major city functions like the administration of local government, and the departments of public services, including police, fire, and parks. Revenues for the fund are generated through the general fund mill levy on real and personal property and motor vehicles; licenses and permits; state and federal intergovernmental revenues; intergovernmental fund transfers; and charges for services.

Several transportation-related services are supported by this fund including public services (engineering and streets) and the City of Bozeman Police Department. The street department is responsible for maintaining the city streets and alleys including: pavement repair, street cleaning, striping and signing, lighting and traffic signal maintenance, and plowing and sanding during the winter. In addition to revenue from the General Fund, some revenue used to operate the street department is generated from gas tax funds and street maintenance district funds. The police department is obviously responsible for enforcing traffic laws on the street system.

Although most of the highway-designated monies are oriented toward maintenance activities, some new construction and street-widening projects may be financed through the General Fund. This revenue source has been used in conjunction with other resources to finance local street and highway projects.

The city is currently using the General Fund to provide some transit financing assistance to Streamline. There is a dedicated mill levy for this purpose generating about $15,000 annually.

- *Special Revenue Funds*

These funds are used to budget and distribute revenues that are legally restricted for a specific purpose. Several such funds that benefit the transportation system are discussed briefly in the following paragraphs.

- *SID Revolving Fund*

This fund provides financing to satisfy bond payments for special improvement districts in need of additional funds. The city can establish street SID's with bond repayment to be made by the adjoining landowners receiving the benefit of the improvement. The city has provided labor and equipment for past projects through the General Fund, with an SID paying for materials.

- *Gas Tax Apportionment*

Revenues are generated through State gasoline taxes apportioned from the State of Montana. Transfers are made from this fund to the General Fund to reimburse expenditures for construction, reconstruction, repair and maintenance of streets. Half of the City's allocation is based upon population, and half is based on the miles of streets and alleys in the City. The City Gas Tax Fund received an allocation of $630,724 for FY 2007.

- *Development Impact Fees*

These fees are paid by developers to help finance improvements to the Major Street Network. The fee structure is based upon the number of residential units or square footage of commercial buildings being constructed.

- *Developer Exactions*

Road construction or roadway improvements are performed by developers as a condition of approval for their development project. Improvements are typically limited to the local roads within, and the road system adjacent to, the proposed development.

- *Bozeman Parking Commission*

Monthly lease rental payments and meter collections fund this program. Revenues are used to fund parking improvements in the downtown area.

- *Tax Increment Financing (TIF)*

Downtown Bozeman is a current TIF-funded improvement district. The funds generated from the TIF could be used to finance projects including street and parking improvements; tree planting; installation of new bike racks; trash containers and benches; and other streetscape beautification projects within the downtown area.

- **Gallatin County**

  - *Road Fund*

The County Road Fund provides for the construction, maintenance, and repair of all county roads outside the corporate limits of cities and towns in Gallatin County. Revenue for this fund comes from intergovernmental transfers (i.e., State gas tax apportionment and motor vehicle taxes), and a mill levy assessed against county residents living outside cities and towns. The county mill levy has a ceiling limit of 15 mills. Gallatin County's FY 2007 state gas tax apportionment added $294,261 to the Road Fund.

County Road Fund monies are primarily used for maintenance with little allocated for new road construction. It should be noted that only a small percentage of the total miles on the county road system are located in the study area. Projects eligible for financing through this fund will be competing for available revenues on a county-wide basis.

  - *Bridge Fund*

The Bridge Fund provides financing for engineering services, capital outlays, and necessary maintenance for bridges on all off-system and Secondary routes within the county. These monies are generated through intergovernmental fund transfers (i.e., vehicle licenses and fees), and a county-wide mill levy. There is a taxable limit of four mills for this fund.

  - *Special Revenue Funds*

Special revenue funds may be used by the county to budget and distribute revenues legally restricted to a specific purpose. Several such funds that benefit the transportation system are discussed briefly in the following paragraphs.

  - *Capital Improvements Fund*

This fund is used to finance major capital improvements to county infrastructure. Revenues are generated by loans from other county funds, and must be repaid within ten years. Major road construction projects are eligible for this type of financing.

  - *Rural Special Improvement District (RSID) Revolving Fund*

This fund is used to administer and distribute monies for specified RSID projects. Revenue for this fund is generated primarily through a mill levy and through motor vehicle taxes and fees. A mill levy is assessed only when delinquent bond payments dictate such an action.

- *Special Bond Funds*

A fund of this type may be established by the county on an as-needed basis for a particularly expensive project. The voters must approve authorization for a special bond fund. The county is not currently using this mechanism.

