MAIN STREET EVOLVED

ENVISIONING A COMPREHENSIVE APPROACH TO MAIN STREET REDEVELOPMENT
IN SMALL MOUNTAIN COMMUNITIES

by

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A REPORT

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MASTERS OF LANDSCAPE ARCHITECTURE

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ABSTRACT

The main streets of the Rocky Mountain West are the social, economic, and cultural centers of their respective communities. Often, these main streets may deteriorate or become abandoned as a result of edge shopping malls and strip style economic development. Thus, a downtown or main street redevelopment effort by the community can help to ensure these economic centers remain. Yet, too often, the redevelopment efforts are oversimplified and fail to integrate the most current street development principles and design initiatives that can benefit not only the community but also the surrounding environment.

In the modern American city, almost half of all daily trips are less than three miles and a third are under one mile. (McCann 2010) "These are distances easily traversed by foot or bicycle, yet 65 percent of trips under one mile are made by automobile." (McCann 2010) This mobility trend has led to the foundation of programs and organizations that try to promote non-motorized travel. Although these initiatives respond to the human/physical environment, they are far from comprehensive. Today, an integration of smart ecological ideals is essential.

How can the revitalization efforts of Rocky Mountain communities be guided to ensure they consider not only the built environment; but also the natural environment? The face of the future main street will be multi-modal and ecologically responsible. Yet, there is presently no clear method of combining the two. A union of the multi-modal principles behind Complete Streets and the ecologically responsible ideals green infrastructure can provide a framework for a new and more inclusive redevelopment approach.

The merging of modern ecological and street design principles can lead to a comprehensive Main Street redevelopment program and therefore successfully guide the revitalization efforts of small Rocky Mountain communities in a way that is responsive to future development needs as well as the cultural and ecological aspects of the region. Main Street Evolved will provide a set of tools to guide Colorado Rocky Mountain Main Street redevelopment efforts by providing strategies and implementation guidelines that focus on balancing multi-modal ideals and ecological stormwater management techniques within a small-town mountain context.

main street evolved

envisioning a comprehensive approach to main street redevelopment in small mountain communities

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abstract

The main streets of the Rocky Mountain West are the social, economic, and cultural centers of their respective communities. Often, these main streets may deteriorate or become abandoned as a result of edge shopping malls and strip style economic development. Thus, a downtown or main street redevelopment effort by the community can help to ensure these economic centers remain. Yet, too often the redevelopment efforts are oversimplified. In most cases, general beautification, historical preservation, or economic revitalization are the primary objectives of the redevelopment effort. Although beneficial in their own right, these efforts fail to integrate the most current street development principles and design initiatives that can benefit not only the community but also the surrounding environment.

In the modern American city, almost half of all daily trips are less than three miles and a third are under one mile. (McCann 2010) "These are distances easily traversed by foot or bicycle, yet 65 percent of trips under one mile are made by automobile." (McCann 2010) This mobility trend has led to the foundation of programs and organizations that try and promote non-motorized travel. Programs like Complete Streets and Livable Streets are examples of recent efforts at defining how to implement and design the modern multi-modal streets. (Greenberg 2008)

These initiatives respond to the human/physical environment, but are far from comprehensive. Today, an integration of smart ecological ideals is essential. Green infrastructure & Green Streets are movements that have begun to rethink the methods we use to manage urban stormwater. Green infrastructure attempts to manage stormwater by incorporating a system of stormwater management within a streets right-of-way, thus using natural processes to clean and dissipate urban runoff. (US EPA 2009)

How can the revitalization efforts of Rocky Mountain communities be guided to ensure they consider not only the built environment; but also the natural environment? The face of the future main street will be multi-modal and ecologically responsible. Yet, there is presently no clear method of combining the two. A union of the multi-modal principles behind Complete Streets and the ecologically responsible ideals green infrastructure can provide a framework for a new and more inclusive redevelopment approach.

The merging of modern ecological and street design principles can lead to a comprehensive Main Street redevelopment program and therefore successfully guide the revitalization efforts of small Rocky Mountain communities in a way that is responsive to future development needs as well as the cultural and ecological aspects of the region. Main Street Evolved will provide a set of tools to guide Colorado Rocky Mountain main street redevelopment efforts by providing strategies and implementation guidelines that focus on balancing multi-modal ideals and ecological stormwater management techniques within a small-town mountain context.

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acknowledgements

This project represents the culmination of my advanced education efforts and is a reflection of the people who guided me through these many years. Thank you to all the faculty and staff of the College of Architecture, Planning, and Design at Kansas State University who have assisted me over the last three years. I wish to send genuine thanks to my major professor Blake Belanger and secondary committee members Laurence Clement and Stephanie Rolley for their aid throughout the entirety of this project. Without your assistance, I could not have completed such a daunting task.

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Finally, I wish to thank my parents for continually pushing me to reach my full potential and to my brother and sister for their constant competition. Without you, I would not be who I am today.

00 prelude

prelude

Introduction

This prelude section describes the process for the development of the capstone project and report. Beginning with a basic overview of the master's report project process then moving into project genesis and personal goals, this section will briefly describe the basic steps that led to the development of Main Street Evolved.

The Kansas State University master's project and report allows Landscape Architecture/ Regional and Community Planning students the opportunity to take full control over a project from genesis to completion. Based around personal interest and career goals, the master project and report demonstrates the master's level competence achieved through the entirety of a student's educational career. The master's project and report is a two semester long effort that provides student's with the opportunity to identify and document the entire process and methodology for a cumulative design effort. Including literature investigation, case study documentation, and program development, the master project and report allows students an opportunity to advance the field of landscape architecture and utilize their design competence.

Derived from a number of personal experiences, the Main Street Evolved project genesis has been an evolving process over the last few years. Through the first eighteen years of my life, I lived in a small mountain community in the Black Hills of South Dakota. Like many other mining and supply towns, the primary economic source for my hometown had a major shift in the early 20th century. In recent years, a Main Street revitalization effort was attempted with poor results. Fragmented streetscape features were placed haphazardly across a two-block region with little to no unity among the elements or the buildings they augment. In general, the lack of effort to create a cohesive street led to a main street design that did very little to enhance user experience.

This substandard redevelopment effort sparked my curiosity. How could I, as a designer, guide small Mountain communities through their Main Street revitalization efforts to minimize the chance for failure? After some thought and deliberation, I decided that the formation of a Main Street redevelopment program/framework would allow me to contribute to the efforts of many communities with a single document.

personal goals + objectives

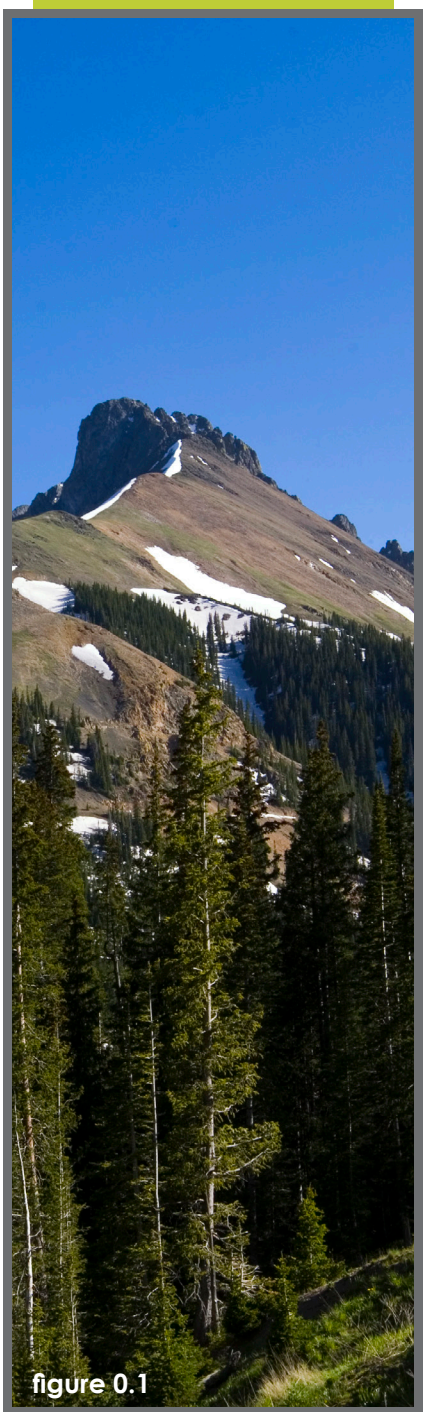


figure 0.1

+ To develop a usable framework for the redevelopment of small mountain communities across the Rocky Mountains.

+ To assemble, merge, and illustrate accepted street design standards from national, regional, and local institutions and programs.

+ To apply my design knowledge toward a comprehensible resource that can be interpreted and retrieved for future use.

+ To develop a system for Main Street identification and guidelines for the development of Main Street Evolved.

+ To explore new graphic techniques and ways of conveying ideas, dimensions, and designs that are easily read and understood.

+ To create a project that will demonstrate the skills and knowledge that I have gained through my course of study.

part one:
research

01 delineate

the dilemma

As word of the discovery of gold in California spread; thousands of hopeful adventurers headed West seeking riches. With the discovery of rich deposits in states like Colorado, Montana, Wyoming, and South Dakota; the Rocky Mountain West is as far as many would-be fortune hunters would need to travel. Soon many mining towns began to spring up in response to this new booming economy. These boom towns started to dot the landscape and the population of the Rocky Mountains exploded. Yet, when the precious minerals ran out, these boom town economies began to bust. Many mining towns turned to ghost towns, while a few were able to sustain through the later part of the 20th century. In an effort to survive, these remaining towns were forced to turn to historical tourism, outdoor recreation, gambling, and other economic draws as new income sources.

As Rocky Mountain Communities begin to adapt to meet an influx of seasonal users, the design of the unique main streets will need to adapt with them. Yet, too often the redevelopment efforts focus on a singular goal. In most cases, general beautification, historical preservation, or economic revitalization are the primary objectives of the redevelopment effort. Although beneficial in their own right, these efforts fail to integrate current street development principles and design initiatives that can benefit not only the community but also the surrounding environment. With this in mind, the core question is;

How is it possible to guide the Main Street redevelopment efforts of Rocky Mountain communities in a way that responds not only to future development needs, but also the natural and cultural characteristics of the area?

figure 1.1

The merging of modern ecological and street design principles can lead to a comprehensive Main Street redevelopment program and therefore successfully guide the revitalization efforts of small Rocky Mountain communities in a way that is responsive to future development needs as well as the cultural and ecological aspects of the region.

location

Although it would be ideal to consider every Rocky Mountain community throughout the western United States, time constraints and practicality issues restricted the area-of-interest to a smaller region. With this in mind, only communities within the state of Colorado were considered. Colorado represents the historical "center" of the Rocky Mountain gold rush, and as such contains a wide variety of communities that were settled over the course of the fifty-year gold rush. (Smith 2009)

With six distinct ecoregions, Colorado is an extremely diverse state. Ranging from the Mountainous Southern Rockies to the desert like Arizona/New Mexico Plateau, Colorado includes a variety of communities with varying contextual issues. Beyond the ecological and contextual diversity, the wide range in population diversity within the mountainous communities of Colorado makes it an ideal choice to represent the Rocky Mountain region.

Colorado | *Rocky Mountain Communities*

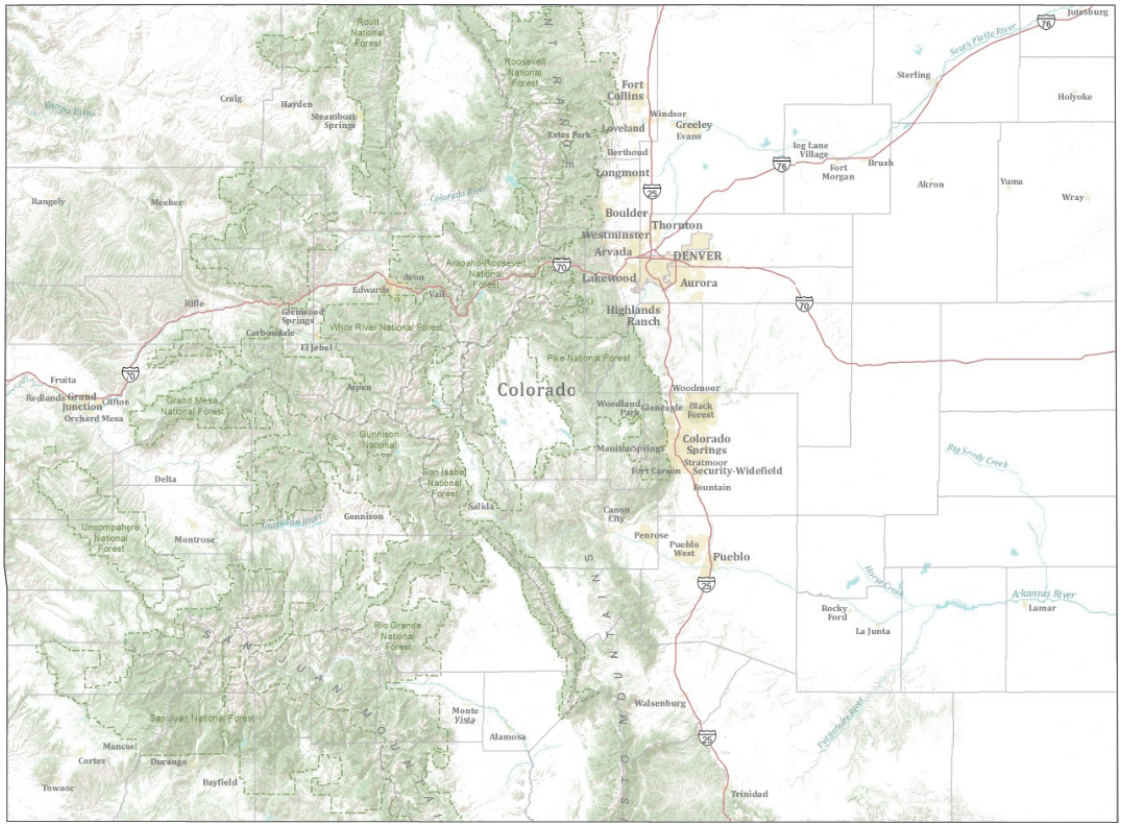


figure 1.2 Colorado Base Map
(Murner 2010, adapted from: ArcGis Explorer 2010)

Colorado | *Ecoregions Map*

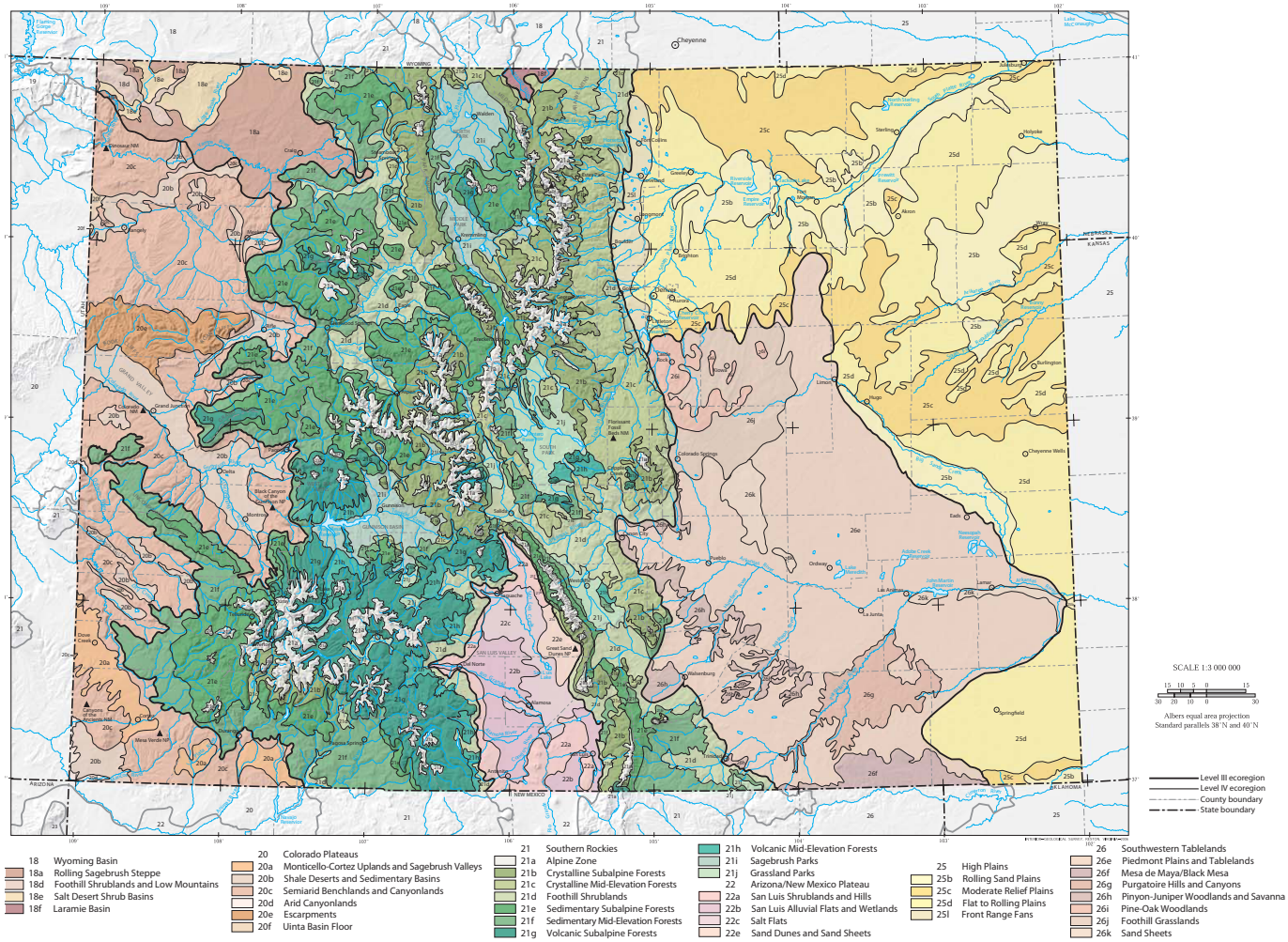


figure 1.3 Colorado Ecoregions Map
(Murner 2010, adapted from: Chapman, S.S. et.al. 2006)

design philosophy + process

My personal design philosophy is built around the merging of the built, ecological, and contextual environments. For every project, no matter the size, location, or context, the ecological, contextual, and built environments are considered and investigated to ensure a holistic approach is achieved.

Understanding the subtle nuances between each, and the tensions created by bringing them together is as vital to the success of a design as any other aspect. As an over-aching goal for all my designs, I attempt to stimulate the built environment by integrating and incorporating the ecological and contextual environments.

My abstracted design process, shown in Figure 1.5, represents the nonlinear, cyclical process I attempt to use for all projects. Throughout the design process, continual cycling and revising is necessary to ensure that all goals are met and my philosophy is taken into consideration.

Merging the ecological, contextual, and built environments may seem like a common idea, yet too often at least one of the environments is negated. With this in mind, the ecological, contextual, and built environments are the primary programmatic elements of Main Street Evolved. All aspects of the Main Street Evolved program will revolve around meeting and integrating these three environments.

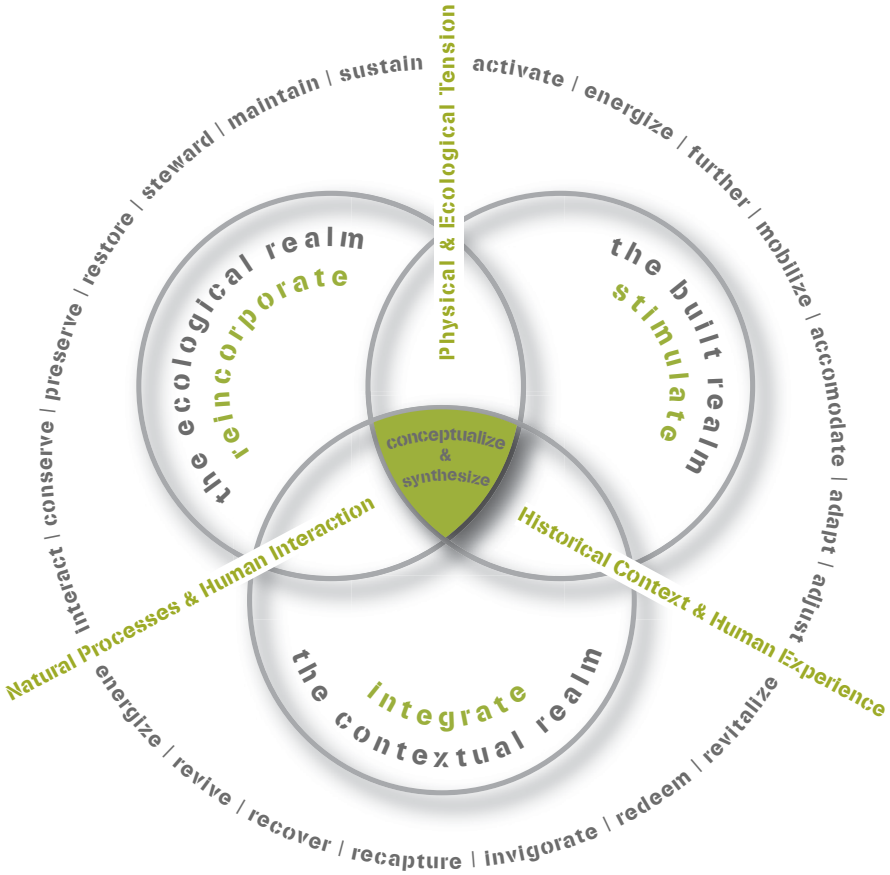


figure 1.4 Main Street Evolved Philosophy (Murner 2010)

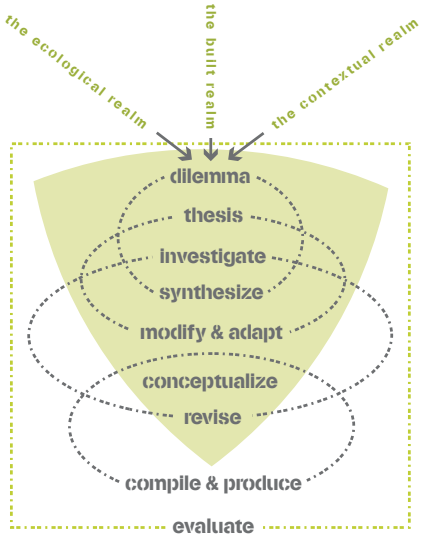


figure 1.5 Main Street Evolved Process (Murner 2010)

relevancy to landscape architecture

In the field of landscape architecture, a number of street development issues and strategies are currently beginning to gain momentum. Optimizing multi-modal access and integrating green infrastructure to reduce stromwater pollution are the most prevalent. Main Street Evolved attempts to merge both of these current street design issues within a Rocky Mountain context.

In the modern city, almost half of all daily trips are less than three miles and a third are under one mile. (McCann 2010) "These are distances easily traversed by foot or bicycle, yet 65 percent of trips under one mile are made by automobile." (McCann 2010) This mobility trend has led to the foundation of programs and organizations that try to promote non-motorized travel. Programs like Complete Streets and Livable Streets are examples of recent efforts at defining how to implement and design the modern multi-modal streets. (Greenberg 2008)

These initiatives respond only to the human/built environment and are far from comprehensive. Today, an integration of smart ecological ideals is essential. When considering the street, the most significant ecological factor to consider is non-point source pollution from urban runoff. (Perlman 2010) "Streets can cover up to a third of the urban landscape and, more than any single element, have the greatest effect on storm water quality. The combination of vehicle and other pollutants that settle on the extensive impervious surfaces of streets are washed by storms directly to storm sewers that often flow untreated to near-by streams, sometimes in volumes larger than the original stream channel could accommodate." (Metropolitan Service District 2002)

Green infrastructure & Green Streets are movements that originated in the Portland, Oregon metro area that have begun to rethink the methods we use to manage urban stormwater. Green infrastructure attempts to incorporate a system of stormwater management within a streets right-of-way using natural processes to clean and dissipate urban runoff.

The future street will be multi-modal and ecologically responsible. Yet, there is presently no clear method of combining the two. The principles of multi-modal access and green infrastructure both will shape future streets, but how can they work together to create a truly comprehensive Street? This report will provide landscape architects, planners, and designers with a usable framework and guidelines for designing an ecologically sound multi-modal Main Street. Yet, instead of developing over-generalized guidelines that may provide a basic understanding of how to develop ecological and multi-modal streets for any situation; this report will focus on small community Main Streets in the Rocky Mountain West. The Main Streets of the Rocky Mountain West are the social, economic, and cultural centers of their respective communities. Often, without outside assistance, these main streets may deteriorate or become abandoned as a result of edge shopping malls and strip style economic development.

Thus, this project will attempt to reveal the advantages of implementing multi-modal street design and green infrastructure together in a Rocky Mountain context. The Main Street Evolved process and guidelines will allow landscape architects to design future main street redevelopment projects to meet not only the future development needs of the city, but also respond to the ecological and cultural aspects of the region.

primary elements

The primary program elements directly relate to existing site conditions and the critical features established for creating an Evolved Main Street. With this in mind, the primary program elements fall under three main groups:

The Built Environment

A project that responds to the unique physical character of the mountainous communities is essential to a suitable redevelopment design. This will require a focus on multi-modal streets and reasonably allowable pedestrian ways.

The Ecological Environment

A main street redevelopment project that responds only to the built environment may have been considered comprehensive in years past, yet today an integration of smart ecological ideals is essential. This will require a focus on the integration of natural processes into the aesthetics of a redevelopment scheme.

The Contextual Environment

Although, in most cases, the historical shell of Main Street buildings may be intact, a strong connection to the rich cultural past should be made to provide identity and sense-of-place within each community. An integration of the historical culture and traditional mountain community character will rekindle the cultural identity of the community while ensuring the preservation of the historical site.

Beyond the cultural aspects, the climatic conditions found within the Colorado Rockies present unique concerns related to street development. Harsh winters, large quantities of snow, and high altitudes all play a role in the development of mountain streets.


figure 1.6

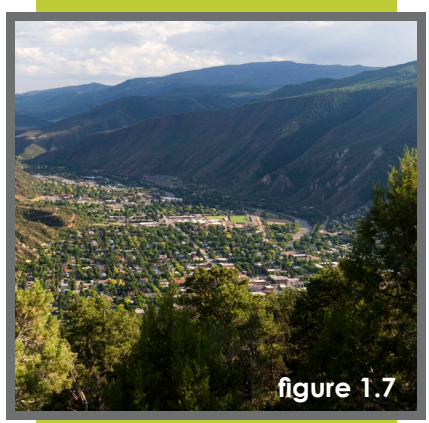


figure 1.7

figure 1.8

02 exploration

exploration

Introduction

In the small mountain communities of the Rocky Mountains, the Main Street is the center of activity. This can be said of almost all small communities across the United States, but Rocky Mountain Communities have some unique dilemmas. The mountainous context, seasonal influx of users, and rich history all play roles in how the community centers were shaped and how they exist today.

As communities adapt to meet modern needs, the Main Streets will need to evolve to meet future demands. This evolved Main Street needs to consider vehicles, pedestrians, cyclists, nature, and cultural aspects as equals. There are three features of Main Streets that should be considered and designed for when developing an evolved Main Street.

The Built Environment

It must safely serve pedestrians, bicyclists, transit riders, and drivers.

The Ecological Environment

It must account for the ecological processes the street disturbs by considering and diminishing pollution from urban runoff.

The Cultural Environment

It must retain the historical character of the community, thus giving it an identity of its own.

The following literature review & precedent studies briefly describes some of the recent movements, strategies, and goals used by designers, planners, and communities across the country when designing for each of the aspects of Main Street Evolved.

Main Street Evolved | *literature map*

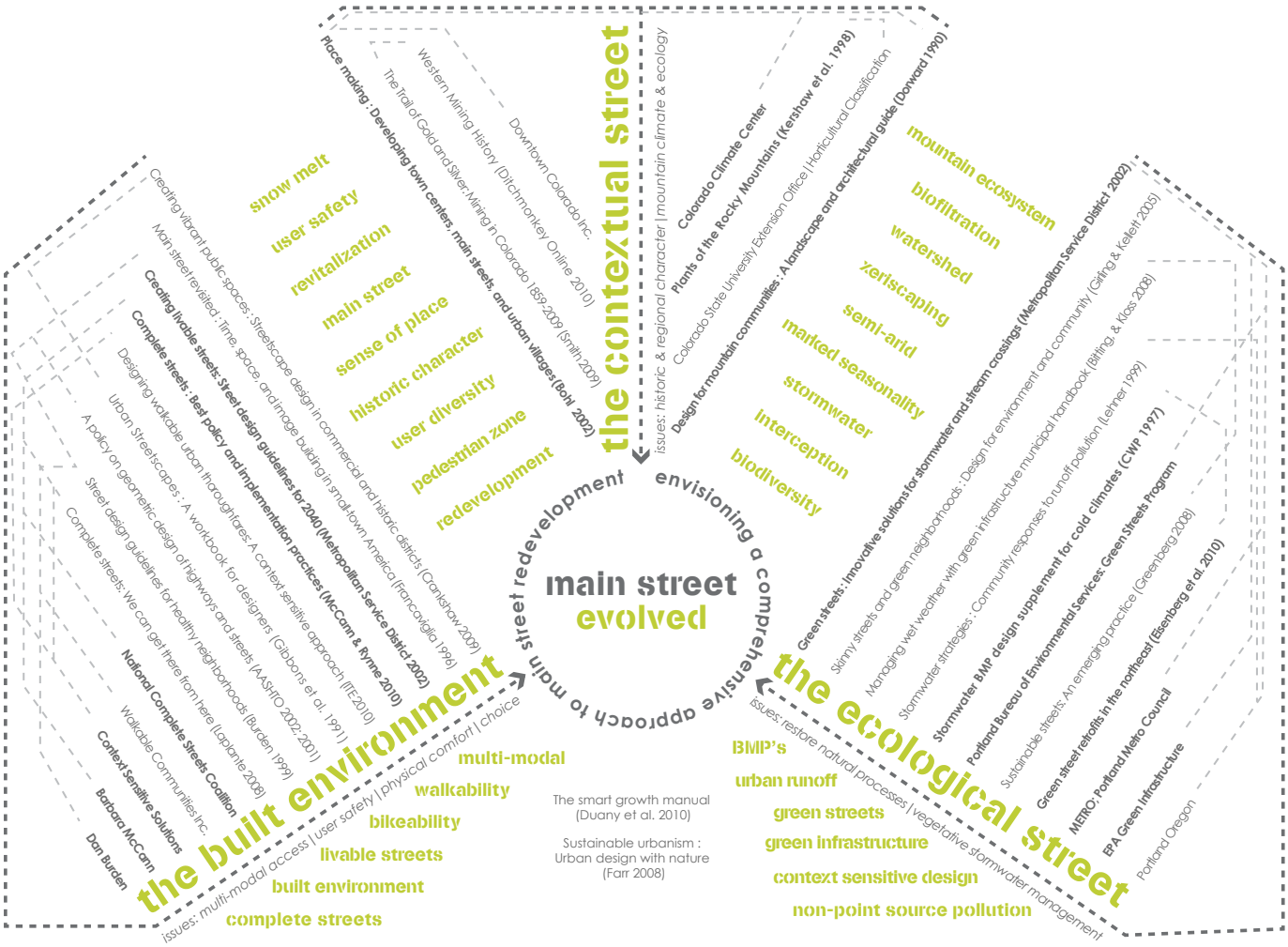


figure 2.1 Main Street Evolved literature map (murner 2010)

literature review

The Built Environment

The automobile has dominated the proverbial "street" since the early part of the 19th century. An emphasis on how to get more cars, to their destinations, in a swift and efficient manner was the sole goal of street designers. Yet, in the early 1990's the U.S. government passed the Americans with Disabilities Act.; effectively initiating a movement that would convert the street from an automobile exclusive feature to a multi-modal feature for motorists, pedestrians, and cyclists alike.

The culmination of this multi-modal movement was the development of the Complete Streets program. Complete Streets attempt to create streets that are designed for all modes of travel, "the resulting thoroughfares will typically provide narrow (slower-speed) travel lanes, bicycle facilities, on-street parking, continuous tree cover, ample sidewalks, appropriate street furniture and lighting, as well as supportive building frontages." (Duany et. Al. 2010)

Creating Livable Streets: Street Design Guidelines for 2040

In 1995, Metro (the Portland Oregon regional government responsible for furthering issues in sustainability) adopted the 2040 Growth Concept and the Regional Transportation Plan. One of the functions of these plans was to rethink the way they designed streets. The goal of these new street designs was to "promote community livability by providing safe options for travel in the region and by considering the traffic functions of a street in conjunction with other modes of travel and the character of the surrounding community when making transportation decisions on streets of regional significance." (Metropolitan Service District 2002)

To achieve this lofty goal, Metro developed Creating Livable Streets: Street Design Guidelines for 2040, a handbook for "linking the design of streets to multi-modal street function, community livability, and economic vitality." (Metropolitan Service District 2002) With a focus on regional streets, classified as highways, boulevards, and streets, Metro provides design guidelines for both new and reconstructed roads. In response to this focus, Metro provides a set of goals for creating "Livable Streets";

1. Provide travel mode choice
2. Support regional multi-modal travel
3. Support the economic vitality of the region
4. Create pedestrian and bicycle accessibility
5. Support public social contact
6. Provide orientation and identity to the region
7. Provide a safe environment
8. Provide for physical comfort
9. Provide spatial definition by orienting buildings to the street
10. Provide high quality of construction and design
11. Maintain the quality of the environment

*(Metropolitan Service District 2002)

To meet these goals, Metros' guidelines attempt to "identify the individual elements that make up regional streets design and present ideas to consider and specific recommendations for designing balanced multi-modal streets" (Metropolitan Service District 2002) To this end, the design suggestions presented in the guidelines are structured into four categories;

Street Realm
The overall environment of the street

Travelway realm
The travelway elements devoted to motorized and non-motorized vehicular movement

Pedestrian realm
The areas where pedestrians use is a priority

Adjacent land use
The elements that abut the street and define the street's character and use.
*(Metropolitan Service District 2002)

The goals of "Livable Streets" are applicable to any city/community in the world. Although some of the goals are more specifically related to the development of new streets, all other goals should be considered when developing an evolved Main Streets. As a preliminary breakdown of streets, the four categories presented for design consideration should be used to define the areas that make up an Evolved Main Street.

Complete Streets: Best Policy and Implementation Practices

Coined by America Bikes in 2003, "Complete Streets" are streets that ""serve everyone—pedestrians, bicyclists, transit riders, and drivers—and they take into account the needs of people with disabilities, older people, and children."(McCann 2010)
Cities, communities, and states across the nation are beginning to develop and implement Complete Street policies. Some choose to implement the policy based on a set of overall future development goals, while other are sparked by local advocacy groups.

No matter the reason, the future of streets design will inevitably incorporate safe multi-modal principles.

Complete Streets: Best policy and Implementation Practices provides information on introducing, implementing, and designing Complete Streets. One of the first steps in introducing a Complete Street policy is to describe their benefits to a populace Complete Streets: Best policy and Implementation Practices places the benefits under five categories; Safety, Health, Climate Change, Special Populations, and Growth and Revitalization.

Safety
"The fundamental impetus behind complete streets is the need to provide safe travel for all users. Close to 5,000 pedestrians and bicyclists die each year on U.S. roads, and more than 70,000 are injured." (McCann 2010) Because roads have been designed with the automobile in mind, pedestrian and bicycle safety took a back seat to fast and efficient auto travel. Sidewalks, medians, better bus-stops and bicycle lanes are all design elements that increase safety for all users.

Health
"The transportation infrastructure associated with complete streets—such as street connectivity, narrow street widths, sidewalks and bicycle lanes, street crossings, and street furniture—makes walking and bicycling more inviting." (McCann 2010) By providing safe means of non-motorized travel, complete streets have the potential to promote exercise and reduce vehicle dependence. With more people walking and biking, the pollution associated with automobiles can be reduced.

Climate Change
"Complete streets are essential to enable Americans to drive less and get around more easily by foot, bike, and public transportation. The potential to shift trips to lower-carbon modes is undeniable." (McCann 2010) In an urban or community setting, complete streets have the potential to provide an opportunity for people to walk, bike, or ride to their short-range destinations instead of driving. This has the potential to reduce carbon emissions, as well as, alleviate some oil dependency issues.

Special Populations
"Complete Streets provide safe travel options for groups that have limited access to automobiles: children, older adults, people with disabilities, and low-income Americans." (McCann 2010) Complete Streets provide safe opportunities for children to walk to school, elderly citizens to walk or ride mass-transit, and special needs citizens to independently access all attributes of a community.

Growth and Revitalization
"Creating infrastructure for non motorized transportation and lowering automobile speeds by changing road conditions can improve the economic situation for both businesses owners and residents." (McCann 2010) By allowing citizens and visitors to walk, bike, ride, or drive; communities have the potential for growth and revitalization in failing commercial districts.

Although design suggestions are provided; the core information in Complete Streets: Best policy and Implementation Practices is devoted to the writing, integration, and implementation of complete street policy. McCann and Rynne maintain "In developing a complete street policy, creating new design standards should be secondary to making a deliberate shift from vehicle-oriented transportation planning priorities to a truly multi-modal approach." (McCann 2010)

The Ecological Environment

Main street redevelopment projects that respond only to the human/physical realm may have been considered "complete" in years past, yet in today's "sustainable" world an integration of smart ecological ideals is essential. In a street situation, the most significant ecological factor to consider is non-point source pollution from urban runoff.

"Streets can cover up to a third of the urban landscape and, more than any single element, have the greatest effect on storm water quality. The combination of vehicle and other pollutants that settle on the extensive impervious surfaces of streets are washed by storms directly to storm sewers that often flow untreated to near-by streams, sometimes in volumes larger than the original stream channel could accommodate." (Metropolitan Service District 2002) p.39

Stormwater Strategies: Community responses to runoff pollution.

In urban areas, both large and small, impervious surfaces dominate the landscape. In the motorized world in which we live, the extensive impervious surfaces are inevitable. Yet, "Urban and suburban development, with the creation of buildings and roads, and the innumerable related activities, turn rain and snow into unwitting agents of damage to our nation's waterways." (Lehner and Natural Resources Defense Council 1999)

In general, urban impervious surfaces prevent water from infiltrating into the soils. The lack of infiltration presents two major issues that contribute to the ecological health and stability of a region:

1. An increase of the volume and velocity of water across the landscape
2. Water contamination/pollution from the impervious surfaces.

*(Lehner and Natural Resources Defense Council 1999)

While the increase of water volume and velocity has the direct potential to cause flooding, increase erosion, change habitat, and decrease stream stability; it also has the potential to pick up and transport contaminates to the surrounding water resources. When considered as a single issue, the contaminated high velocity flows from urban areas can wreak havoc on regional waterways.

As communities across the nation discover the benefits of implementing storm water management strategies, feasible methods are a necessity for future success of urban storm water management. Storm water Strategies: Community Responses to Runoff Pollution is a report by the Natural Resources Defense Council that attempts to provide successful examples of, as they state, "some of the most effective and cost-effective strategies to address storm water runoff pollution currently in practice around the country." (Lehner and Natural Resources Defense Council 1999)

Environmental Gains

Biological, hydrological, or chemical improvements.

Economic Gains

Cost saving, low implementation cost, or have long term cost avoidance

Collateral Benefits

Natural water treatment and land for other uses. Although it may not be possible, it should be a goal for Main Street Evolved to attempt to meet the ecological, economic, and collateral success criteria outlined in Stormwater Strategies: Community Responses to Runoff Pollution.

Green Streets: Innovative solutions for stormwater and stream crossings

In an effort to address the urban runoff issue, Metro (the Portland Oregon regional government responsible for furthering issues in sustainability) has developed Green Streets: Innovative solutions for storm water and stream crossings. The Green Streets handbook is a manuscript that attempts to communicate basic storm water management theories through case studies and design/implementation strategies for the Portland metro area. Among the goals that the Green Streets handbook includes, maintaining and restoring natural processes and improving water quality are the two that most directly apply to urban runoff.

Maintain and Restore Natural Processes

"Typical modern American street systems have been designed based almost exclusively on traffic engineering considerations for motor vehicles such as providing capacity for peak hour volumes, maximizing speeds, minimizing conflicts and crash potential, and minimizing maintenance costs of the transportation agency. Environmental considerations have been narrowly construed to be the minimal required by NEPA and DEQ. This should be changed to more fully consider the impacts of streets on stormwater filtration, stream corridors, tree canopy

coverage, as well as the social life of the communities through which they run. Solutions should be grounded in the appreciation that the natural process of stormwater infiltration and natural drainage patterns are optimal for providing multiple benefits. Furthermore, careful implementation and maintenance of natural processes is affordable."
(Metropolitan Service District 2002) p.9

Improve Water Quality
"A stream is only as healthy as its water. Efforts are needed to improve the quality of stormwater runoff through natural processes of infiltration and biofiltration. New Development, including roads, must reduce impervious surfaces allowing rain to infiltrate as near as possible to where it falls ("ubiquitous infiltration"). When water is conveyed, the flow should go through a process of biofiltration that enables vegetation to filter and treat runoff. Trees are an important part of the natural hydrologic cycle and can be used to control flow volume and velocity, improve water quality and prevent soil erosion. Finally, control of volume and flow-rate of water is needed to mimic natural flow rates and reduce the water quality impacts of fine sediment erosion."
(Metropolitan Service District 2002) p.9

To achieve these goals, the Green Streets Handbook delineates five functions that the design/implementation solutions are meant to address

1. Runoff prevention
2. Detention
3. Retention
4. Conveyance
5. Water quality

Although not all the solutions address each of these issues, the implementation of several design/implementation solutions will help address multiple stormwater management functions. The eight design/implementation strategies described in the Green Streets handbook are;

1. Street Tree implementation and preservation
2. Reduction of impervious surfaces
3. Permeating or eliminating curbs and gutters
4. Implementing filter strips and swales
5. Implementing infiltration trenches
6. Implementing linear detention basins
7. Implementing street tree wells
8. Integration of engineered products.

Not all of these solutions are applicable to urban street based stormwater management, but several of them have the potential for reducing runoff, allowing infiltration, and improving water quality on Mountain Main Streets.

The Cultural Environment

Although the automobile has made life much easier and efficient in more ways than can be counted, it has also created one of the greatest cultural blunders of the last one-hundred years; suburban sprawl. In the early part of the 20th century the automobile allowed people to move out of the city and into the suburbs. The key dilemma with the suburban development was "They weren't places, they were simply street after street of single-family homes, with an occasional school thrown in. But there were no true public realms, no civic centers, no main streets." (Bohl 2002)

Place Making: Developing Town Centers, Main Streets, and Urban Villages.

What makes a place? How do we define one place from another? Place making: Developing Town Centers, Main Streets, and Urban Villages by Charles C. Bohl, suggests that "A combination of many things—from architecture, to cultural institutions, to topography, history, economy, and physical appearance—create place. But there is one more key factor: you must have social interaction to have a true place." (Bohl 2002)

A strong Main Street has the potential to provide place to community. It is important that the integration of historical, and contextual elements be incorporated into Main Street Evolved to ensure that each design is unique to the community it is designed for.

Snow Management

In cold/mountainous climates, snow and snow management is a major concern. Snow as the primary antagonist of any mountain development story, can make or break the success of Main Street Evolved. "Given the right combination of climatic factors and slope gradient, snow can paralyze circulation, collapse structures , and bury anything in its path" (Dorward 1990) With this in mind, considerations toward the snow and snow management should be integrated into Main Street Evolved. Although traditional methods of on-street snow management and storage will remain, considerations toward snow and green infrastructure will be required.

Stormwater BMP Design Supplement for Cold Climates

Although primarily focused on the ecological environment, the Stormwater BMP Design Supplement for Cold Climates represents a contextual adaptation and thus is included in the Contextual environment. "Designing stormwater best management practices (BMPs) that are effective at removing pollutants, acceptable to the public and affordable is not easy in any climate. Cold climates present additional challenges that make some traditional BMP designs less effective or unusable. " (CWP 1997) Yet, due to the ecologically minded nature of our modern society, the integration of green infrastructure into cold climates is unavoidable.

The Center for Watershed Protection was commissioned by the U.S. Environmental Protection Agency to address this very issue. The "Stormwater BMP Design Supplement for Cold Climates" is a design manual that consists of surveys and suggestions collected from engineers, designers, and experts from around the country

The first step in designing stormwater BMP's for cold climates is to determine the climatic conditions of the region in question. Issues of:

Temperature & Depth to Frost Line

+ Can cause pipe freezing, permanent icing, reduced infiltration, frost heaving, and reduced biological activity.

Growing Season

+ Can limit vegetation establishment and planting pallet

Snow Depth

+ Can cause high runoff and pollutant volumes in spring melt
+ Can increase salt/pollutant intake from winter street management.

* (CWP 1997)

"Despite the somewhat grim picture depicted above, stormwater BMP design can be modified for cold climates." (CWP 1997) With minor alteration, stormwater BMPs can be implemented in cold climates. With the exception of shallow marshes, pervious pavement, and sand filters; all common stormwater BMPs can be effective in cold climates.

precedent theory

To gain an enhanced understanding of how Complete Streets and green infrastructure can be applied in a real world context, a series of precedent studies that focus on street development will aid in the discovery of possible issues and unique implementation strategies used in practice today. The chosen precedent studies will focus on one of three topics; green infrastructure, complete streets, or mountain street development.

The purpose of the selected studies will be to pinpoint the specific issues that directly relate to the application of each over-arching topic. The precedent studies for this project represent a systematic examination of the decision-making, strategies, and results of each selected project, in an effort to better inform the Main Street Evolved guidelines.

precedent study

Precedent Strategy

There are a number of unique factors to consider when implementing green infrastructure or complete streets, and even more when considering implementation into a mountain context. In order to discover and understand these factors, a minimum of three (3) precedent studies for each of the three topics will be completed. Although the general information for each study will be the same, each topic area will need to include specific information pertaining to its particular philosophy.

In general, each study will include; **backgrounds, goals, program elements, success, criticisms, relevance, and design elements.**

Background

+ location
+ design date
+ physical context
+ implementation conditions
+ general focus

Goals

+ if available, what are the specific goals set out by the designer or community?
+ if unavailable, what seem to have been the over-arching goals of the development?
    + Assumptions based on imagery of implementation strategies

Program elements

+ methods of meeting the defined goals
+ specific objectives the design accommodates

Project success

+ specific information regarding the success of the design
+ apparent visual and functional success
+ how does the project accommodate the original dilemma?

Criticism

+ where the projects can be improved?
+ what was not thought of by the designer?
+ what "post-design" elements have been added to make the project function?

Relevance

+ How is the project relevant to its particular topic?
+ How is the project relevant to Main Street Evolved?
+ What would need to be considered if the project were to be implemented in a mountainous context?

Design Elements

+ The specific elements of the design
+ Size, number, and function

Unique category

+ Each precedent study will have a unique category for its specific topic area.
    + Green infrastructure: Stormwater Management Process
    + Complete Streets: the complete streets principles met by the project
    + Mountain Street Development: Unique features of the design because of its context

Street Element Diagram

Each precedent study will be accompanied by a diagram illustrating the street design principles/elements present in each project. To gain an understanding of how each project meets the multi-modal and green elements needed for an evolved Main Street , the diagrams will all need to visualize the same elements.

Each diagram will illustrate the travel-way, bicycle access, parking situation, pedestrian access, vegetation, and stormwater movement. These diagrams will provide a visual understanding of the successes and failures of each project in regards to Complete Streets and green infrastructure.

Goal of Precedent Study

The general goal of the precedent study is to discover the various techniques used by designers for implementing complete streets and green infrastructure. This process will not only inventory specific implementation strategies, but also uncover issues related to a real-world application.