- *Specialized Transportation Fund*

This type of fund may be established to supplement the cost of transit service to disabled or low-income county residents. The county is not currently using this mechanism.

- **<u>Private Funding Sources and Alternatives</u>**

Private financing of highway improvements, in the form of right-of-way donations and cash contributions, has been successful for many years. In recent years, the private sector has recognized that better access and improved facilities can be profitable due to increases in land values and commercial development possibilities. Several forms of private financing for transportation improvements used in other parts of the United States are described in this section.

- *Development Financing*

The developer provides the land for a transportation project and in return, local government provides the capital, construction, and necessary traffic control. Such a financing measure can be made voluntary or mandatory for developers.

- *Cost Sharing*

The private sector pays some of the operating and capital costs for constructing transportation facilities required by development actions.

- *Transportation Corporations*

These private entities are non-profit, tax exempt organizations under the control of state or local government. They are created to stimulate private financing of highway improvements.

- *Road Districts*

These are areas created by a petition of affected landowners, which allow for the issuance of bonds for financing local transportation projects.

- *Private Donations*

The private donation of money, property, or services to mitigate identified development impacts is the most common type of private transportation funding.

Private donations are very effective in areas where financial conditions do not permit a local government to implement a transportation improvement itself.

- *Private Ownership*

This method of financing is an arrangement where a private enterprise constructs and maintains a transportation facility, and the government agrees to pay for public use of the facility. Payment for public use of the facility is often accomplished through leasing agreements (wherein the facility is rented from the owner), or through access fees whereby the owner is paid a specified sum depending upon the level of public use.

- *Privatization*

Privatization is either the temporary or long-term transfer of a public property or publicly owned rights belonging to a transportation agency to a private business. This transfer is made in return for a payment that can be applied toward construction or maintenance of transportation facilities.

- *General Obligation (G.O.) Bonds*

The sale of general obligation bonds could be used to finance a specific set of major highway improvements. A G.O. bond sale, subject to voter approval, would provide the financing initially required for major improvements to the transportation system. The advantage of this funding method is that when the bond is retired, the obligation of the taxpaying public is also retired. State statutes limiting the level of bonded indebtedness for cities and counties restrict the use of G.O. bonds. Bozeman used G.O. bonds to implement some of the improvements recommended in the 1993 Transportation Plan Update. The present property tax situation in Montana, and recent adverse citizen responses to proposed tax increases by local government, would suggest that the public may not be receptive to the use of this funding alternative.

- *Development Exactions/Impact Fees*

As mentioned in the section on city funding sources, exaction of fees or other considerations from developers in return for allowing development to occur can be an excellent mechanism for improving the transportation infrastructure. The County is currently using this funding mechanism. Developer exactions and fees allow growth to pay for itself. The developers of new properties should be required to provide at least a portion of the added transportation system capacity necessitated by their development, or to make some cash contribution to the agency responsible for implementing the needed system improvements.

Establishment of an equitable fee structure would be required to assess developers based upon the level of impact to the transportation system expected from each project. Such a fee structure could be based upon the number of additional vehicle trips generated, or upon a fundamental measure such as square footage of floor space. Once the mechanism is in place, all new development would be reviewed by the local government and fees assessed accordingly.

- *Tax Increment Financing (TIF)*

Increment financing has been used in many municipalities to generate revenue for public improvements projects. As improvements are made within the district, and as property values increase, the incremental increases in property tax revenue are earmarked for this fund. The fund is then used for improvements within the district. Expenditures of revenue generated by this method are subject to certain spending restrictions and must be spent within the district. Tax increment districts could be established to accomplish transportation improvements in other areas of the community where property values may be expected to increase. A TIF is currently being utilized in downtown Bozeman. Additional TIF districts could be established in other areas of the city and county to accomplish a variety of transportation-related improvements.

- *Multi-Jurisdictional Service District*

This funding option was authorized in 1985 by the State Legislature. This procedure requires the establishment of a special district, somewhat like an SID or RSID, which has the flexibility to extend across city and county boundaries. Through this mechanism, an urban transportation district could be established to fund a specific highway improvement that crosses municipal boundaries (e.g., corporate limits, urban limits, or county line). This type of fund is structured similar to an SID with bonds backed by local government issued to cover the cost of a proposed improvement. Revenue to pay for the bonds would be raised through assessments against property owners in the service district.

- *Local Improvement District*

This funding option is only applicable to counties wishing to establish a local improvement district for road improvements. While similar to an RSID, this funding option has the benefit of allowing counties to initiate a local improvement district through a more streamlined process than that associated with the development of an RSID.