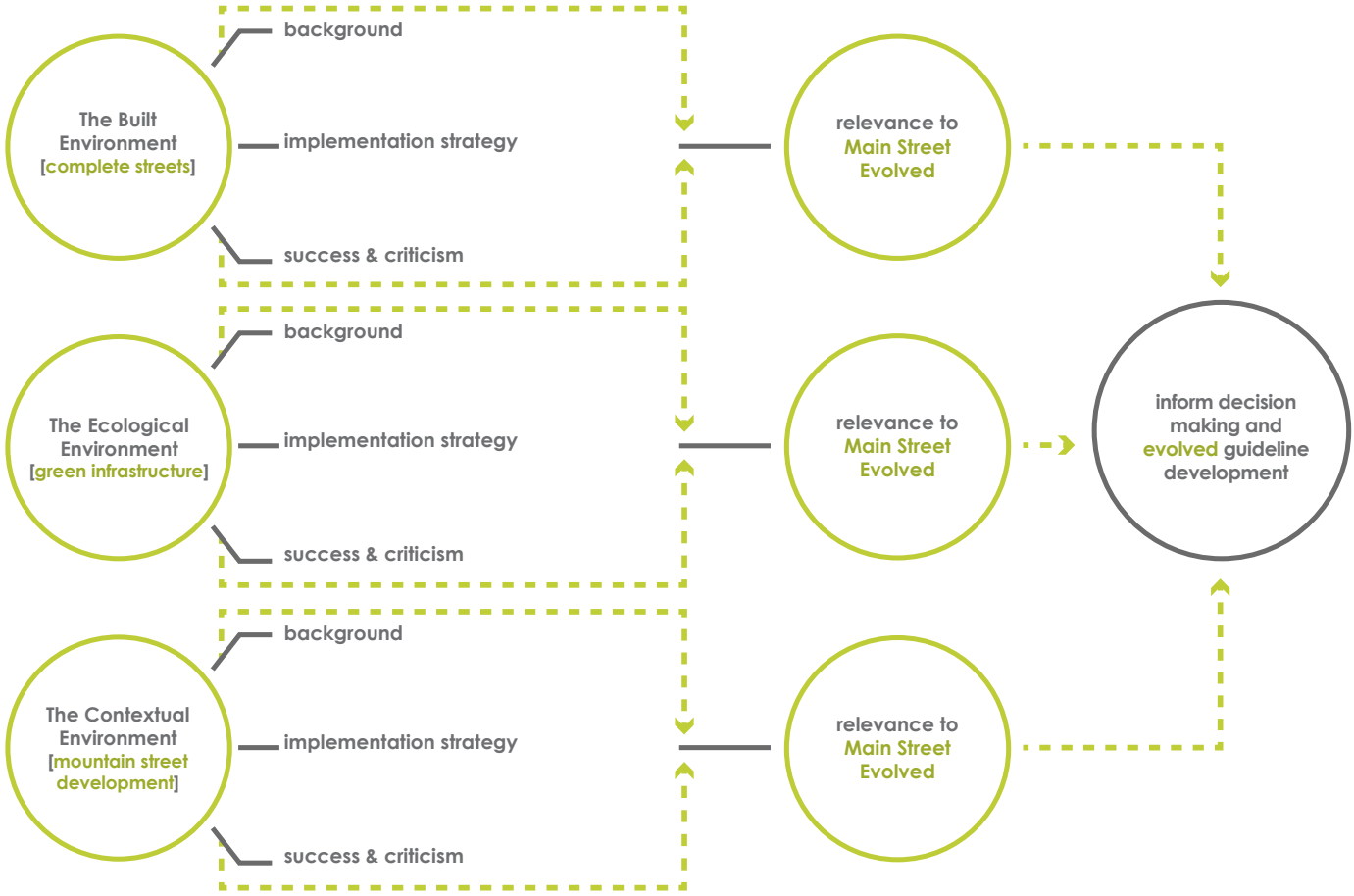


figure 2.2 Main Street Evolved precedent methodology (murner 2010)

green infrastructure

SW 12th Street Green Street Project | *Portland, Oregon*

All information in the SW 12th Green Street precedent study was collected and interpreted from the City of Portland SW 12th Green Streets report. The report was accessed on 11/26/2010 from (http://www.portlandonline.com)


figure 2.3

Background

Located adjacent to the Portland State University campus, the SW 12th Avenue project is an example of a green street retrofit design. Built in the summer of 2005, the project adapted a typical vegetated buffer area between the sidewalk and 12th Avenue into a series of four vegetated stormwater planters. Although strormwater management was the major focus, the design also integrates this functional aspect into the aesthetics of a streetscape. Touted as one of the leading green street retrofit projects, the design successfully illustrates how to incorporate natural stormwater management techniques into the urban realm.

Goals

+ Low-cost in its design and execution.
+ Benefit the environment and embodies community livability.
+ Provide a model for other jurisdictions in addressing important national and local stormwater regulations.
+ Maximize the capture, treatment, and infiltration of street runoff, while providing a visual amenity for the neighborhood.


figure 2.4

Program Elements

+ Maximize stormwater planters while minimizing conflict with other street processes.
  + Integrate pedestrians, parking, street trees, landscaping, lighting, signage, and stormwater planters within an eight-foot space.
+ Special focus on the landscape element
  + Integration of aesthetically pleasing native planting that can withstand both wet & dry conditions.
  + Specific spacing for easy maintenance.
+ Fully integrate aesthetics & safety
  + Visually separate the pedestrian, stormwater, and street zones.
  + Integrate vegetative buffers to soften edges


figure 2.5


figure 2.6


figure 2.7


figure 2.8

Stormwater Management Process

+ Runoff flows down the existing curb and gutter system on 12th Avenue until it reaches the first stormwater planter.

+ A one foot wide curb cut directs runoff over a concrete sediment trap, into the first stormwater planter.

+ Upon entering the planter, stormwater is allowed to pond up to 7 inches before infiltrating the soil at a rate of 4 inches per hour.

+ If the rain event produces more than the allowed 7 inch ponding capacity, the water exits the first planter through a second curb cut, where it proceeds to the 2nd planter. This process is reaped for the 3rd and 4th planters where, if necessary, the overflow can drain into the existing stormwater system.

+ The planters capture area is roughly 7,500 square feet, resulting in the management of nearly 180,000 gallons of stormwater from 12th Avenue.

Success

The project was able to accommodate and manage nearly all of the estimated 180,000 gallons of runoff from 12th Avenue. In conjunction with the functional success, the design also safely allows pedestrians to enter and exit their vehicles parked adjacent to the planters. The integration of plants softens the harsh concrete edges of the planter, while native plants give the project a sense-of-place in the Pacific Northwest.

Criticism

The 90 degree curb cuts work well when runoff velocity is low. Yet, in a severe storm event, water can bypass the system. To remedy this situation, asphalt berms have been placed on the downhill side of the "entry" curb cuts. (Figure 2.7) These asphalt berms are aesthetically unappealing and could have been accounted for from design inception. To remedy the berms, cuts could have been angled or depressions in the street could have been placed on initial design.

Although the exterior planting direct pedestrians away from the depressed planters, safety issues may still exist. The possibility of a railing or bollard system could be considered.

Relevance

The SW 12th Avenue Green Street project represents a real world application of stormwater management strategies. Although some features should be modified to aid in stomwater intake, the general design can be imitated in almost any situation. Specific aspects of native plants, local contextual features and slopes all need to be considered prior to implementation on another site. For Main Street Evolved, issues of pre and post-winter maintenance should be considered.

green infrastructure

SW 12th Street Green Street Project | *Portland, Oregon*

Figure | 2.9 (murner 2011)

Design Elements

+ (4) 18' x 4' x 18" vegetated planters
  + 6" x 4" perimeter curb
  + Max ponding depth 7"

+ 3' concrete paver parking egress zone
  + Provide for safe vehicle access

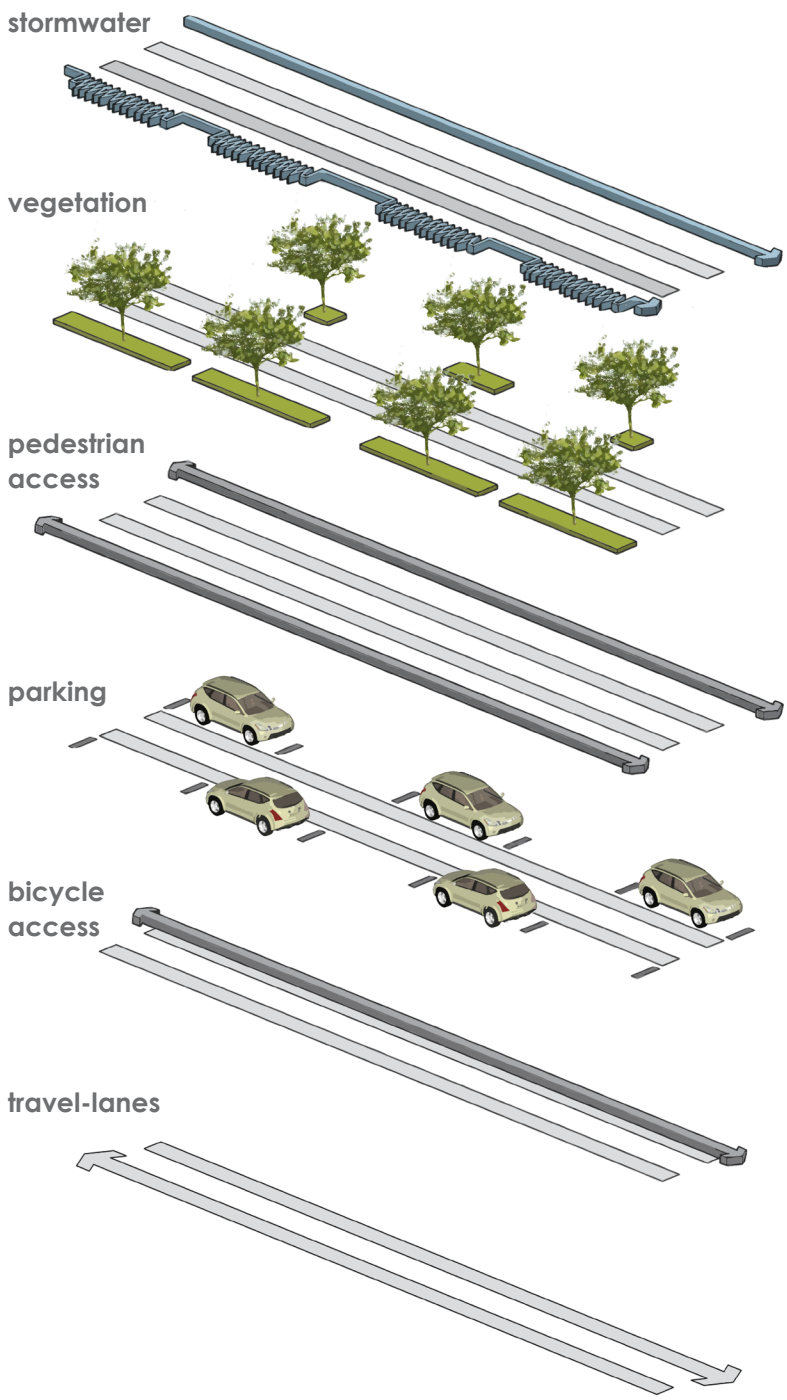
+ 2' wide landscape buffer at each end of the planters
  + Directs pedestrian movement without the use of railings

+ Treatment train system
  + Overflow from each planter flows out of a second curb cut, into the next planter.
  + If necessary, final overflow flows out of the last planter into the existing storm drain.

+ Sediment Catch
  + 18" concrete pad at each planter's uphill curb cut slows water velocity and collects sediment.

+ Plants | *Include*
  + Densely planted Grooved Rush (Juncus patens)
    + Planted at 18" on center for easy maintenance.
    + Tolerant of both wet & dry conditions.
    + Rigid, upright structure slows water velocity
    + Captures pollutants
    + Absorbs water.

+ Cost
  + Stormwater Management Area: $34,850



green infrastructure

NE Fremont Green Street Project | *Portland, Oregon*

figure 2.10

All information in the NE Fremont Green Street precedent study was collected and interpreted from the City of Portland NE Fremont Green Street report. The report was accessed on 11/23/2010 from (http://www.portlandonline.com)

Background

Located at the intersection of NE Fremont St and NE 131st Pl, the NE Fremont Green Street project is an example of a green street curb extension retrofit on a residential collector street. Built in July of 2005, the "project removed approximately 300 square feet of paved surface and transformed it into a vegetated system for stormwater management." (City of Portland Bureau of Environmental Services 2005)

figure 2.11

Implemented as a demonstration project, the NE Fremont Street project was the first Green Street conceived, designed, and implemented jointly by the Portland Bureau of Environmental Services (BES) and the Portland Bureau of Transportation (BOT). The NE Fremont Street project represents a unique opportunity for integrating vegetative stormwater management and multi-modal ideals.

Goals

+ Low-cost in its design and execution.
+ Benefit the environment and community livability.
+ Provide pedestrian safety and visual appeal for the Fremont neighborhood

Program Elements

+ Maximize stormwater management
  + Remove impervious surface, roughly the space needed to park two cars, and integrate a vegetative area that will retain, treat, and infiltrate street runoff.
+ Improve pedestrian safety & visual appeal
  + Incorporate an ADA accessible crossing within the stormwater management area
  + Integration of aesthetically pleasing native planting that can withstand both wet & dry conditions.
+ Retain existing utilities and traffic flow
  + Situate the project between existing utility meters to minimize interference.
  + Situate project in space dedicated to parking, thus maximizing traffic and pedestrian movement.

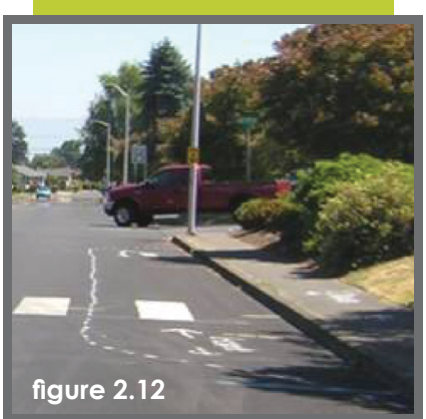


figure 2.12

Stormwater Management Process

+ Runoff flows down the existing curb and gutter system on NE Fremont Street until it reaches the stormwater planter
+ An 18 inch curb cut directs into the western portion stormwater planter
+ Upon entering the planter, stormwater is allowed to pond up to 6 inches before reaching its maximum depth
+ If more than the allowed 6 inches of ponding capacity are produced, the water exits the stormwater planter though a 6 inch curb cut on the western portion where the excess overflow can drain into the existing stormwater system
+ The planters capture area is roughly 4,500 square feet, resulting in a storage volume of approximately 150 cubic feet of stormwater from NE Fremont Street

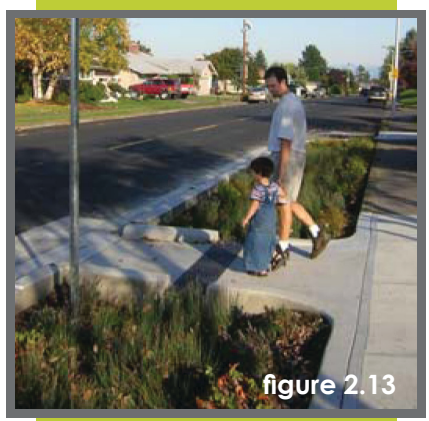


figure 2.13

Success

The NE Fremont Street project was able to retain, treat, and infiltrate the majority, if not all of the 4,500 square foot catchment area it was designed for. This mark was determined to be a representative size of the existing stormwater sewer systems of the area, and shows that this type of system can manage predictable stormwater rates. Beyond the stormwater aspect, the project was also Portland's first attempt, and success, at integrating ADA accessible crossings into the design of a curb extension. In addition, the project also reduced impervious surface area and introduces vegetation into the street environment.


figure 2.14

Criticism

The removal of parking spaces is an interesting adaptation of the street environment. Although the removal of parking maybe possible on this low volume neighborhood collector, considerations to the removal of parking on a commercial street may need to be considered. Although the planting scheme was chosen for its stormwater management benefits, the incorporation of one or more street trees could increase the aesthetic appeal of the project.

Relevance

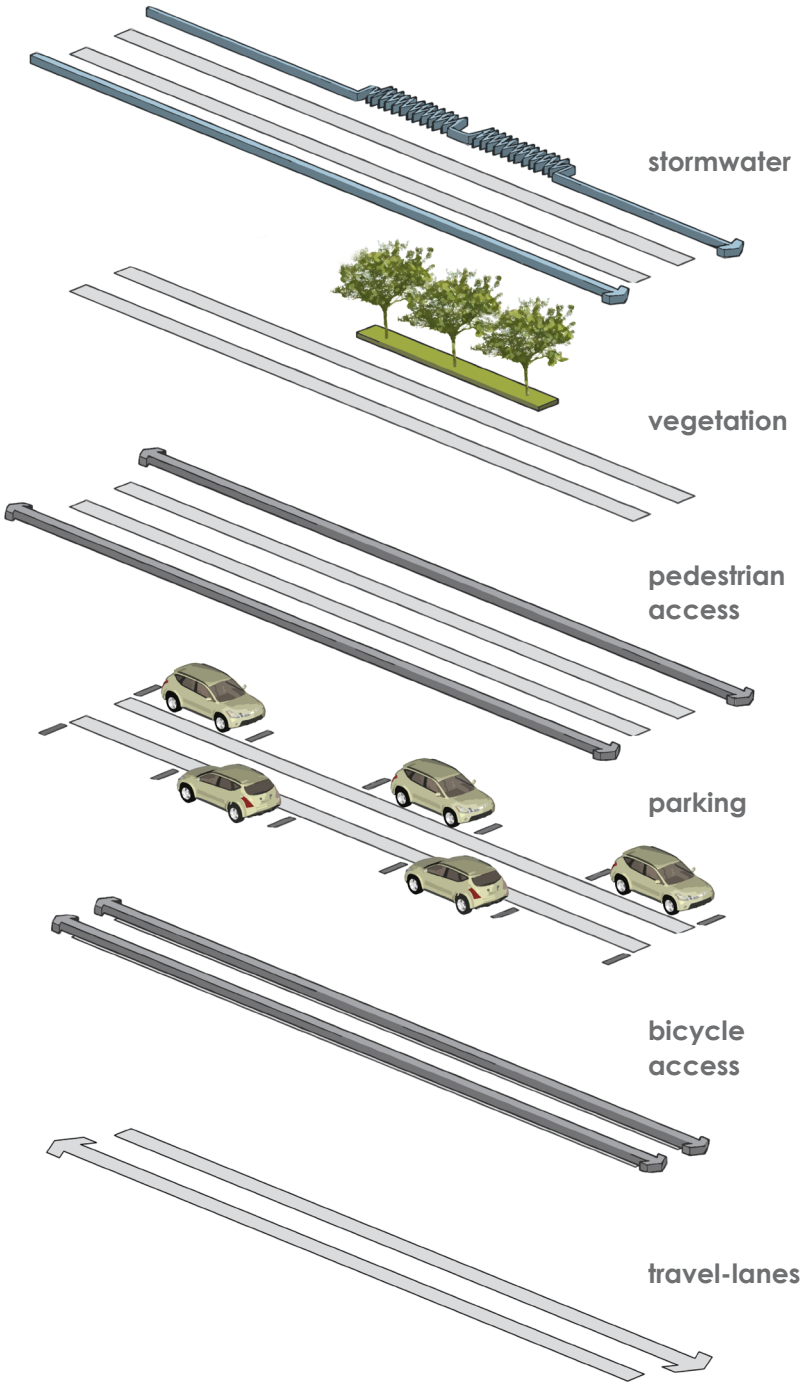
Although this project is situated on a residential street, it illustrates the numerous benefits for space saving, traffic calming, and mulit-modal integration. Although the removal of on-street parking in a Main Street context may seem absurd, it may be possible to incorporate this type of stormwater management system into a mid-block crossing. Although small in scale, the NE Fremont project directly illustrates the union of stormwater management and multi-modal transportation ideals that are at the heart of the Main Street Evolved program.


figure 2.15

green infrastructure

NE Fremont Green Street Project | *Portland, Oregon*

Figure | 2.16 (munrer 2011)



Design Elements

+ (1) 65' x 7' x 8" vegetated planters
  + 6" x 4" perimeter curb
  + Max ponding depth 6"
  + Total landscape area of 300 square feet

+ 3' concrete ADA Accessible crossing
  + Provide for safe pedestrian access over the management area

+ 1' wide concrete trench
  + Connects the two portions of the stormwater planters and conveys stormwater under the accessible ramp.

+ Plants | *Include*
  + Densely planted Grooved Rush (Juncus patens)
  + Hebe (Hebe 'Autumn Glory')
  + Dwarf English lavender (Lavandula angustifolia 'Hidcote Blue')
  + New Zealand orange sedge (Carex testacea)
    + Tolerant of both wet & dry conditions.
    + Rigid, upright structure slows water velocity, captures pollutants, and absorbs water.
    + Evergreen foliage provides year round appeal

+ Cost
  + Stormwater Management Area: $16,400

green infrastructure

NE Siskiyou Green Street Project | *Portland, Oregon*

All information in the NE Siskiyou Green Street precedent study was collected and interpreted from the City of Portland NE Siskiyou report. The report was accessed on 11/26/2010 from (http://www.portlandonline.com)


figure 2.17

Background

Located between NE 35th Pl and NE 36th Avenue in Portland, Oregon, the NE Siskiyou Green Street Project is an example of a green street curb extension retrofit on a residential street. Built in October of 2003, the project removed approximately 590 square feet of paved surface and transformed it into a vegetated system for stormwater management. Implemented as a demonstration project, the NE Siskiyou Street project was the first Green Street in the Portland area to use vegetated curb extensions to manage stormwater runoff. (City of Portland Bureau of Environmental Services 2003)

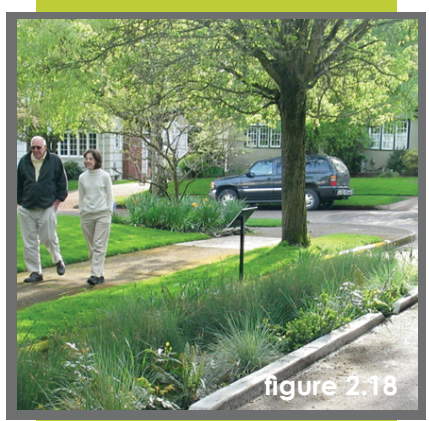


figure 2.18

Goals

+ Low-cost in its design and execution.
+ Benefit the environment and embodies community livability.
+ Provide visual appeal and coherence into the surrounding neighborhood.

Program Elements

+ Maximize stormwater management
  + Remove impervious surface, roughly the space needed to park two cars, and integrate a vegetative area that will retain, treat, and infiltrate street runoff.
+ Incorporate as a true retrofit design
  + Remove only road surface, retain and use existing curb.
  + Allow residents to park on adjacent streets without interrupting normal procedure
+ Integrate into the surrounding aesthetic
  + Use low growing evergreen and perennials to match the aesthetic of the surrounding neighborhood
+ Allow for normal traffic movement
  + Place a stormwater planter on each side of the 28 foot wide low-traffic street, allowing traffic to flow between.

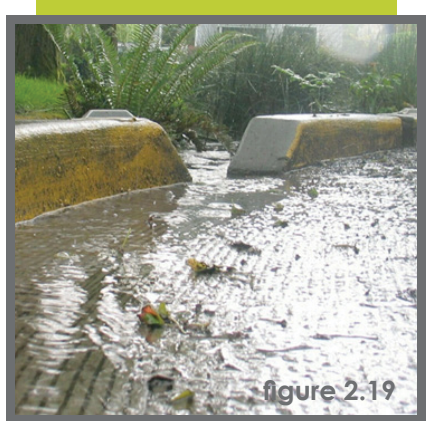


figure 2.19

Stormwater Management Process

+ Runoff flows down both sides of the existing curb and gutter system on NE Siskiyou Street until it reaches the stormwater planters
+ An 18 inch curb cut directs into the uphill portion stormwater planter


figure 2.20

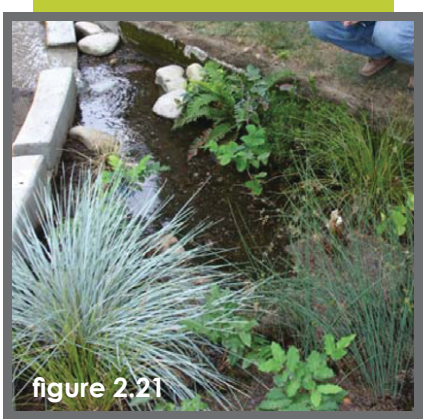


figure 2.21

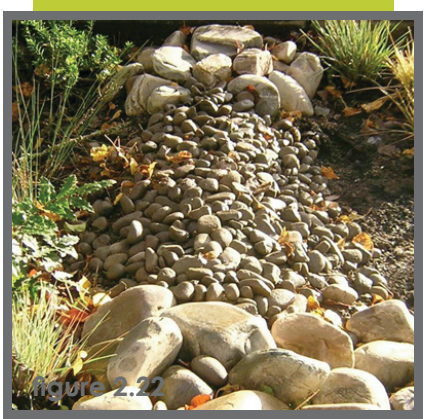


figure 2.22

+ Additional curb cuts, 6 inches in width are located on the uphill side of each check dam to allow missed stormwater to enter the system
+ Upon entering the planter, stormwater flows into the first of four internal bays. Each bay is restricted by a check dam which reduces flow velocity and allows the stormwater to pond
+ If stormwater fills the first bay, it then travels over the check dam and into the second bay. This process continues until the fourth and final bay has been filled
+ If more than the allowed 7 inches of ponding capacity are produced,, the water exits the stormwater planter though a 6 inch curb cut on the downhill portion where the excess overflow can drain into the existing stormwater system
+ The planters capture area is roughly 9,300 square feet, resulting in a storage volume of approximately 120 cubic feet of stormwater from NE Siskiyou Street and adjacent driveways

Success

The NE Siskiyou Street project was able to retain, treat, and infiltrate the majority, if not all of the 9,300 square foot catchment area it was designed for. This mark was determined to be a representative size of the existing stormwater sewer systems of the area and demonstrates that this type of system can manage predictable stormwater rates for this size of street. Beyond the stormwater aspect, the project was also Portland's first attempt, and success, at integrating stormwater management into a curb extension. In addition, the project also reduced impervious surface area and introduces vegetation into the street environment that responds to the aesthetic set up by the residents.

Criticism

The stormwater curb extensions on NE Siskiyou adequately allow for the interception of stormwater before it reaches the existing storm sewer. Yet without any kind of trap, they also intercept all of the sediments and debris from the street. This requires continual maintenance to ensure the system works properly. In addition, the clay check dams can be seriously eroded in severe storm events. (City of Portland Bureau of Environmental Services 2003)

Relevance

Although this project is situated on a residential street, it illustrates how curb extensions can be used for multiple purposes. Although the removal of on-street parking in a Main Street context may seem absurd, it may be possible to incorporate this type of stormwater management system into curb extension at an intersection. Although not a perfect example of a maintenance free design, the NE Siskiyou project shows that stormwater management can be incorporated into an already acceptable design alternative. Curb extensions can be found in almost any urban context around the country, including the Rocky Mountain West, and a retrofit of these existing curb extensions may be a plausible solution for the integration of stormwater management.

green infrastructure

NE Siskiyou Green Street Project | *Portland, Oregon*

Figure | 2.23 (munrer 2011)

Design Elements

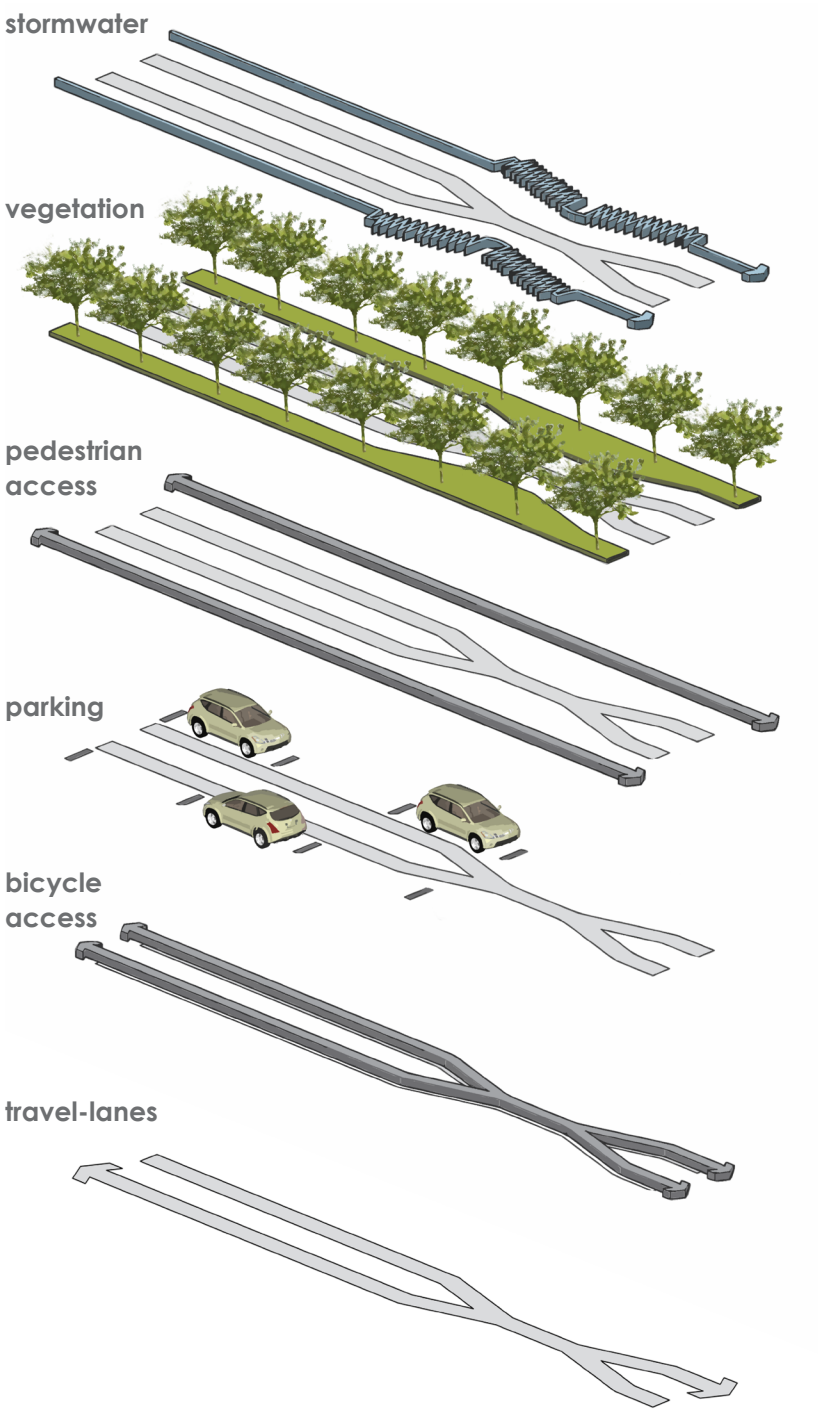
+ (2) 60' x 7' vegetated planters
  + 6" x 4" perimeter curb
  + Max ponding depth 7"
  + Total landscape area of 275 square feet for each planter

+ 3 Clay based check dams in each planter
  + Separate each planter into four "bays"
  + Allow ponding in each bay, slowing stormwater velocity and allowing for infiltration.

+ Swale Configuration
  + 6 inch depth at curbs with a 12 inch depth in the middle.
  + Ensures stormwater remains within the planter

+ Plants | *Include*
  + Sword fern (Polyshtichum munitum)
  + Blue Oat Grass (Helictotrichon sempervirens)
  + Iris Bulbs (Iris spp.)
  + Grooved Rush (Juncus patens)
    + Tolerant of both wet & dry conditions.
    + Rigid, upright structure slows water velocity, captures and pollutants.
    + Evergreen foliage provides year round appeal

+ Cost
  + Stormwater Management Area: $17,000



complete streets

US Route 62 Hamburg Project | *Hamburg, New York*

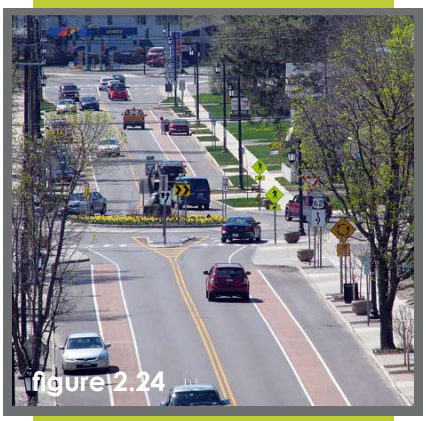


figure 2.24

All information in the US Route 62 Hamburg precedent study was collected and interpreted from the US Route 62 AASHTO/FHWQ Peer Exchange: Context Sensitive Solutions report & the New York State Transportation Department report. The reports were accessed on 10/09/2010 from (CSS.org) & (nysdot.gov)

Background

Located approximately 15 miles southeast of Buffalo, the US Route 62 Hamburg project is an example of a complete street transformation design. Completed in 2009, the project transformed a typical highway into a safe thoroughfare for vehicles and pedestrians alike. The design was connived through a series of community charrettes led by Dan Burden of Walkable Communities inc. and called for the implementation of four roundabouts, mid-block pedestrian crossings, more on-street parking, and narrower travel lanes.

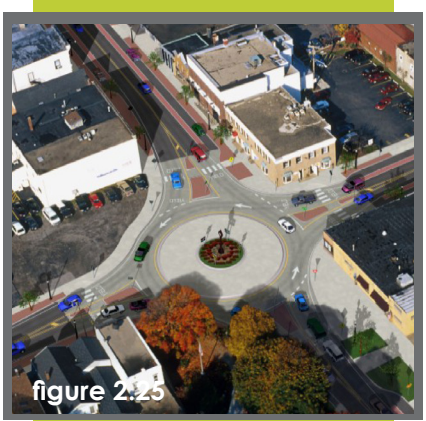


figure 2.25

Although the major focus of the project was to address severe vehicular safety, capacity, and infrastructure issues, the project has also successfully drawn pedestrians and bicyclists to the downtown area thus revitalizing the small community. The project has been highly touted for its innovation and is a top ten nominee in innovative management for a 2010 AASHO Transportation Award.

Goals

+ Improve vehicle & pedestrian safety
+ Increase vehicle & Pedestrian Capacity (reduce vehicle congestion)
+ Update aged infrastructure

Program Elements

+ Maximize vehicle safety and capacity
  + Replace four major intersections with roundabouts to; reduce traffic speed, accidents, maintenance, and increase thoroughfare aesthetics.
  + Slow through traffic with roundabouts, narrowed lanes, and street trees.
  + Incorporate on street parking, separated by safety lanes, into the design.

+ Maximize pedestrian safety and capacity
  + Slow traffic to increase pedestrian comfort.
  + Slow traffic to increase bicycle safety and mobility
  + Incorporate pedestrian gathering spaces

+ Fully integrate aesthetics & safety
  + Implement street trees not only for traffic calming function, but for visual appeal
  + Aesthetic focal point at the center of each roundabout

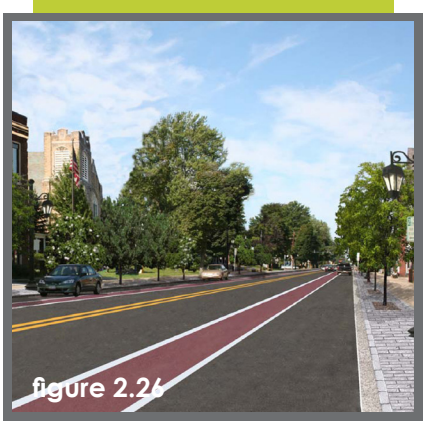


figure 2.26

Complete Streets Principles

+ The implementation of four roundabouts to slow traffic, increase safety, and maximize capacity.

+ The incorporation of mid-block pedestrian crossings to increase the pedestrian convince and safety.

+ The addition of on-street parking to separate pedestrians from traffic, slow vehicle speed, and allow convenient parking to increase street activity.

+ The narrowing of the travel lanes from 12 ft to 9 ft effectively slows traffic and provides more space for pedestrian ways and safety lanes.

figure 2.27

Success

The US Route 62 Hamburg project was able to transform almost 2 miles of traditional two-lane highway into a pedestrian responsive city street. The street improvements have reduced traffic accident by approximately ”70 percent” (New Urban Network, 2010) and increase pedestrian activity within the downtown area.

The roundabouts not only serve a vital functional role but they also provide an opportunity for street vegetation or artwork. Slower traffic, on-street parking, and pedestrian gathering areas have all effectively reinvigorated the downtown district of Hamburg, New York.

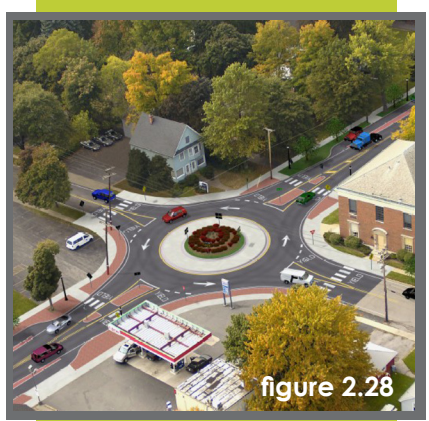


figure 2.28

Criticism

Although the incorporation of a 4 foot wide safety lane between on street parking and the travel lanes provides a buffer for parking, it is too small to be used as a dedicated bicycle lane. With no delineated bicycle lanes to speak of, the widening of the safety lanes for use as bicycle lanes should have been considered.

Relevance

For Main Street Evolved, the incorporation of roundabouts could be considered in the right context. A Main Street that is also a highway may have issues with controlling traffic speeds and congestion; roundabouts have the potential to alleviate both of these issues. Roundabouts may also provide another opportunity to incorporate stormwater management strategies. The incorporation of on-street parking “safety lanes” can serve multiple functions; safety for people exiting cars, bicycle lane, and a secondary pedestrian buffer to remove traffic further away from the pedestrian zone.

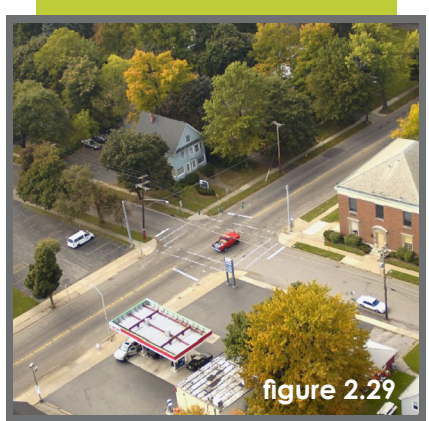
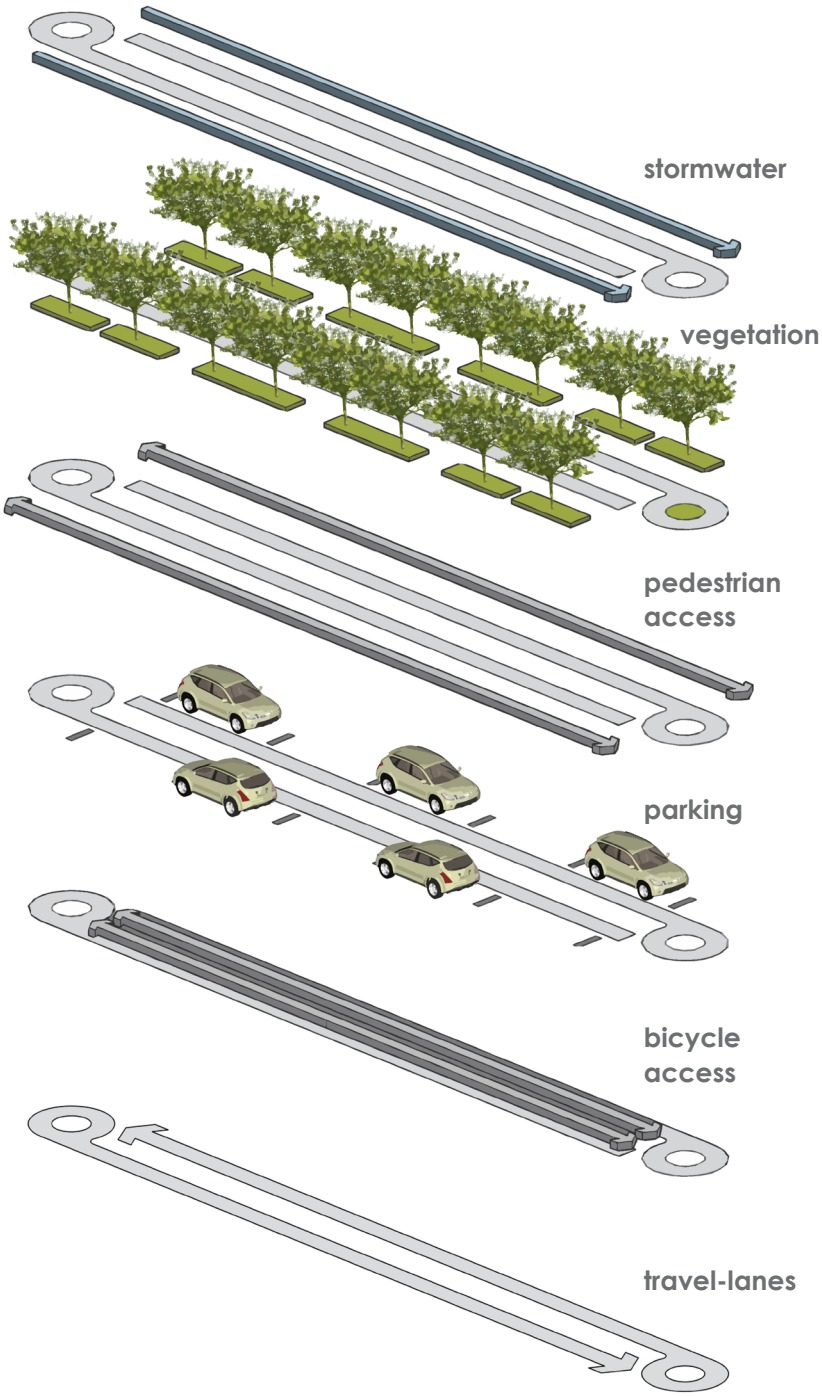


figure 2.29

complete streets

US Route 62 Hamburg Project | *Hamburg, New York*

Figure | 2.30 (munrer 2011)



Design Elements

+ (4) Roundabouts at major intersections
  + Roundabouts located at: Main & Buffalo Street, Main & Center Street, Buffalo Street & Prospect Avenue, and Legion Drive & Clark Street.

+ 2 - lane road reduced from 12' to 9'
  + Narrowed streets slow traffic and increase both vehicular and pedestrian safety

+ Mid-block pedestrian crossings
  + Provide for safe pedestrian access

+ 4' safety lanes between parking and travel lanes
  + Provides a safe exit point for on-street parking & secondary buffer from the traffic lane for pedestrians.

+ Planting
  + Evenly spaced street trees add aesthetic appeal and reduce traffic speeds

  + Vegetated roundabouts provide an aesthetic focal point and reduce traffic by blocking divers' view beyond.

+ Cost
  + Total: $23 Million

complete streets

SR-14/Bingen Redevelopment Project | *Bingen, Washington*

All information in the SR-14/Bingen precedent study was collected and interpreted from the Context Sensitive Solutions "Downtown Revitalization, Safety & Congestion improvements, SR-14" report. The report was accessed on 11/24/2010 from: (contextsensitivesolutions.org)

Background

Located approximately 65 miles northeast of Portland Oregon, the SR-14/Bingen project is an example of a Complete Street transformation design. Completed in 2004, the project transformed a typical highway, which doubles as the city of Bingens' main street, into safe thoroughfare for vehicles and pedestrians alike. The purpose of the project was to reduce traffic congestion, improve traffic flow, and reduce safety concerns with the high speed traffic.

Although the original design intent was to address the traffic issues related to SR-14, the city of Bingen also was in need of economic revitalization. The hope was that the economic vitality of the city would be improved through the introduction of traffic calming measures and improving pedestrian safety. Through community outreach and stakeholder support, a final design solution was accepted.

Goals

+ Improve safety
+ Reduce vehicle congestion
+ Improve the Economic Vitality

Program Elements

+ Maximize pedestrian access and safety
  + Incorporate wide sidewalks with bulbouts
  + Material change for crosswalks
  + Unifying lighting element
+ Maximize vehicle capacity and traffic flow
  + Provide two through lanes
  + Provide a two-way left-turn lane
+ Boost local economic vitality
  + Increase pedestrian users by making the downtown more pleasing
  + Increase on-street parking

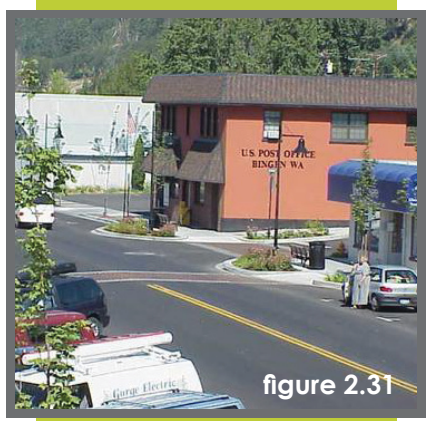


figure 2.31


figure 2.32

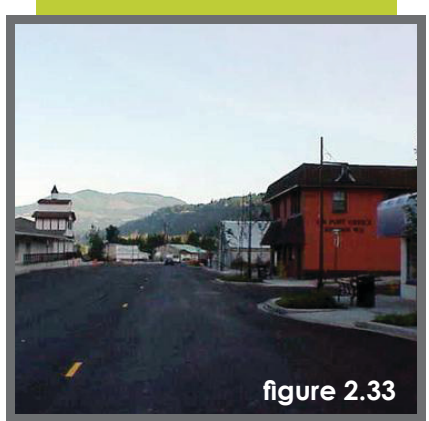
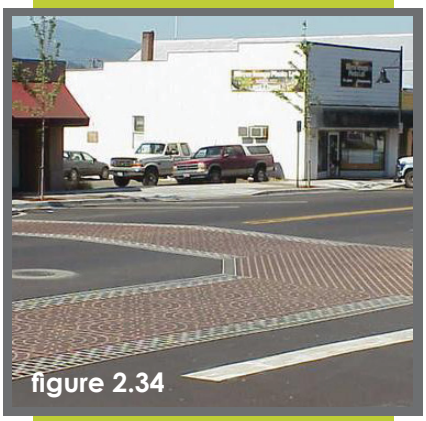


figure 2.33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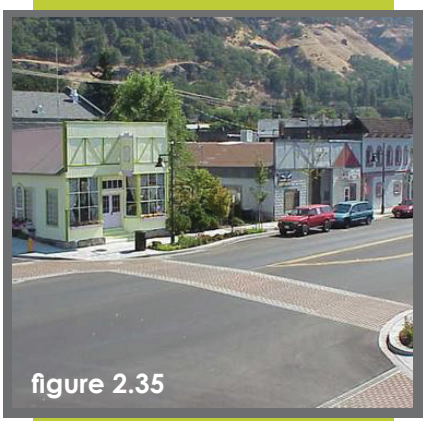


figure 2.35


figure 2.36

Complete Streets Principles

+ West of Bingen, the shoulders were widened to 6 feet, which act as pedestrian buffer and bicycle lanes
+ Left-turn lanes and right-turn pockets added to facilitate traffic movement
+ Street trees and planting strips were added in the downtown area to slow traffic, and add aesthetic appeal
+ Pedestrian bulb-outs and wide sidewalks encourage pedestrian activity
+ Concrete pavers, street furniture, and special light standards added to improve the aesthetics & user comfort

Success

The SR-14/Bingen revitalization project was able to transform an unsafe highway into a safe multi-modal street. By widening the shoulders on the highway outside of Bingen and providing wide travel lanes within, cyclists can use the road with comfort. The widening of the sidewalks, addition of vegetated bubouts, and incorporation brick paver crosswalks have all made the commercial district more inviting to pedestrians. Slower traffic, on-street parking, and inviting pedestrian areas have all effectively reinvigorated the downtown of Bingen, Washington.

Criticism

Although the widening of the highway shoulders outside the city limits of Bingen has provided for safe bicycle travel, it seems as if it was neglected within the city itself. The addition of sharrows could remedy this issue or a change in parking orientation on the southern side of SR-14 could be considered. Angled parking was chosen on the south side of the road and requires much more space than parallel parking. If parallel parking was implemented, a dedicated bicycle lane could have been incorporated.

Relevance

For Main Street Evolved, the incorporation of sidewalk bulbouts, a change in crosswalk material, and the addition of dedicated turning lanes could provide the space and multi-modal needs of many streets. The addition of sidewalk bulbouts also offers an opportunity to integrate stormwater management. The traffic congestion issues faced by Bingen are also dilemmas faced by many communities across the Rocky Mountain west. Reducing extraneous lanes and providing dedicated turn lanes may remedy the congestion issues and also provide space for other improvements.

complete streets

SR-14/Bingen Redevelopment Project | *Bingen, Washington*

Figure | 2.37 (munrer 2011)

Design Elements

+ 6 ' wide shoulders along SR-14
  + Although not provided within the town proper, the widened shoulders adequate accommodate bicycles in a safe an efficient manner.

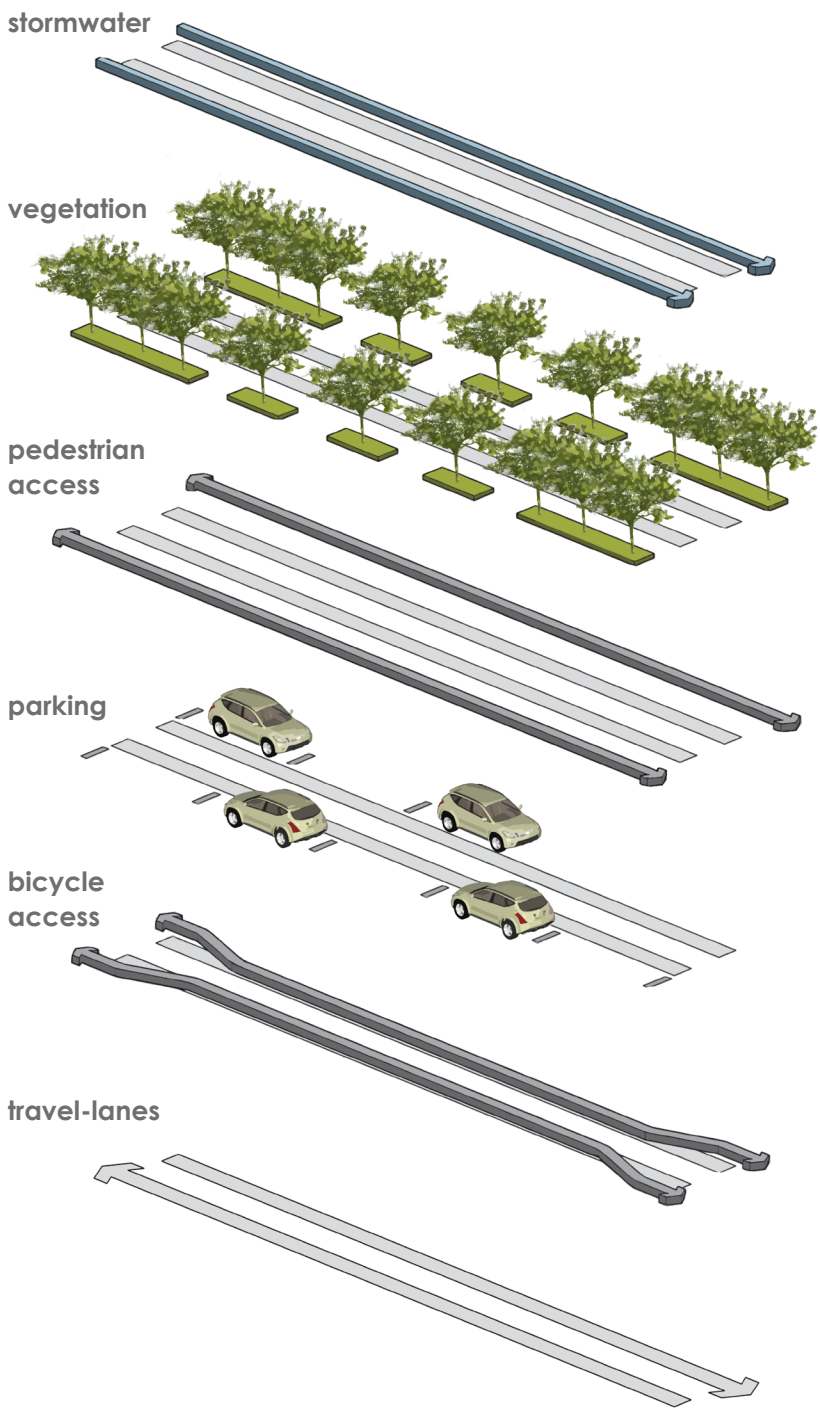
+ Brick paver cross-walks
  + Changing the cross-walk material provides safe pedestrian crossing while also enhancing aesthetic appeal beyond the prototypical painted walks.

+ Pedestrian Bulbouts
  + Sidewalk bulbouts provide a chance to incorporate vegetation and also increase pedestrian safety by reducing crossing distance and increasing visibility.

+ Plants
  + Evenly spaced street trees add aesthetic appeal and reduce traffic speeds

  + Vegetated bulbouts provide an aesthetic focal point and reduce crossing distance for pedestrians.

+ Cost
  + Total: $ 8.2 Million



complete streets

East Main Street Reconstruction Project | *Westminster, Maryland*


figure 2.38

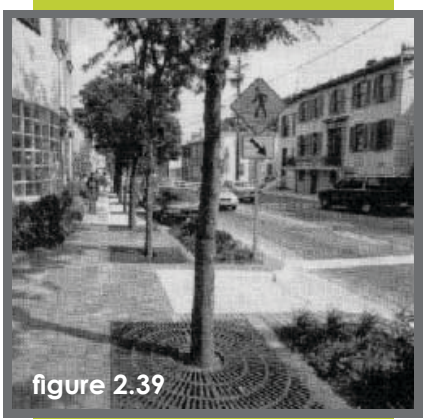


figure 2.39


figure 2.40

All information in the East Main Street precedent study was collected and interpreted from the United States Federal Highway Administration "Flexibility in Highway Design: East Main Street Reconstruction" report.

Background

Located approximately 35 miles northwest of Baltimore, the East Main Street Reconstruction project in Westminster, Maryland is an example of a complete street transformation design. Completed in December of 1994, the project sought to reinvigorate the deteriorating downtown district. Prior to the redevelopment, East Main Street was extremely unfriendly to vehicles and pedestrians alike.

"Countless repavings had raised the street's center, resulting in slanted parking spaces that caught car doors on curbs. Porches, stoops, and utility poles encroached onto narrow, cracked, and caved-in sidewalks." (Federal Highway Administration, 1997) After an original design concept that would have removed numerous existing trees and done little to improve pedestrian walkability failed, city officials were forced to consider alternatives.

Goals

+ Improve walkability and comfort
+ Retain existing vegetation
+ Increase aesthetic appeal
+ Improve the Economic Vitality

Program Elements

+ Improve walkability and comfort
  + Narrow traffic lanes
  + Widen sidewalks
  + Provide sidewalks where there were none
  + Increase pedestrian zone "buffer" width
  + Provide gathering areas

+ Retain existing vegetation & Increase aesthetic appeal
  + Narrow travel lanes to increase vegetation areas
  + Extend curbs to provide "breathing room" for existing trees
  + Provide tree grates to ensure soil porosity around trees
  + Incorporate aesthetically pleasing paving materials

+ Improve the Economic Vitality
  + Increase pedestrian users by making the downtown more pleasing
  + Retain on-street parking

Complete Streets Principles

+ Widen Sidewalks to provide for safe and comfortable pedestrian movement
+ Well defined cross-walks and brick paver pedestrian areas increase aesthetic appeal and safety.
+ Narrow traffic lanes to slow through traffic
+ Retain & include additional street tree planting to slow traffic, provide shade, and increase aesthetic appeal.
+ Incorporate sidewalk bulbouts to increase pedestrian visibility and safety
+ Widen "buffer" zone between the sidewalk and travel lanes to increase safety and provide space for street vegetation.

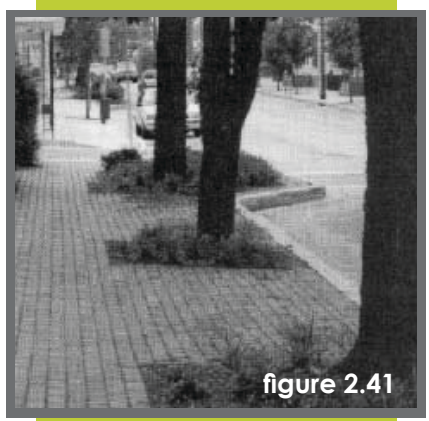


figure 2.41

Success

The redevelopment of East Main Street in Westminster, MD is an example of how the implementation of Complete Streets can revitalize a historic downtown district. The two major concerns with the original plan, which called for the removal of all existing vegetation and the incorporation of five foot sidewalks, were addressed. Sidewalks were widened from 5 to 10 feet and 34 of the original 42 existing street trees were retained. Through the implementation of the Complete Street ideals, the economic vitality of the downtown was restored. It was predicted that all of the redevelopment budget, $3.15 million, would be returned to the city within four years based on increased demand for downtown retail space.

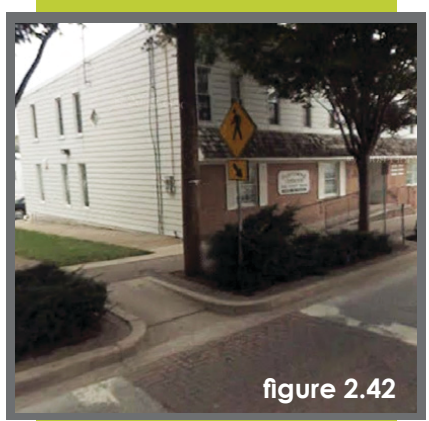


figure 2.42

Criticism

Although not addressed within the redevelopment scope, bicycle lanes or sharrows could have been incorporated to allow for safe bicycle travel. At the time the project was conceptualized, the term Complete Streets was non-existent and could contribute to the absence of bicycle space. Although the city wished to place existing utilities below ground, this process would have nearly doubled the cost of the project. (Federal Highway Administration, 1997)

Relevance

For Main Street Evolved, the East Main Street project represents an example of how to integrate Complete Streets within a historic context. As many of the mining communities across the Rocky Mountain west fall under the umbrella of National Historic Sites, it is critical to understand how these ideals can be incorporated while meeting the Historic Sites requirements. Beyond the historical context, the East Main Street project also represents another example of the revitalization power of Complete Streets. For many Rocky Mountain communities, a revitalized downtown may aid or restore the local economic viability of the historic downtowns.

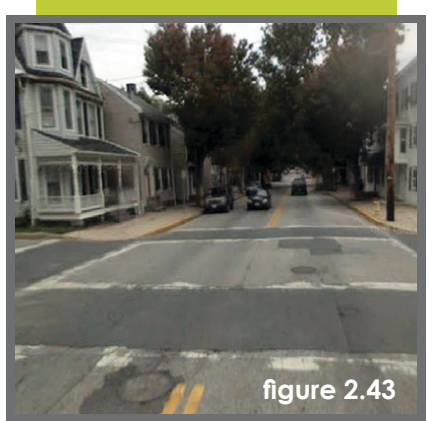
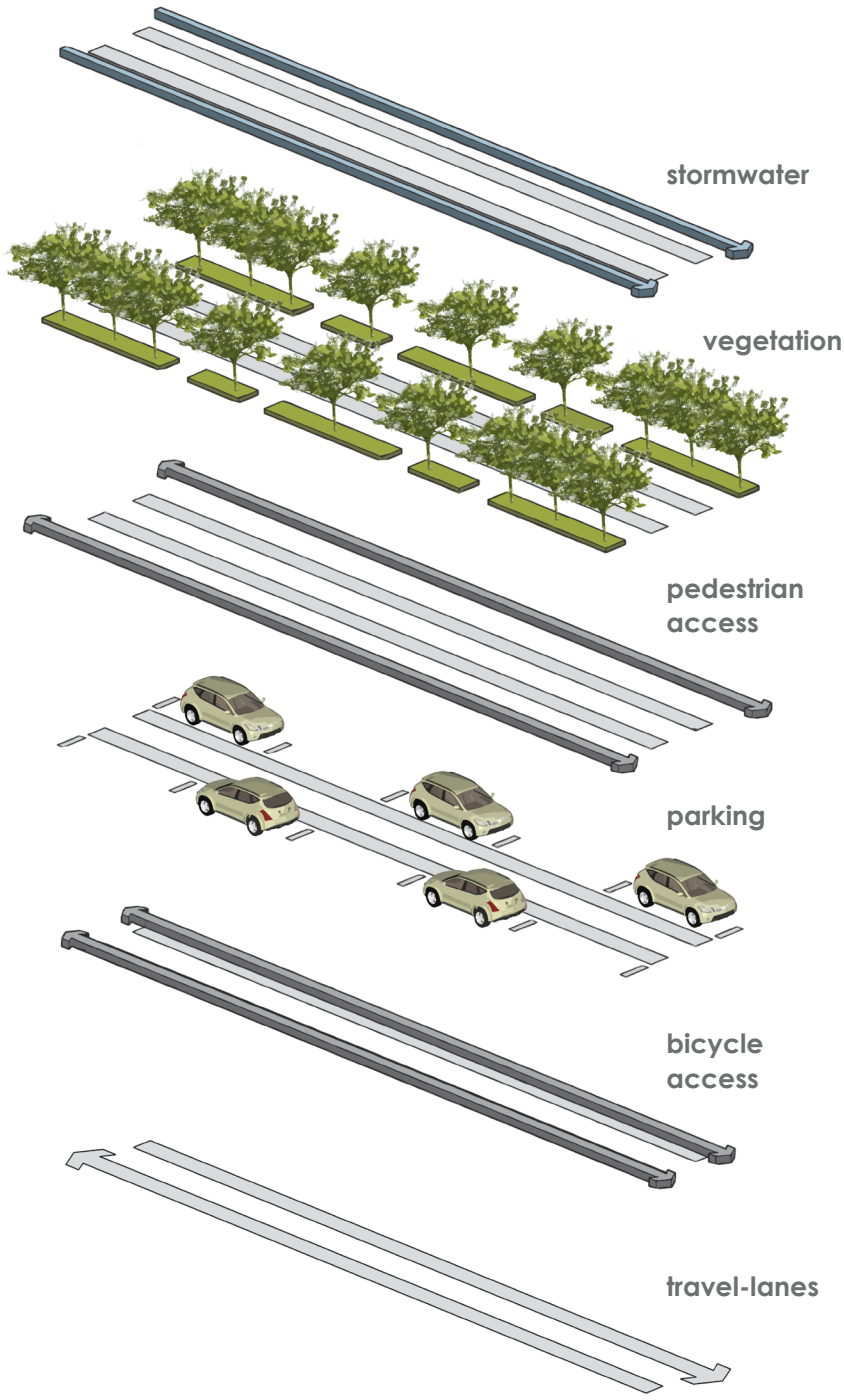


figure 2.43

complete streets

East Main Street Reconstruction Project | *Westminster, Maryland*

Figure | 2.44 (munrer 2011)



Design Elements

+ Reduction of Paved Surfaces
  + Overall, the paved surface was reduced from 40ft to 38 ft.
  + In addition, the travel lanes were reduced from 12 ft to between 11 & 10 ft
+ Widened Pedestrian Zones
  + Sidewalks were widened from 5 ft to 10 ft and sidewalk bulbouts were widened to 6 ft to allow for additional street vegetation
+ Safe Cross-walks
  + Cross-walks were better defined by continuously painted intersections.
+ Plants
  + 34 of the existing 42 street trees were retained and an additional 104 trees were added to ensure dense foliage saturates the street.
+ Cost
  + Total: $ 3.15 million

mountain street development

Manitou Avenue Project | *Manitou Springs, Colorado*

All information in the East Main Street precedent study was collected and interpreted from the city of Manitou Springs: Rainbow Vision Plan 2000. The plan was accessed on 10/10/2010 from (manitousprings-co.gov/PDF/Rainbow%20Vision%Olan%292999.PDF)


figure 2.45

Background

The city of Manitou Spring, Colorado is located approximately 5 miles west of Colorado Springs. At the center of the historic town lies Manitou Avenue, the economic & social heart of the city. Beginning in the early 90's, the city developed the "Manitou Springs Vision 2000 Plan", which set out the redevelopment plans of the city. As part of Vision 2000 plan, the city called for a focus on; community image & character, public service, and traffic & transportation. (City of Manitou Springs, 1994) In response to these goals, the city has re-imagined Manitou Avenue to be more responsive to pedestrians. The additions of wider sidewalks, mid-block crossings, lighting, street seating, and pedestrian gathering areas have all helped to reinvigorate the historical community.

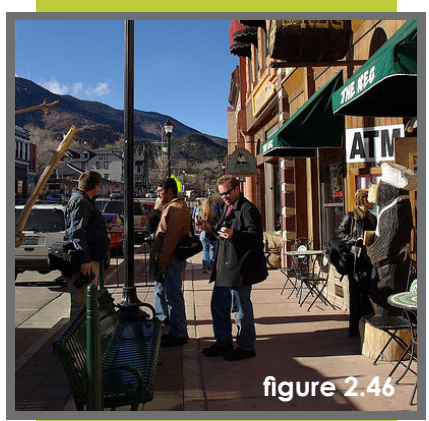


figure 2.46

Goals

+ Non-gambling community
+ Encourage historic preservation
+ General beautification; more green space
+ Address infrastructure improvements
+ Emphasize multi-modal travel

Program Elements

+ Address infrastructure improvements
    + Repave streets, sidewalks, and leading zones

+ Beautification and streetscape improvements
    + Integrate landscape elements into the redesign street
        + Street trees, bulbouts, and pocket gathering spaces
    + Integrate lighting & seating elements into the redesigned street
        + Act as buffer from the travel lane & pedestrian zone
    + Incorporate pedestrian gathering spaces & pocket parks
        + Small areas for street performances and transit stops.

+ Improve pedestrian walkability & safety
    + Incorporate mid-block crossings between major intersections
    + Incorporate safety zone between travel lanes and sidewalks
    + Transform center lane into a loading zone which can double as pedestrian median

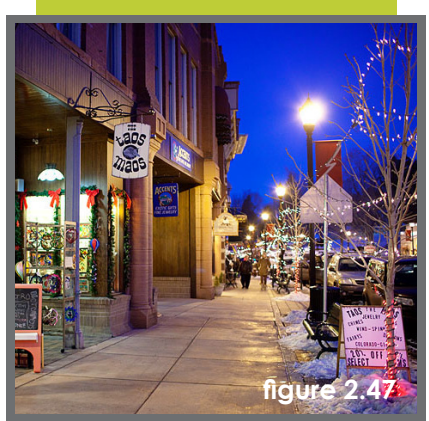


figure 2.47


figure 2.48


figure 2.49

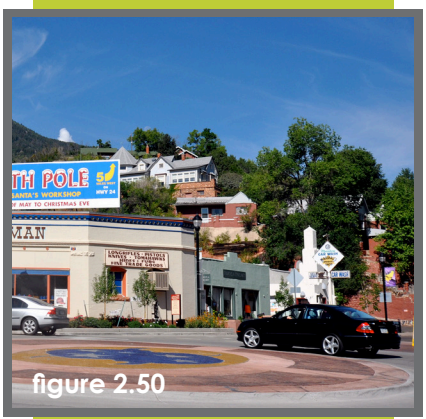


figure 2.50

Unique Opportunity

An especially innovative strategy was implemented within the center lane. The long blocks of Manitou Springs made the turning lane somewhat superfluous. The additions of colored concrete has changed the unused lane into a vehicle loading zone which, by purpose or mistake, has also created a pedestrian crossing median.

Success

The Manitou Avenue redevelopment project is an example of mountain community redevelopment with an emphasis on culture and historical context. By placing an emphasis on pedestrian responsiveness, Manitou Springs has become a nationally recognized tourist destination. Although the integration of vegetation, lighting, seating, and mid-block crossings are typical street improvements, the Manitou Avenue project represents how they can function within the context of a historical mountain community.

Criticism

The sidewalks of the historical street seem narrow along the majority of the downtown area. By incorporating lighting, benches, and vehicle unloading areas within the already narrow space, the walking area within the pedestrian zone seems inadequate. Although the newly refurbished center lane serves multiple functions, the reduction or elimination of this lane could have gave way to wider sidewalks & pedestrian zones.

Relevance

For Main Street Evolved, the narrowing of travel lanes or the elimination of an unused turning lane could provide space for wider pedestrian zones. The transformation of an unused turning lane between blocks provides an opportunity to bring together Complete Street & Green Street Ideals into a single location. A uniform design to lighting, seating, and planting zones will help to unite seemingly unconnected areas of a street. The Manitou Avenue project represents the beginnings of an Evolved Main Street in a Rocky Mountain context. Yet, the integration of green street ideals into the central median could aid in stormwater management & reduction of traffic speed.

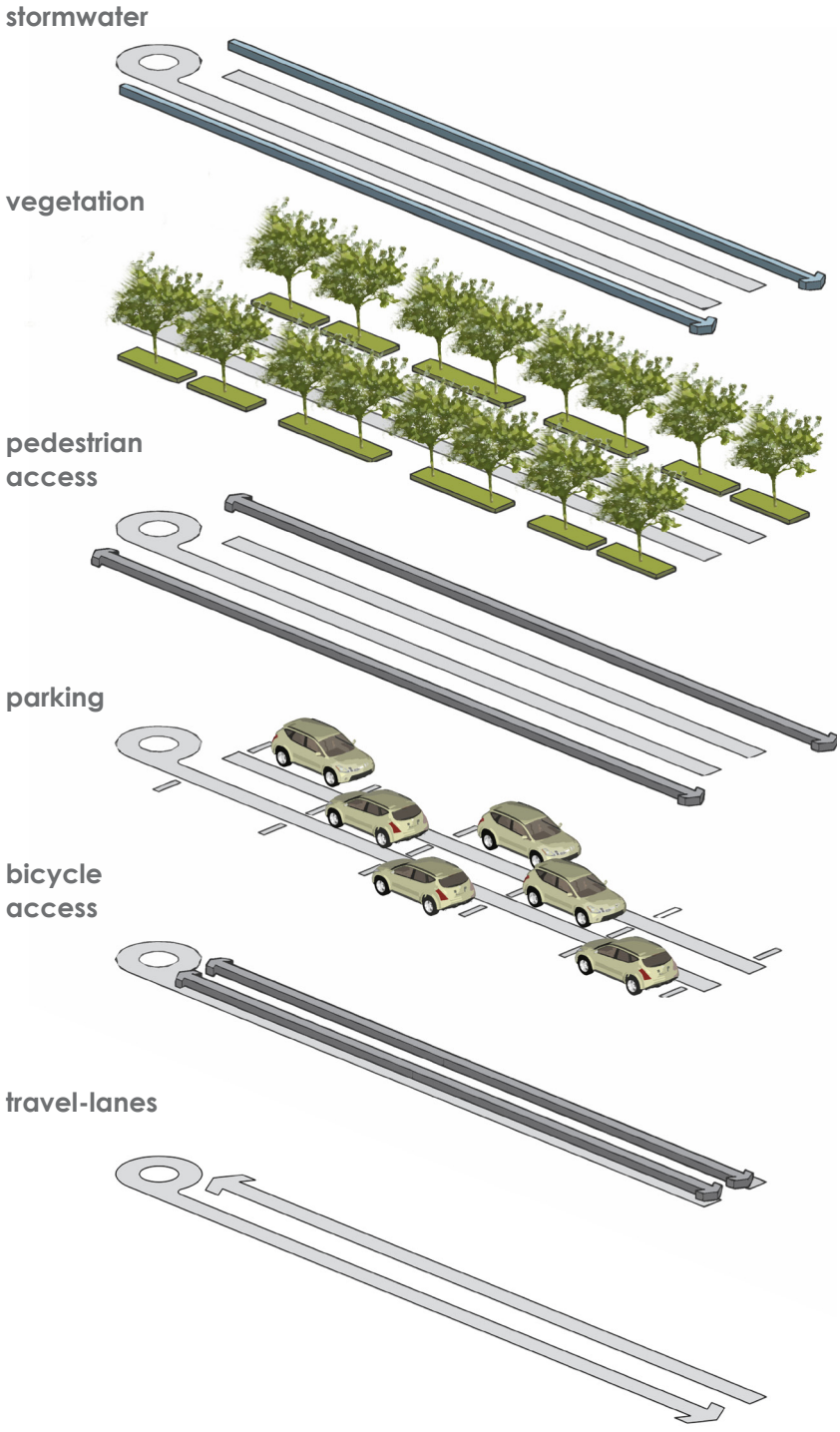
mountain street development

Manitou Avenue Project | *Manitou Springs, Colorado*

Figure | 2.51 (munrer 2011)

Design Elements

+ A roundabout at Manitou Avenue & Ruxon Avenue
  + Caps the end of the downtown area with a unique feature
+ 2 - lane road with center lane loading zone
  + Narrowed streets slow traffic and increase both vehicular and pedestrian safety
  + Center lane provides a trouble-free loading zone for downtown merchants
  + Center lane is also used as a center median to improve pedestrian safety.
+ Mid-block pedestrian crossings
  + Provide for safe pedestrian access
+ 2'-3' concrete paver parking egress zone
  + Provide for safe vehicle access
+ Planting
  + Evenly spaced street trees add aesthetic appeal and reduce traffic speeds
  + Mid-block crossing incorporate a low wall and low plantings to visually signify their existence to vehicles
+ Contextually corresponding material selection
  + Walls built with stone imitate historical character
  + Rose/Sand colored concrete and stone is used to match brick and stone finish on historical buildings.



mountain street development

Sherman Avenue Redevelopment Project | *Coeur d'Alene, Idaho*

figure 2.52


figure 2.53

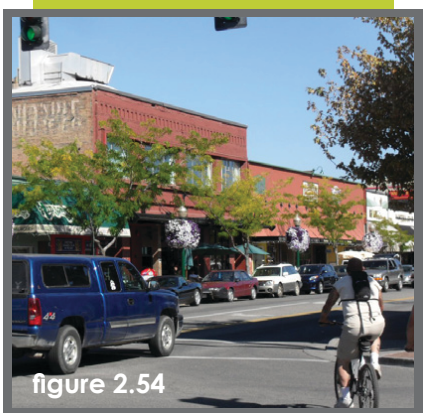


figure 2.54

All information in the Sherman Avenue development precedent study was collected or interpreted from the Coeur d'Alene Downtown Design guidelines and Comprehensive Plan (2007-2027) & Google Street imagery. The guidelines & comprehensive plan were accessed on December 4th 2010 from the city of Coeur d'Alene website. (http://www.cdaid.org/)

Background

The city of Coeur d'Alene, Idaho is located approximately 35 miles east of Spokane, Washington. The core downtown commercial district is centered on Sherman Avenue, which acts as the social and economic hub of the city. Over the past 20 years, major efforts have been made to revitalize the historic downtown. These revitalization efforts have been based around promoting an attractive mixed-use district that retains its historic character. With a focus on promoting choice in travel modes and increasing the economic stability, the city of Coeur d'Alene has successfully molded Sherman Avenue and the surrounding streets into a vibrant commercial district.

Goals

+ A downtown that functions as a multi-use center
+ Encourage choice in travel modes
+ General beautification; more green space & greenscape
+ Develop a unifying streetscape in downtown district
+ Provide for outdoor dining and display

Program Elements

+ Pedestrian friendly sidewalks
  + Wide sidewalks that allow for safe and efficient pedestrian movement

+ Beautification and streetscape improvements
  + Integrate landscape elements into the redesign street.
  + Street trees, bulbouts, and outdoor dining areas
  + Integrate lighting & seating elements into the redesigned street
  + Act as buffer from the travel lane and sidewalk

+ Incorporate informal pedestrian gathering spaces
  + Large sidewalk areas at intersections to allow for safe pedestrian crossing and informal gathering.
  + Improve pedestrian walkability & safety
  + Incorporate safety zone between travel lanes and sidewalks
  + Incorporate on-street parking egress zone into the pedestrian amenity area to increase buffer from the travel lanes.

Unique Opportunity

Many of the turn-of-the century buildings remain within the downtown of Coeur d'Alene. This aids in creating a unique sense of place while allowing non-historic streetscape elements to be integrated. This mixture of historic quality and modern amenities makes downtown Coeur d'Alene a vibrant pedestrian friendly economic hub.

Success

The Sherman Avenue & downtown redevelopment project is an example of a historic mountain community redevelopment with an emphasis on diversification and user oriented streets. By placing an emphasis on pedestrian walkability, Coeur d'Alene has increased its reputation as a exciting tourist destination. Although the integration of vegetation, lighting, and seating are typical street improvements, Coeur d'Alene successfully merged the historic character with these modern improvements. An especially innovative detail exists within the sidewalk design guidelines. Although the sidewalks vary in size, a minimum of seven feet of travel space is required. In the downtown core district, wide sidewalks allow for outdoor dining and signage while still fully accommodating safe and efficient pedestrian mobility.

Criticism

A core goal of the downtown development was to increase pedestrian comfort. Yet, short of comfortable mobility issues the street seems lacking in some aspects of pedestrian comfort. Although seating elements are placed throughout the downtown district, the elements seem spaced too widely. With minor acceptation, seating elements are within close distance to the travel lanes only at street intersections. This placement seems uncomfortable and could be revised.

Relevance

For Main Street Evolved, it may not be possible to completely preserve every aspect of the historical street. Yet by merging historic building character with a uniform design to streetscape elements, the city of Coeur d'Alene illustrates the potential for merging historic and modern design elements. With its focus on pedestrian mobility, Sherman Avenue represents the beginnings of an Evolved Main Street.

figure 2.55

figure 2.56

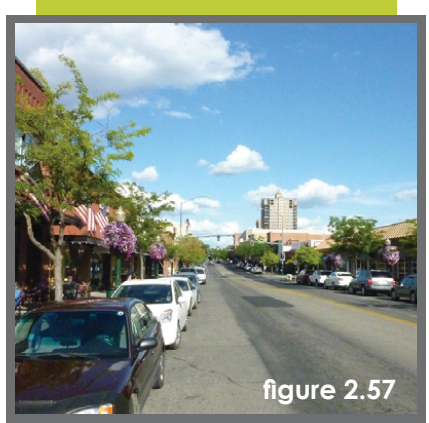
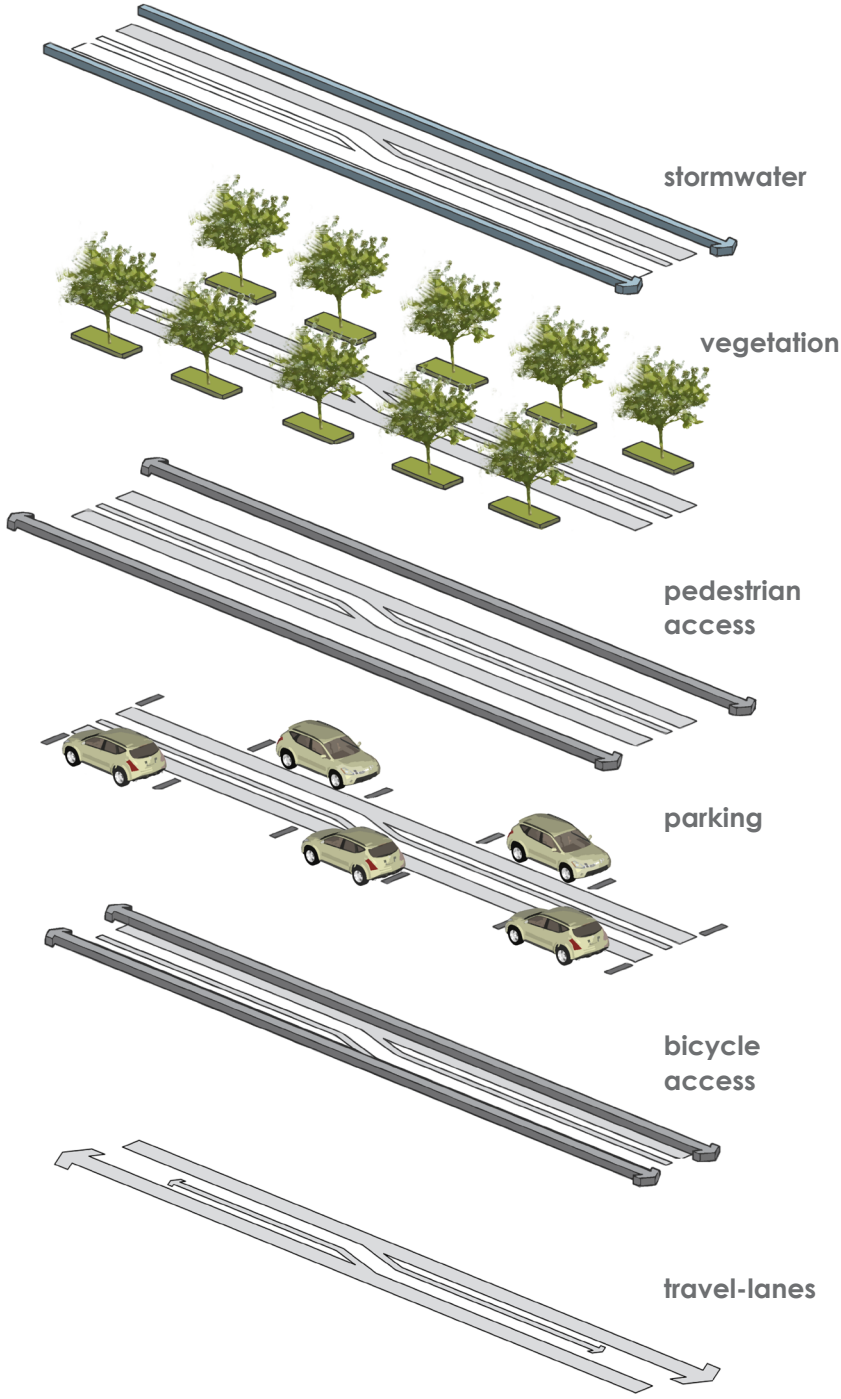


figure 2.57

mountain street development

Sherman Avenue Redevelopment Project | *Coeur d'Alene, Idaho*
Figure | 2.58 (munrer 2011)



Design Elements

+ 2 - lane road with center lane left turn lane
  + Narrow streets slow traffic and increase both vehicular and pedestrian safety
  + Ambiguous center turn lane provides efficient automobile movement

+ Well marked pedestrian crossings
  + Wide crosswalks & sidewalk bulbouts increase pedestrian visibility
  + Provide for safe pedestrian access

+ 2'-3' concrete paver parking egress zone
  + Provide for safe vehicle access
  + Buffer the pedestrian area from the travel ways

+ Wide sidewalks
  + Minimum 7 feet of clear travel space
  + Widened areas for outdoor dining and/or display
  + Sidewalk bulbouts at all intersections to increase pedestrian safety

+ Planting
  + Street trees evenly spaced at 20 -40 foot increments increase aesthetic appeal and reduce traffic speeds

mountain street development

Historic Main Street Development | *Deadwood, South Dakota*

All information for this precedent study was collected and interpreted from the "Downtown Design Guidelines" for the city of Deadwood, South Dakota. The guidelines were accessed on December 3rd 2010 from the city of Deadwood website. (http://www. cityofdeadwood.com)

Background

The city of Deadwood is located approximately 40 miles northwest of Rapid City, South Dakota and is the center of one of the most historic gold rushes in United States history. Yet, like most gold boom towns, Deadwood fell on hard times when individual mining claims collapsed. "ln November of 1989, Deadwood, South Dakota instituted limited gaming - something no other modern community had previously tried.

The ensuing building boom had many of the characteristics of a 20th century gold rush, which threatened the very historic resources whose protection gaming revenues were meant to ensure." (Community Services Collaborative 1991) In 1991, the city adopted design guidelines for its Downtown Historic District in an effort to ensure the preservation of its Historic Character.

figure 2.59

figure 2.60

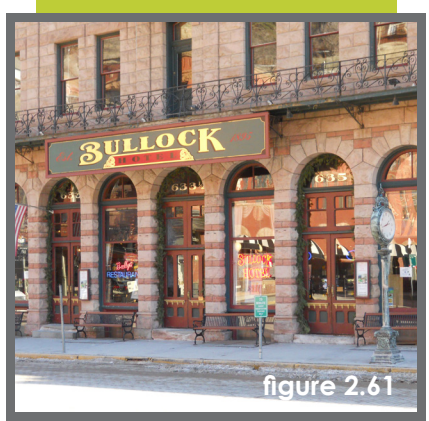


figure 2.61

Goals

+ Retain & restore historic character within the downtown district.
+ Retain existing street widths
+ Restore or mimic historic materiality
+ Removal of above ground utilities from Main Street
+ Historically appropriate unifying streetscape elements

Program Elements

+ Address building character
  + Retain existing street setback for all new development.
  + New and redeveloped building facades will use historically accurate brick, stone, or wood.

+ Address infrastructure improvements
  + Retain and restore Main Street brick paving.
  + Use local aggregate in all new concrete & asphalt to mimic historic color

+ Beautification and streetscape improvements
  + Integrate lighting & seating elements into the redesigned street
  + Uniform lighting & seating placed within the pedestrian zone
  + Implement historically accurate lighting elements, deduced from historic photos, as a unifying street element.
  + Use only cast metal or metal wire materials for all benches and trash receptacles

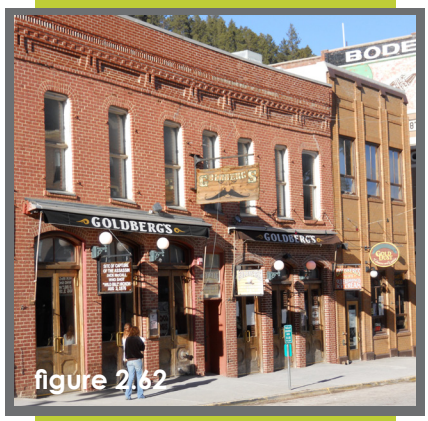


figure 2.62


figure 2.63

figure 2.64

Unique Opportunity

The well documented history of the city allowed for easy recognition of historically accurate materials and features. This allowed the city to restore many of the unique elements that made the early mining community unique. All proposed paving materials, Lighting elements, and street furniture have historically accurate aesthetics.

Success

The Deadwood Main Street redevelopment project is an example of a historic mountain community redevelopment with an emphasis on historic preservation. Although the economic gambling boom could have destroyed the lingering historic character of the downtown core, the efforts of the city have ensured its preservation. With unifying street elements, historically accurate building materials, and strict character guidelines; Main Street Deadwood has retained its rustic western appeal. The brick paving throughout the entire Main Street core gives the street an aesthetic appeal beyond that of traditional concrete.

Criticism

Like many historic mining towns, the Main Street thoroughfares were designed for function rather than pedestrian comfort or aesthetics. With its narrow focus of historic preservation, it seems as though the city of Deadwood has overlooked a major street element; vegetation. The lack of street vegetation reduces pedestrian comfort tremendously. Although the sidewalks are relatively wide and the narrow street ensures slow vehicular traffic, the lack of vegetation gives the street a harsh and callous atmosphere.

Relevance

For Main Street Evolved, the preservation of the historic character throughout the street development process should be vital for all historic communities. A uniform design to lighting, seating, and planting zones will help to unite seemingly unconnected areas of a street. The Deadwood Main Street project illustrates the single minded nature of many redevelopment efforts. Although the preservation of historic aesthetics and character is vitally important, the integration of more pedestrian comforts and vegetation would greatly increase user appeal.

mountain street development

Historic Main Street Development | *Deadwood, South Dakota*

Figure | 2.65 (munrer 2011)

Design Elements

+ Curb to curb brick paving on Main Street
  + Increases aesthetic appeal and provides historic continuity

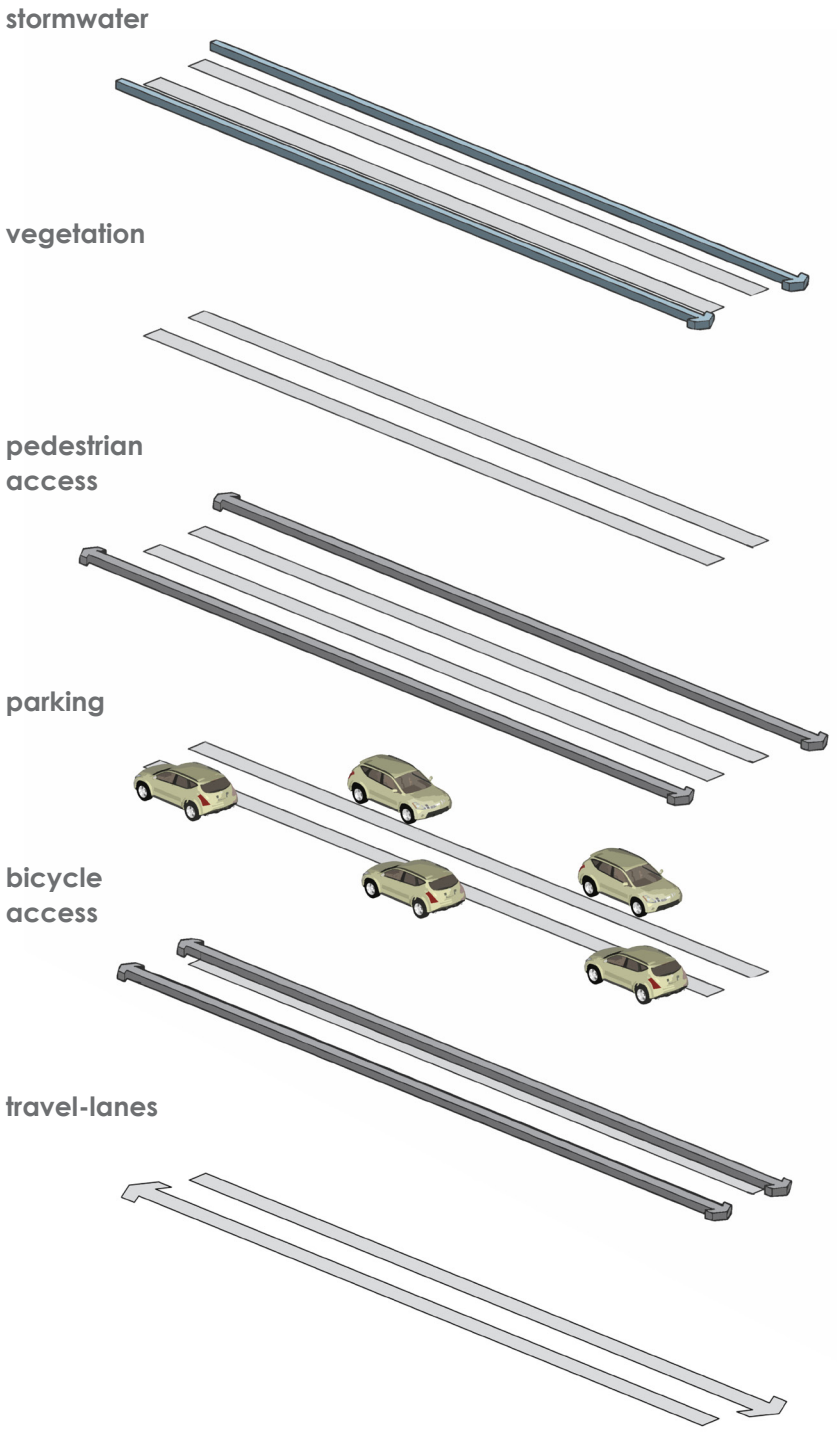
+ Narrow 2 - lane road
  + Narrow streets slow traffic and increase both vehicular and pedestrian safety
  + Limited on-street parking most commonly used for delivery & service vehicles.

+ Intersection pedestrian crossings
  + Well marked and defined pedestrian crossings at intersections
  + Slow low traffic streets allow pedestrians to cross at leisure without designated walks.

+ Wide Sidewalks
  + Provide for safe pedestrian movement & building egress
  + Well marked and defined pedestrian crossings at intersections

+ Contextually corresponding material selection
  + Historically accurate stone, brick, and wood materials used throughout the streetscape.

+ Unifying Streetscape elements
  + Evenly spaced historically accurate amenities increase aesthetic appeal and pedestrian safety.



03 compile

programmatic elements

Introduction

The goals and objectives for Main Street Evolved were developed by synthesizing the information gathered from the literature review, precedent study.

General Program Setup

Area of Consideration

Goal

Objective

+ Criteria

These goals an objectives will be used to guide the programming process.

Primary Goal

To develop a usable handbook for planners and designers that illustrates how to successfully union green infrastructure and Complete Streets in Rocky Mountain communities.

Primary Objectives

+ Create a usable key to identify critical issues related to the implementation of Main Street Evolved

+ Discover and document accepted multimodal and stormwater management strategies that will function within Rocky Mountain communities

+ Define optimum strategies for each of the defined categories.

The following goals and objectives are all based around the primary goal and objectives. The purpose of the sub-goals and objectives is to provide specifics for accomplishing the primary objectives.

The Built Environment

Design Main Streets that are directed toward a safe environment for all users and modes of transportation.

Reduce traffic velocity

+ Slender traffic lanes and ample streetscape elements narrow the field of vision, thus lowering traffic speeds.

Reduce travel-lane width

+ Minimum travel lane 11 feet, 22 foot wide road ((AASHTO 2002)

+ All auxiliary lanes should be a minimum of 10 feet, preferable equal to that of the adjacent through lanes. (AASHTO 2002)

Incorporate separated or shared bicycle lanes

+ Shared bicycle lanes, where parallel parking is present, should be a minimum of 4 to 5 feet. (AASHTO 2002)

+ Dedicated bicycle lanes, where space is available or angled parking is present, should be a minimum of 5 feet. (AASHTO 2002)

Increase accessibility for pedestrians and cyclists

+ A preferable pedestrian zone consists of a minimum 7 foot sidewalk, 3 foot egress & amenities, and a 2 foot storefront zone. (Metropolitan Service District 2002)

+ Incorporate marked mid-block crossings whenever it is prudent. "People cross mid-block when the perceived safety of intersection controls is not worth the extra walking distance." (McCann 2010)

Support/enhance the economic vitality of the Main Street

Incorporate service/delivery zones

+ Adapt or modify ancillary lanes, equal in width to the adjacent travel lanes, to be used for product delivery and service. This will allow limited on-street parking to be used by clientele.

Retain on-street parking

+ Incorporate a maximum number of on-street parking spaces to boost pedestrian/storefront access.

+ Parallel parking, with a minimum width of 7 feet, is preferable on streets with space restrictions. (AASHTO 2002)

+ Angled parking, with a width of 17 feet for sixty degree and 11 feet for forty-five degree, may be implemented on streets with adequate or excess space. (AASHTO 2002)

+ On-street parking provides a buffer between the vehicle travel ways and the pedestrian zone, thus improving pedestrian safety.

Incorporate streetscape amenities that increase comfort, safety, and unity
Unify the streetscape furnishings

+ Street furnishings are defined as any seating, litter bins, lighting elements, bicycle racks or other features incorporated to increase pedestrian comfort and safety.

+ All materials used for street furnishings should match the historic qualities of the local character

+ All street furnishing elements should be of similar style

+ Street furnishings should be placed at regular intervals and located in areas with protection from unpleasant climatic conditions

+ Street furnishing placement should be logical in arrangement to avoid clutter or obstruction from pedestrian areas.

+ All fixtures used for site lighting shall incorporate shields to minimize up-light spill and glare from the light source.

Overflow outdoor dining & display

+ Outdoor dining or display areas may one be implemented in areas where adequate space is available for adjacent pedestrian movement

+ A minimum of 5 feet of sidewalk space must be retained in all areas where dining and display is present.

The Ecological Environment

Design Main Streets that enhance the street environment, restore natural processes, and maximize tree canopy cover.

Incorporate streetscape vegetation into all street designs

+ Minimum widths for tree planters should be developed on a case by case basis, yet the minimum space needed for pedestrian flow should be between 5 and 7 feet. This results in the area for the tree planting design to be the largest size practical. (Urban 2008)

+ Vegetation planters are preferred to be a minimum of 6 foot by 6 foot. (Watson et. al. 2003)

+ Planting should be at least 2 feet from the face of the curb to allow for egress. (Metropolitan Service District 2002)

+ Space street tree planting at 1/3 mature crown width apart to maximize canopy coverage. (Metropolitan Service District 2002)

Incorporate on-street stormwater management strategies

+ Adapt or modify curb situations to allow for stormwater passage into adjacent vegetated areas.

+ Utilize & link planter areas for bio-filtration

+ Fill bio-filtration planters with even spaced plants to slow and reduce stormwater intake into the local sewer system.

+ Integrate stormwater management systems into the street aesthetic

+ If vegetation exists within the Main Street right-of-way, use same or similar species to create a unified streetscape.

+ If no planting exists, use a limited and uniform plant pallet to create uniformity.

Use native plants, hybrids, or noninvasive drought tolerant species

+ Plant selection should be based on soil type, water tolerances, and shade requirements.(Metropolitan Service District 2002)

The Contextual Environment

Adapt Main Streets that respond to the unique Rocky Mountain conditions.

Integrate/consider snow storage & management

+ Temporary snow storage may be places in on-street parking areas or ancillary lanes

+ In specific stormwater BMP's, snow storage may be integrated to reduce removal necessity

Use plants that can withstand periods of wet & dry conditions without supplemental irrigation

+ The Colorado climate conditions require plants that can survive long periods of low moisture with periodic saturation

+ Although native vegetation would be ideal, hybrids and noninvasive plants that meet the aforementioned moisture requirements may be substituted if better suited for a "Street" condition.

Specify adaptations that respond to unique street topography

+ Placement of stormwater management facilities depends upon the street topography

Use regional materials that "fit" the local street character

+ Match selected materials with existing historic character.

04 investigate

inventory & analysis

Introduction

To effectively fabricate design and implementation strategies for executing Main Street Evolved in Rocky Mountain communities, an understanding of the existing conditions within Rocky Mountain Main Streets is critical. Within the context of the development process, the site inventory and analysis represents foundational elements that will tie the design and implementation strategies specifically to the Rocky Mountain context.

In order to understand how best to execute Main Street Evolved across the broad spectrum of communities within the Rocky Mountain west, it is critical to understand the various physical, ecological, and climatic factors of the region. The inventory and analysis phase outlined in this section describes the process I took to better understand the physical, ecological, and climatic factors of Rocky Mountain communities.

This section begins by describing the process I used to narrow the scope of Rocky Mountain communities down into a "representative" list. It then describes the process I used to collect, categorize, and analyze the physical, ecological, and climatic factors of the representative main streets. A synthesis of the inventory and analysis information is then presented in the form of an Evolved Feature Key found in chapter 05, develop.

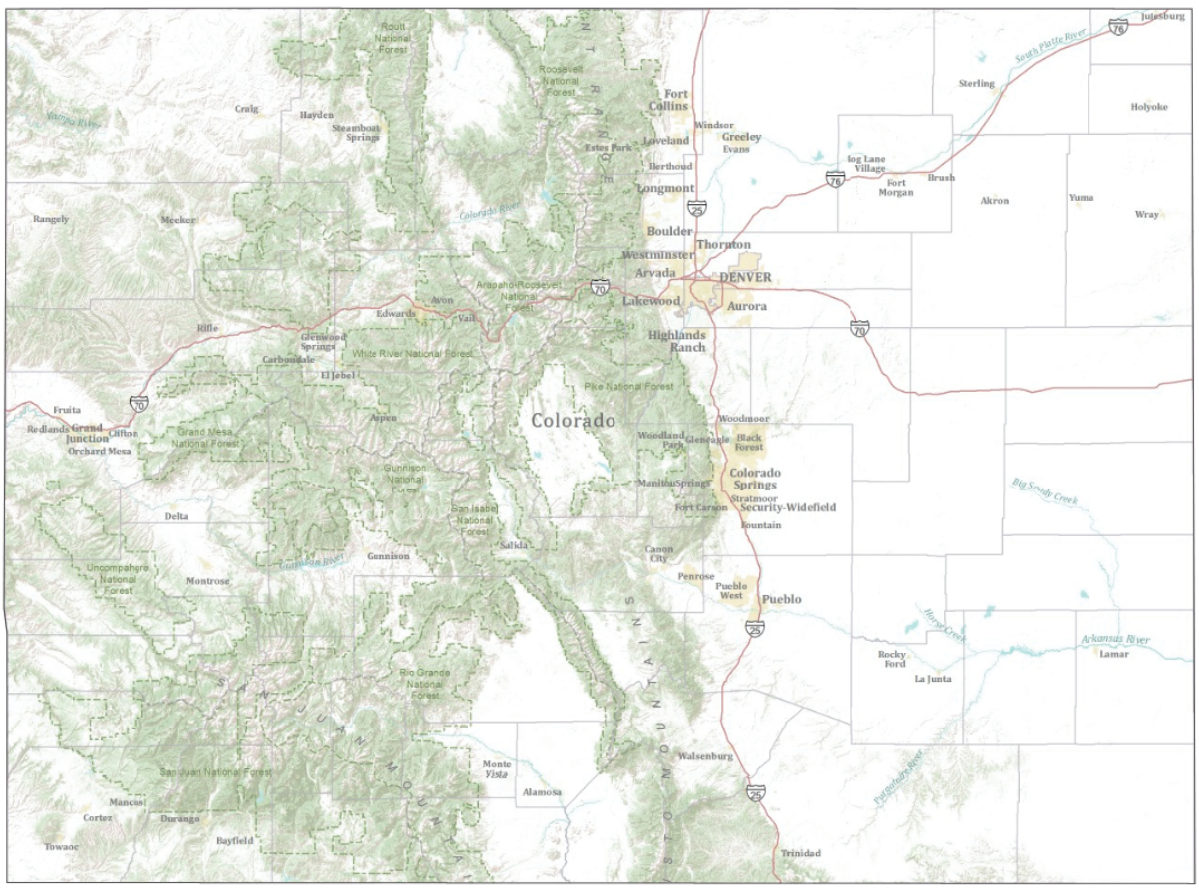


figure 4.1 Colorado base map (adapted from: ArcGis Explorer 2010)

In order to analyze Rocky Mountain communities and their potential for implementing Main Street Evolved, I needed to compile a list of representative communities and their attributes. I broke this process into six basic stages:

+ State
+ Topographic Context
+ County
+ Population
+ Well Defined "Main Street"
+ Regional Distribution

State

I selected Colorado as it represents the historical "center" of the Rocky Mountain gold rush, and as such contains a wide variety of communities that were settled over the course of the fifty-year gold rush. (Smith 2009) Although it would be ideal to consider every Rocky Mountain community throughout the western United States, time constraints and practicality issues restricted the area-of-interest to a smaller region. With this in mind, I only considered communities within the state of Colorado for investigation.

Topographic Context

The purpose of this study is to discover how best to integrate Main Street Evolved in a mountainous context. As such, the next logical step was to select only Colorado communities within a mountainous environment. Topographic maps were analyzed to select portions of the state that are mountainous. Any communities situated east of I-25 and in the San Luis Valley have relatively level topography and can be considered part of the Plains biome. Thus, I only selected communities in the mountainous areas west of these regions. Figure 4.2

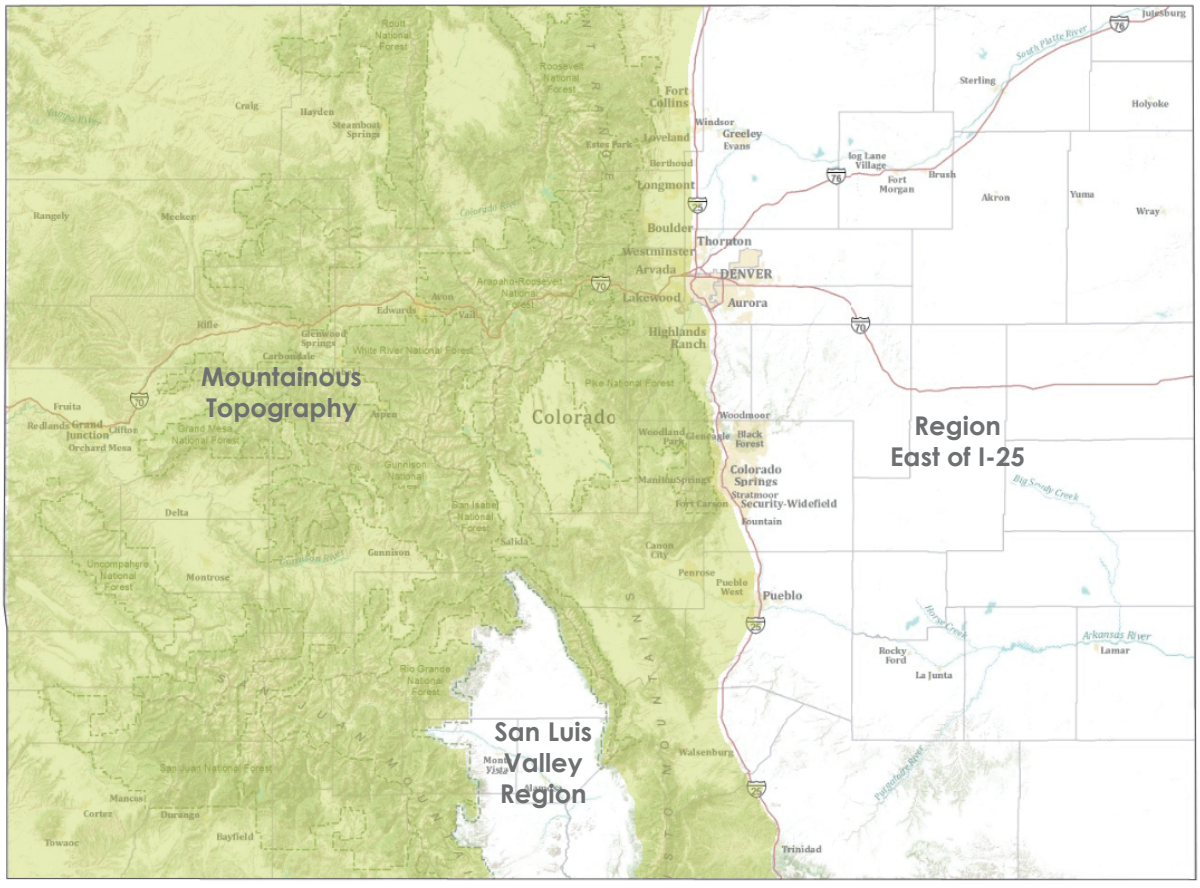


figure 4.2 Colorado topographic breakdown (adapted from: ArcGis Explorer 2010)

County

To gain an accurate understanding of which communities were affected by the topographic context selection process, the next logical step was to transfer the topographic region map onto a Colorado counties map. Figure 4.3

Next, a list of Colorado communities sorted by county was obtained and those that fell within the defined "mountainous" regions were selected for further consideration.

Population

The next step was to define a maximum population that would represent a "Small Community".

The state of Colorado Department of Local Affairs administers various state sponsored downtown development programs; one such program is the "Community Restoration Partnership (CRP)." The purpose of CRP is to assist communities in understanding, and moving into the implementation of a main street redevelopment project. As a caveat, the CRP program is for "communities under 20,000 in population that have not been designated Colorado Main Street communities."(Colorado Department of Local Affairs)

With this in mind, small communities for Main Street Evolved can be defined as having under 20,000 in population. This will allow Main Street Evolved to be related to existing state sponsored redevelopment programs. From the list of available communities, any city with a population fewer than 20,000 were selected for further consideration.

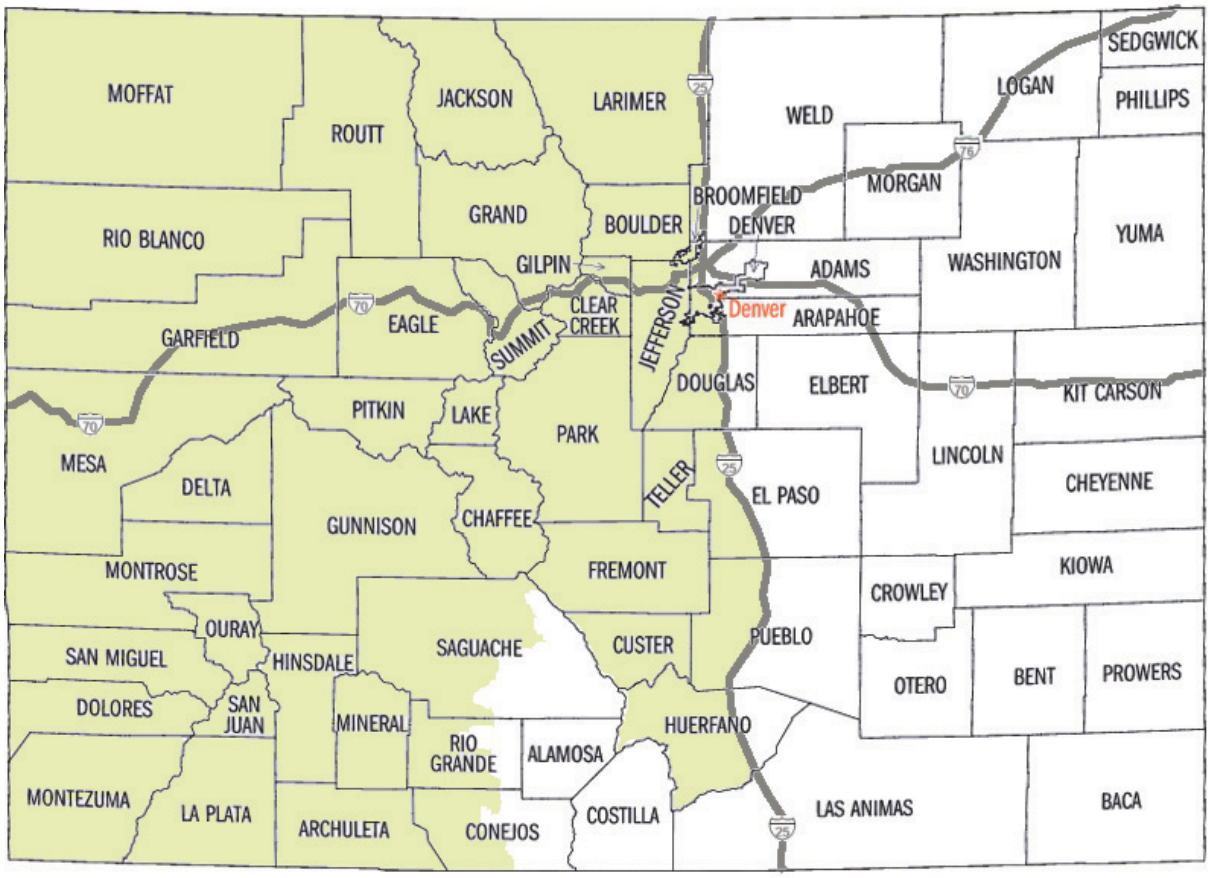


figure 4.3 Colorado county breakdown (adapted from: Land Trust Alliance 2010)

figure 4.4 well defined Main Street
(adapted from: Google 2010)

figure 4.5 poorly defined Main Street
(adapted from: Google 2010)

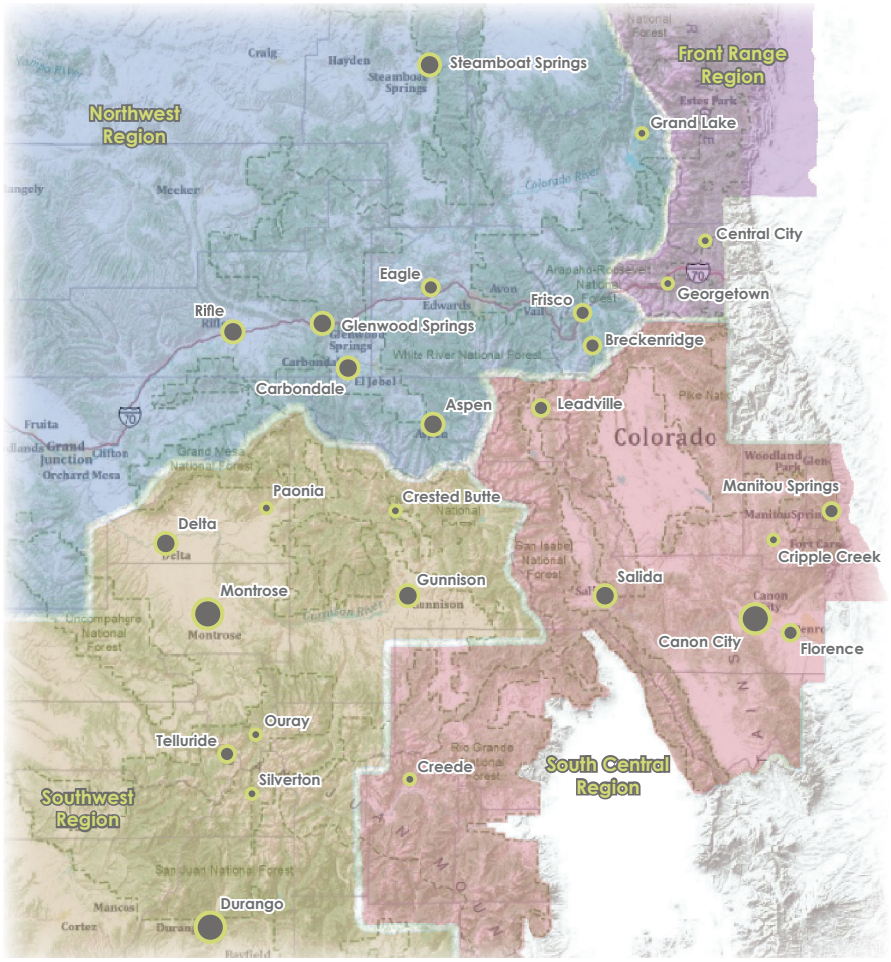


figure 4.6 Colorado Regional Distribution
(adapted from: ArcGis & Colorado Tourism 2010)

Well defined "Main Street"

At this stage, the list of possible communities had been narrowed down to a possible one hundred and fifty-eight cities. The next selection was based on "Main Street" definition. The area of focus for Main Street Evolved is defined as the commercial core of a community.

All communities that were considered have well defined Main Streets that are almost fully fronted by buildings on both sides of the street. To understand which of the remaining one hundred and fifty-eight communities had well defined Main Streets, I used street photography to analyze the selected communities and define each "Main Street". An example of this analysis is shown in Figure 4.4 & 4.5

Regional Distribution

Once the sample community list was selected, the next step was to ensure that there was a reasonable distribution of communities across the state. To achieve this reasonable distribution the remaining counties were grouped by region.

The remaining communities fell into the; Front Range, Northwest, Southwest, and South Central regions.

The final community list was mapped and overlaid on the regions to ensure every region was represented. Figure 4.6

This breakdown resulted in a final representative list of twenty-eight (28) communities. Table 4.1

Main Street Evolved | *representative communities*

critical features & information

City	County	Pop.	Main Street	Region	ROW	Travel Lanes	Parking	Pedestrian Zone	Street Orientation	Elevation (ft)	Ave. Snowfall (in)	Ave. Precip (in)
Aspen	Pitkin County	5914	Main St.	Northwest	95	4	Parallel	Average	NW	7,908	137.5	19.4
Breckenridge	Summit County	2408	Main St.	Northwest	70	2	Parallel	Narrow	NS	9,603	162.2	19.4
Canon City	Fremont County	15431	Main St.	South Central	100	3	Angled	Average	NE	5,332	36.5	12.8
Carbondale	Garfield County	5196	Main St.	Northwest	60	2	Parallel	Narrow	EW	6,181	50.7	20.6
Central City	Gilpin County	515	Main St.	Front Range	40	1	Parallel	Narrow	NS	8,496	77	15
Creede	Mineral County	377	Main St.	South Central	50	2	Parallel	Narrow	NS	8,852	46.8	13.4
Crested Butte	Gunnison County	1529	Elk Ave.	Southwest	60	2	Parallel	Average	EW	8,885	197.2	23.5
Cripple Creek	Teller County	1115	Bennett Ave.	South Central	70	2	Parallel	Average	EW	9,494	36.6	14.7
Delta	Delta County	6400	Main St.	Southwest	100	5	Parallel	Average	NS	4,961	14.9	7.9
Durango	La Plata County	13922	Main Ave.	Southwest	75	4	Parallel	Average	NE	6,512	68.8	19.1
Eagle	Eagle County	3032	Broadway St.	Northwest	80	2	Angled	Average	NS	6,600	47.7	10.6
Florence	Fremont County	3653	Main St.	South Central	80	2	Angled	Average	NW	5,187	18.4	11.9
Frisco	Summit County	2443	Main St.	Northwest	90	2	Mixed	Average	NE	9,097	127.7	16.1
Georgetown	Clear Creek County	1088	6th St.	Front Range	45	1	Parallel	Average	NW	8,519	90.3	16.1
Glenwood Springs	Garfield County	7736	Grand Ave.	Northwest	100	5	Parallel	Average	NS	5,746	50.7	20.6
Grand Lake	Grand County	447	Grand Ave.	Northwest	80	2	Parallel	Average	NW	8,369	144.3	20.2
Gunnison	Gunnison County	5409	Main St.	Southwest	100	5	Parallel	Wide	NS	7,703	50.6	10.4
Idaho Springs	Clear Creek County	1889	Miner St.	Front Range	50	2	Parallel	Narrow	EW	7,540	77	15
Leadville	Lake County	2821	Harrison Ave.	South Central	80	4	Parallel	Average	NW	10,152	117.5	15.7
Manitou Springs	El Paso County	4980	Manitou Ave.	South Central	80	3	Parallel	Average	NW	6,412	141.2	14
Montrose	Montrose County	12344	Main St.	Southwest	95	5	Parallel	Average	NE	5,794	10.4	8.8
Ouray	Ouray County	813	3rd. St	Southwest	100	3	Mixed	Average	NS	7,706	138.6	22.8
Paonia	Delta County	1497	Grand Ave.	Southwest	80	2	Angled	Average	NS	5,674	52.8	14
Rifle	Garfield County	6784	3rd St	Northwest	80	2	Angled	Average	EW	5,345	38.6	11.6
Salida	Chaffee County	5504	F St	South Central	55	2	Parallel	Average	NE	7,036	48.3	10.2
Silverton	San Juan County	531	Green St.	Southwest	100	2	Angled	Average	NE	9,318	154.4	24.4
Steamboat Springs	Routt County	9815	Lincoln Ave.	Northwest	100	5	Parallel	Wide	NW	6,695	165.6	23.8
Telluride	San Miguel County	2221	Colorado Ave.	Southwest	75	3	Parallel	Narrow	NW	8,750	170.2	23.2

table 4.1 representative communities | *critical features & information* (Murner 2010)

figure 4.7 development estimation (adapted from: Google 2010)

figure 4.8 Main Street estimation (adapted from: Google 2010)

figure 4.9 Community estimation (Murner 2010)

Main Street **Evolved** | *representative communities*

development patterns & street orientation

figure 4.10 development patterns & Main Street orientation (Murner 2010)

Once a representative community list was defined, I collected specific physical, ecological, and climatic characteristics of each Main Streets. This phase of the site inventory and analysis process can be broken into two major sections; the built environment and the ecological/contextual environment.

The elements within each section represent the process used to collect and categorize the detailed information associated with the built, ecological, and climatic factors of the representative main streets.

Once categorized, I then assessed the information based on the impacts of each street feature, the relationship to Main Street Evolved, and possible concessions related to future adaptation.

The Built Environment

The critical features addressed under the built environment are:

+ Right-Of-Way
+ Travel Lanes
+ Parking Orientation
+ Pedestrian Zone
+ Street Orientation
+ Street Topography

Right-of-Way

I define the right-of-way as the entire area of the street from building face to building face. The purpose of the right-of-way is to support and facilitate all modes of travel and their movements, recreational activity, and social interactions. Yet, the width of the right-of-way plays a major role on the functions and elements within.

The street right-of-way represents the primary bounding element of the main street. The available space from building front to building front is one element that cannot be changed. With this in mind, all modifications, adaptations, and strategies must occur within this defined space.

Obtained from Google Earth, I used aerial imagery used to calculate the distance from building face to building face. Although this does not represent the actual right of way distance, it does represent a fair estimation for categorization. The estimation was based on aerial imagery from Google Earth. Figure 4.11

Once the data was collected, the representative main streets were categorized into three groups;
Narrow, Average, and Wide.

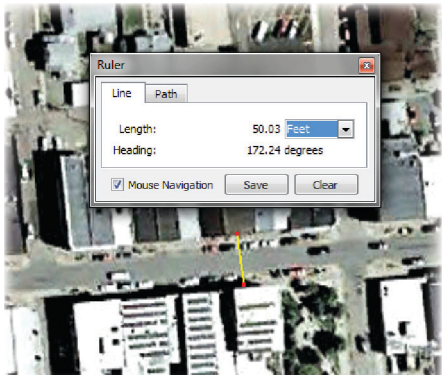


Figure 4.11 right-of-way estimation (Murner 2010)

Narrow Rights-of-Way

For this report, I define a narrow right-of-way as any Main Street with less than sixty-five feet (65') of space from building face to building face. In a general sense, "narrow" Rights-of-Way consist of:

+ One to two travel lanes twelve (12) feet or less
+ Two pedestrian zones of ten (10) feet or less
+ Approximately Ten (10) foot parallel parking areas
    + Total maximum "narrow" street right-of-way sixty-four feet (64')

Assessment

Narrow Rights-of-Way have very limited space and because of this, some concessions will be required to fully accommodate the mobility needs of pedestrians, bicycles, and the automobile along with the spatial requirements for vegetated stormwater management. Figure 4.12

Average Rights-of-Way

For this report, I define an average right-of-way as any Main Street with between sixty-five (65) to ninety (90) feet of space from building face to building face. In a general sense, "average" Rights-of-Way consist of:

+ Two to three travel lanes twelve (12) feet or less
+ Two pedestrian zones of ten (10) feet or less
+ Approximately Ten (10) foot parallel parking areas or seventeen (17) foot angled parking areas
    + Total maximum "average" street right-of-way ninety feet (90')

Assessment

An average right-of-way represents the predominant situation for Rocky Mountain Main Streets. Although space is not constrained, to fully accommodate mobility needs and spatial requirements associated with Main Street Evolved; some adaptations will be required. Figure 4.13

Wide Rights-of-Way

For this report, I define a wide right-of-way as any Main Street over ninety (90) feet of space from building face to building face. In a general sense, "wide" Rights-of-Way consist of:

+ Two to five travel lanes over ten (12) feet wide
+ Two pedestrian zones over seven (7) feet wide
+ Approximately Ten (10) foot parallel parking areas or seventeen (17) foot angled parking areas
    + Total minimum "wide" street right-of-way ninety feet (90')

Assessment

Wide Rights-of-Way have ample space and as such do not have the same mobility and spatial issues associated with narrow and average Rights-of-Way. Yet, the excess space brings with it issues related to safe pedestrian access. Wide streets can act as barriers for pedestrians and should be adapted for safe crossing. Figure 4.14

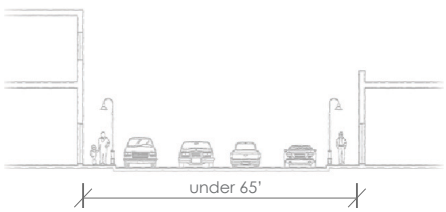


figure 4.12 narrow right-of-way (Murner 2010)

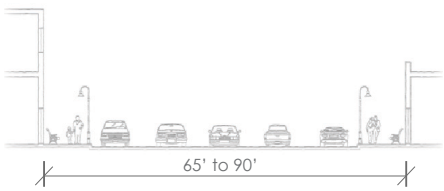


figure 4.13 average right-of-way (Murner 2010)

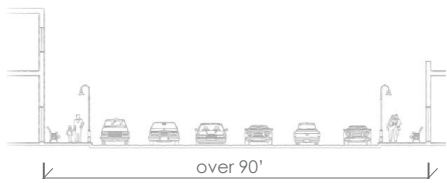


figure 4.14 wide right-of-way (Murner 2010)

built, ecological, & climatic

Travel-lanes

Although the travel lanes may seem to be one of the most established elements of the travel-way, they also represent one of the most distinctive opportunities for change and expansion. The narrowing, removal, or transformation of travel-lanes can provide an opportunity for space making.

I used street imagery from Google Earth Street View to calculate the number of travel lanes. All vehicle travel, turning, and loading lanes were inventoried under the travel-lane moniker.

Once the data was collected, the representative main streets were categorized into 5 groups; one-lane, two-lane, three-lane, four-lane, and five-lane streets.

One-Lane Streets

Typically found in extremely narrow Rights-of-Way, one-lane streets represent a difficult situation for Main Street Evolved.

Assessment

The single lane, even if narrowed, may not provide enough space to safely incorporate a dedicated bicycle lane or widen an adjacent pedestrian zone. Other areas of the street will need to be adapted or concession must be made.

Two-Lane Streets

Two-lane main streets can be found in any right-of-way situation across the Colorado Rockies.

Assessment

Due to the ambiguous setting, situating multi-modal zones and vegetated stormwater facilities may be an effortless or challenging process, depending on right-of-way width.

Three-Lane Streets

Three-lane Main Streets are typically found in communities with average to wide Rights-of-Way.

Assessment

With some adaptation, these streets have at least a noteworthy opportunity for integration of multi-modal and vegetated stormwater facilities with minimal adaptation.

Four-Lane Streets

Four-lane Main Streets typically occur in communities with average Rights-of-Way.

Assessment

Four travel-lanes and average Rights-of-Way create streets that have a great opportunity for the integration of multi-modal and vegetated stormwater facilities if narrowed.

Five-Lane Streets | *Assessment*

Five -lane Main Streets are typically only found in communities with wide-Rights-of-Way.

Assessment

Due to the traffic needs of the community, it may not be possible to reduce or narrow the lanes.

Parking Orientation

Although on-street parking is often only considered as an economic benefit, it also offers an opportunity for adaptation. The change in width or orientation of street parking may provide an opportunity for space making.

I used street imagery from Google Earth Street View to tabulate parking orientation.

Once the data was collected, the representative main streets were categorized into 3 groups; parallel, angled, and mixed

Parallel Parking | *Assessment*

The typical orientation found with the representative communities, parallel parking orientation allows on-street parking within a narrow right-of-way. Already the narrowest parking orientation, parallel parking situations may not be able to provide extra space unless spaces are removed.

Angled Parking | *Assessment*

Angled parking requires the most space of any single element within a street right-of-way and as such should be adapted in narrow situation. Yet, angled parking allows for maximum parking density, so specific community needs should be taken into consideration.

Mixed | *Assessment*

Mixed on-street parking may provide an unfair economic advantage to one side of the street. Yet, it also provides a preferable increase of parking density while still reducing street width.

Pedestrian Zone

I define the pedestrian zone as the total space from the curb to the building face. This includes all sidewalks, planters, and street furniture areas. The pedestrian zone effects how users move and rest within the street. An adequate pedestrian zone is composed of streetscape, sidewalk, and frontage zones. If all three zones do not exist with a streets right-of-way, adaptations should be made to ensure safe and comfortable pedestrian use.

I used street imagery from Google Earth Street View to estimate the width of main street pedestrian zones. This visual Assessment is subjective, but estimation was the key objective.

Once the data was collected, the representative main streets were categorized into 3 groups; narrow, average, and wide.
figure 4.15

Narrow Pedestrian Zones

Narrow pedestrian zones, described as having less than seven (7) feet of space from building face to curb, are usually composed of only the sidewalk zone.

Assessment

Narrow pedestrian zones are extremely constrained and do not have enough space to fully accommodate all forms of pedestrian activity. Narrow zones may need to be expanded for Main Street Evolved

Average Pedestrian Zones

The average pedestrian zone, described as any pedestrian zone with between seven (7) and ten (10) feet of distance from building face to curb, are typically composed of a sidewalk zone and streetscape zone.

Assessment

Average pedestrian zones usually have enough space for pedestrian access, vehicle egress, and amenities. Yet, typically do not have enough space for window-shopping.

Wide Pedestrian Zones

A wide pedestrian zone, described as any pedestrian zone with over ten (10) feet of space between the building face and curb, are typically composed of all three sub-zones.

Assessment

Wide pedestrian zones usually have enough space for all pedestrian activity yet may need expansion for stormwater management.

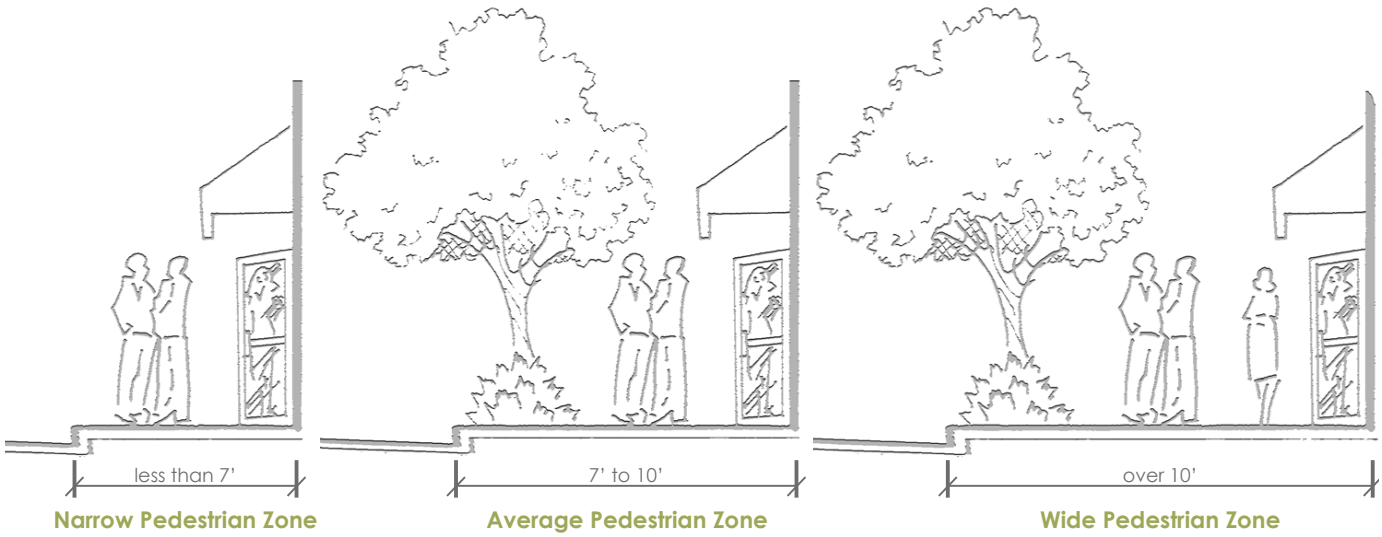


figure 4.15 pedestrian zone delineation (Murner 2010)

built, ecological, & climatic

Street Orientation

Street orientation effects the amount and duration of sunlight that reaches the main street. This has implications to vegetation growth, pedestrian comfort, and snow melt.

Street orientation was collected based on aerial imagery from Google Earth. The generalized development area and commercial core blocks were deduced based on building density, then both were mapped over the top of the aerial imagery. Figure 4.10

Once the data was collected, the representative main streets were categorized into 4 groups; N/S, E/W, NE/SW, and NW/SE

To understand the effect that street orientation plays on the amount of sun that reaches a street, see the sun/shade diagrams.

N/S

N/S refers to any community North/South main street orientation. Figure 4.16

Assessment

Streets with a North/South orientation allow sun to reach both sides of the street throughout the year and as such represent the ideal situation. Although winter conditions will still effect vegetation growth, snow storage can be ambiguous.

E/W

E/W refers to any community East/West main street orientation. Figure 4.17

Assessment

Streets with an East/West orientation only allow direct sunlight to the north side of the street. This orientation results in snow melt & vegetation damage issues during the winter months.

NE/SW

NE/SW refers to any community Northeast / Southwest main street orientation.. Figure 4.18

Assessment

Streets with a Northeast/Southwest orientation allow direct morning sunlight to both sides of the street and limited afternoon exposure on the eastern side of the street. With this in mind, winter snow storage should be focused on the eastern side of the street.

NW/SE

NW/SE refers to any community Northwest / Southeast main street orientation . Figure 4.19

Assessment

Streets with a Northwest/Southeast orientation allow direct afternoon sunlight to both sides of the street and limited morning sunlight on the western side of the street. With this in mind, winter snow storage should be focused on the western side of the street.

figure 4.16 N/S diagram (Murner 2010)

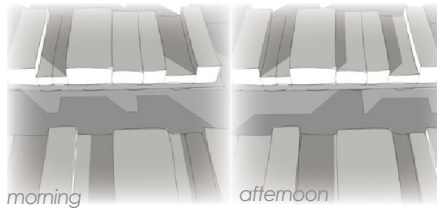


figure 4.17 E/W diagram (Murner 2010)

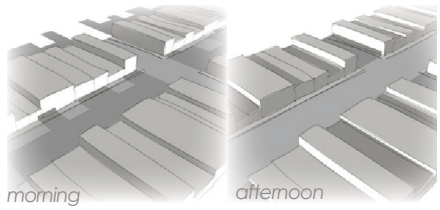


figure 4.18 NE/SW diagram (Murner 2010)

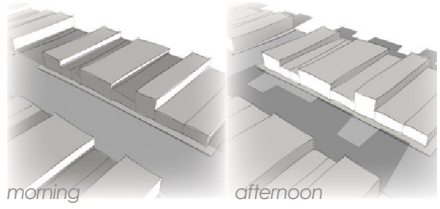


figure 4.19 NW/SE diagram (Murner 2010)

Figure 4.20 level Main Street topography (Murner 2010)

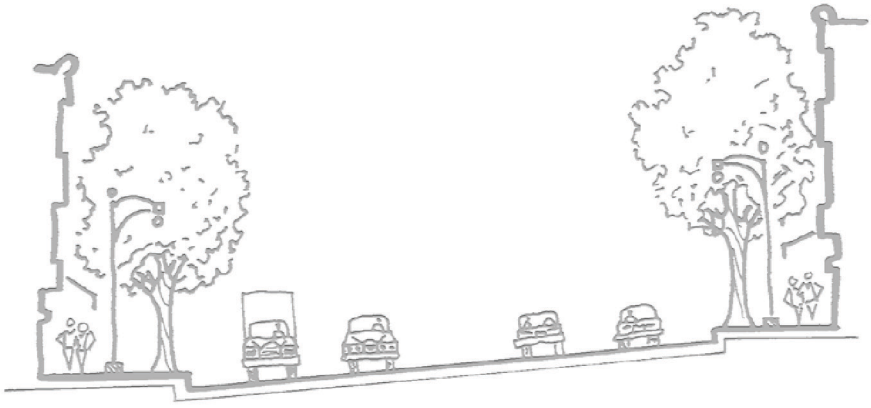


Figure 4.21 profile slope Main Street topography (Murner 2010)

Figure 4.22 cross-section slope Main Street topography (Murner 2010)

General Street topography

The topography of a street effects the overall drainage patterns of the urban area. Depending on the slope severity and orientation, specific stormwater management placement will vary.

Once the data was collected from Google Earth, the representative main streets were categorized into 3 groups; level, profile slope, and cross-section slope.

Level Slope | *Assessment*

Streets with a level topography are those with no significant cross or profile slope. Streets with level topography drain evenly to both sides of the street and will require an even distribution of stormwater management facilities on both sides of the street. Figure 4.20

Profile Slope | *Assessment*

Streets with a profile slope are those with significant grade change over the complete length of a street. Streets with a profile slope also drain evenly to both sides of the street, yet stormwater intensity is far greater. This will require reduction of water intensity prior to its entry into the management facility. Figure 4.21

Cross-Section Slope | *Assessment*

Streets with a cross-section slope are those with significant grade change over the breadth of the right-of-way. Streets with a cross-section slop drain to one side of the street and will require stormwater management facilities to be focused on the down slope side. This could give an "uneven" look to the street. Figure 4.22

The Ecological Street and Climatic Environments

The critical features that will be addressed under the ecological and climatic street are:

+ Elevation
+ Vegetation
+ Precipitation
+ Snowfall

Elevation

The elevation at which the community sits has implications toward the vegetation that can be planted. An understanding of the mountain ecosystem classification and the typical plant life within each will aid in selecting suitable plants.

Community elevation was collected in an effort to understand the type of native vegetation that exists in the region.

Once the data was collected, the representative main streets were categorized into 3 groups based on the National Park Service ecosystem classification;Foothills, Montane, and Sub-Alpine. Figure 4.23

Foothills

Any representative community blow 7,000' in elevation and consist of low evaluation scrubland. For a list of typical vegetation found within the U.S. Rocky Mountain Foothills, see Table 4.2

Montane

Any representative community between 7,000' and 9,500' in elevation and consist of mid-elevation forests. For a list of typical vegetation found within the U.S. Rocky Mountain Montane forest, see Table 4.2

Sub-Alpine

Any representative community over 9,500' in elevation and consist of high-elevation forests. For a list of typical vegetation found within the U.S. Rocky Mountain Sub-Alpine forests, see Table 4.2

Assessment

Although it may not be possible to use only native vegetation, plants that naturally occur in the climatic context should be implemented.

Native Vegetation	
Common Name	**Latin Name**
Foothills Zone	
Blue grama	*Bouteloua gracilis*
Indian ricegrass	*Oryzopsis hymenoides*
Gumweed	*Grindelia spp.*
Golden-aster	*Heterotheca Villosa*
Two-needle pi`non pine	*Pinus edulis*
Apache plume	*Fallugia paradoxa*
Rabbitbush	*Chrysothamnus nauseosus*
Antelopebrush	*Purshia tridentata*
Grambel's oak	*Quercus gamelii*
Mountian mahogany	*Cercocarpus montanus*
Skunkbush	*Rhus trilobata*
Montane Zone	
Prairie rose	*Rosa woodsii*
Squaw current	*Ribes cereum*
Mountian muhly	*Muhlenbergia montana*
Timber oatgrass	*Danthonia intermedia*
Red osier dogwood	*Cornus sericea*
Rocky Mountain ninebark	*Physocarpus monogynus*
Common juniper	*Juniperus communis*
Douglas-fir	*Psuudotsuga menziesii*
Lodgepole pine	*Pinus contorta*
Trembling aspen	*Populus tremuloides*
Ponderosa pine	*Pinus ponderosa*
Limber pine	*Pinus flexilis*
Sub-Alpine Zone	
One-flowered wintergreen	*Moneses uniflora*
Yellow columbine	*Aquilegia flavescens*
Cinquefolia	*Pentaphylloides floribunda*
Snowbrush	*Ceanothus velutinus*
Grouseberry	*Vaccinium scoparium*
Black elderberry	*Sambucus racemosa*

table 4.2 common native vegetation (adapted from Kershaw 1998)

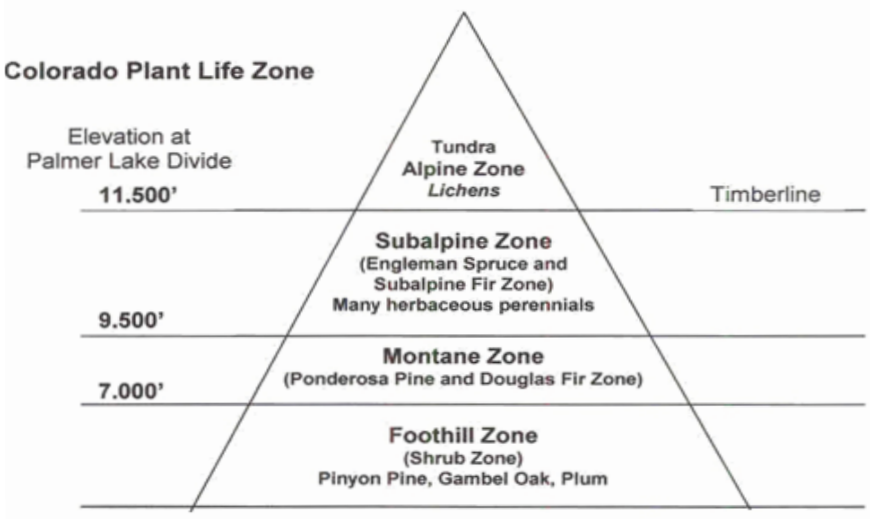


figure 4.23 mountain ecosystem breakdown (Whiting et al. 2009)

Snowfall

Although it may be overlooked in other areas across the country, the average annual snowfall within many Colorado communities is a vital issue. How snow is managed within a street depends on the amount that typically falls in a year.

All snowfall & precipitation averages were attained from (Fast Forward 2010)

The average snowfall for each of the representative communities was collected and categorized in an effort to understand the amount of snow that must be managed by Rectified Main streets.

Once the data was collected, the representative main streets were categorized into 4 groups; nominal, nuisance, hindrance, and excessive.

Nominal

Communities within nominal category receive less than 25 inches of average snowfall a year.

Assessment
Although not negligible, Nominal snowfall may be removed or piled with little effect.

Nuisance

Communities within the nuisance category receive between 25 and 50 inches of snowfall a year.

Assessment
Snowfall between 25 and 50 inches a year may be piled, but could reduce on-street parking or ordinary vehicle flow. Removal may be necessary.

Hindrance

Communities within the nuisance category receive between 50 and 100 inches of snowfall a year.

Assessment
Snowfall between 50 and 100 inches will most likely be piled for a short time, but removal will be necessary if melting does not occur.

Excessive

Communities within the excessive category receive over 100 inches of snowfall a year.

Assessment
Snowfall over 100 inches a year will require removal and unique storage consideration.

Precipitation

The average amount of precipitation within the state of Colorado is twenty-five inches a year. This places the state in a semi-Arid climate.

To understand the amount of rainfall to be managed and the type of vegetation that may be implemented without supplemental irrigation, the average annual precipitation was collected for each representative community and categorized into four categories; semi-arid dry, semi-arid, and semi-arid wet.

Precipitation categories are based on the typical "semi-arid" climate of Colorado. Wet and Dry conditions are representative compared to a typical semi-arid rainfall condition.

Semi-Arid "Dry"

Communities within the dry category receive less than ten (10) inches of rainfall on an average year.

Semi-Arid

Communities within the semi-arid category receive between ten (10) and twenty (20) inches of rainfall on an average year.

Semi-Arid "Wet"

Communities within the wet category receive over twenty (20) inches of rainfall on an average year.

Assessment
Although some communities may receive more or less than the typical semi-arid amount, all situations will require supplemental irrigation to sustain plant life.

summary of findings

The first portion of the Main Street Evolved project focused on researching the current state of street design and documenting the existing condition of Main Streets in the Colorado Rockies. An in-depth look at modern literature and design efforts led me to an adequate understanding of the current trends and implementation principles associated with the fields of Complete Streets, green infrastructure and contextual design. The research started with a literature review, which provided an understanding of the recent movements, strategies, and goals used by designers, planners, and communities across the country when considering multi-modal, ecological, and cultural design strategies.

The second step in the research portion of the project consisted of a series of nine precedent studies that I separated into 3 categories; the ecological environment, the built environment, and the contextual environment. The ecological environment precedent studies focus on projects that incorporated green infrastructure into the street design. The built environment precedent studies focus on projects that incorporated various multi-modal, traffic calming, and general Complete Street principles. The contextual environment precedent studies focus on mountain street redevelopment projects to gain an understanding of the current state of street development within a mountainous context. The completion of the precedent studies led me to an understanding of the real world application techniques of the principles I discovered in the literature review.

In the final step of the research portion, I investigated the context for Main Street Evolved. Although ideally I would have considered every community across the Rocky Mountains, due to time and resource limitations, I selected a list of communities that represent small mountain communities across the Colorado Rockies. I began the selection process with the entire state of Colorado and then selected communities based on topographic context, county, population, street definition, and region. This process resulted in a list of twenty-eight communities that serves as the projects representative group. Next, I systematically inventoried and analyzed each community based on nine critical features of their respective Main Street. The nine critical features for each community inventoried and analyzed include;

- Right-of-way Distance
- Number of Travel Lanes
- Parking Orientation
- Sidewalk Width
- Street Orientation
- General Street Topography
- Elevation
- Average Annual Snowfall
- Average Annual Precipitation

This inventory and analysis portion of the project provided me with an in-depth understanding of the basic makeup of Rocky Mountain main streets and the range of scenarios that exist. The original goal of Main Street Evolved was to categorize the representative communities into typologies. Yet after the inventory and analysis investigation, I determined that due to the vast difference between each street, generalizing entire streets into typologies would have been extremely difficult and in some respects dangerous in terms of overgeneralization. Upon further investigation, I decided that a categorization of the critical features would allow me to analyze and provide guidelines for each feature, then assemble the features into a comprehensive and holistic street design.

Once I inventoried, assessed, and categorized the critical features for each of the representative communities; I assembled them into the Main Street Evolved Feature Key. The purpose of the key is to provide an efficient means of discovering and codifying a community's Main Street features. Once the designer/planner obtains the streets code, it can be referenced to specific guidelines and strategies for developing an Evolved Main Street.

In an over-arching sense, the research portion of the project provided me with an understanding of the current issues and application techniques related to a variety of street design philosophies. After I attained this basic understanding, it was next important to obtain an understanding of the existing conditions present within the context of small Colorado Rocky Mountain communities. These two portions of the research allowed me to understand what guidelines to address, the issues related to the application of the guidelines, and some critical considerations of applying the guidelines in a Rocky Mountain context.

The second section of this document addresses the specific issues, procedure, and the application process for implementing Main Street Evolved. This "Method" section explains how a design/planner would use the Main Street Evolved process to create and compare design alternatives for a street. In order to illustrate what the Main Street Evolved process might look like, I demonstrate how the framework is applied by developing a series of schematic designs for the city of Rifle, Colorado. These schematic designs represent examples of what the process would be like for a designer/planer to implement. In the end, the design of street improvements is a site-specific process and cannot be generalized, but the Rifle scenarios illustrate what the process and outcome may look like.

part two:
method

05 develop

development

Introduction

Part one of the Main Street Evolved program illustrates the process and information documented to create a series of usable and beneficial Main Street development guidelines. Part two documents the specific issues, procedure, and application process for implementing Main Street Evolved. The subsequent design guidelines, considerations, and strategies identify the specific elements that make up a typical Rocky Mountain Main Street and provide an approach for the adaptation of each street feature.

The process for following the Main Street Evolved approach is a basic three-stage process:

1. Document the existing conditions & Identify specific dilemmas
2. Identify & prioritize strategies
3. Develop a street design

Ultimately, these guidelines, strategies, and considerations should be a springboard for design and adaptation. All design scenarios outlined in this document are suggestive illustrations of how to use or integrate a specific guideline/strategy.

The over-arching goal of this document is to provide a singular resource for a comprehensive approach to Main Street development in the Rocky Mountain West and not a definitive design solution. Communities will need to make design decisions based on the existing conditions, community dilemmas, and prioritized strategies.

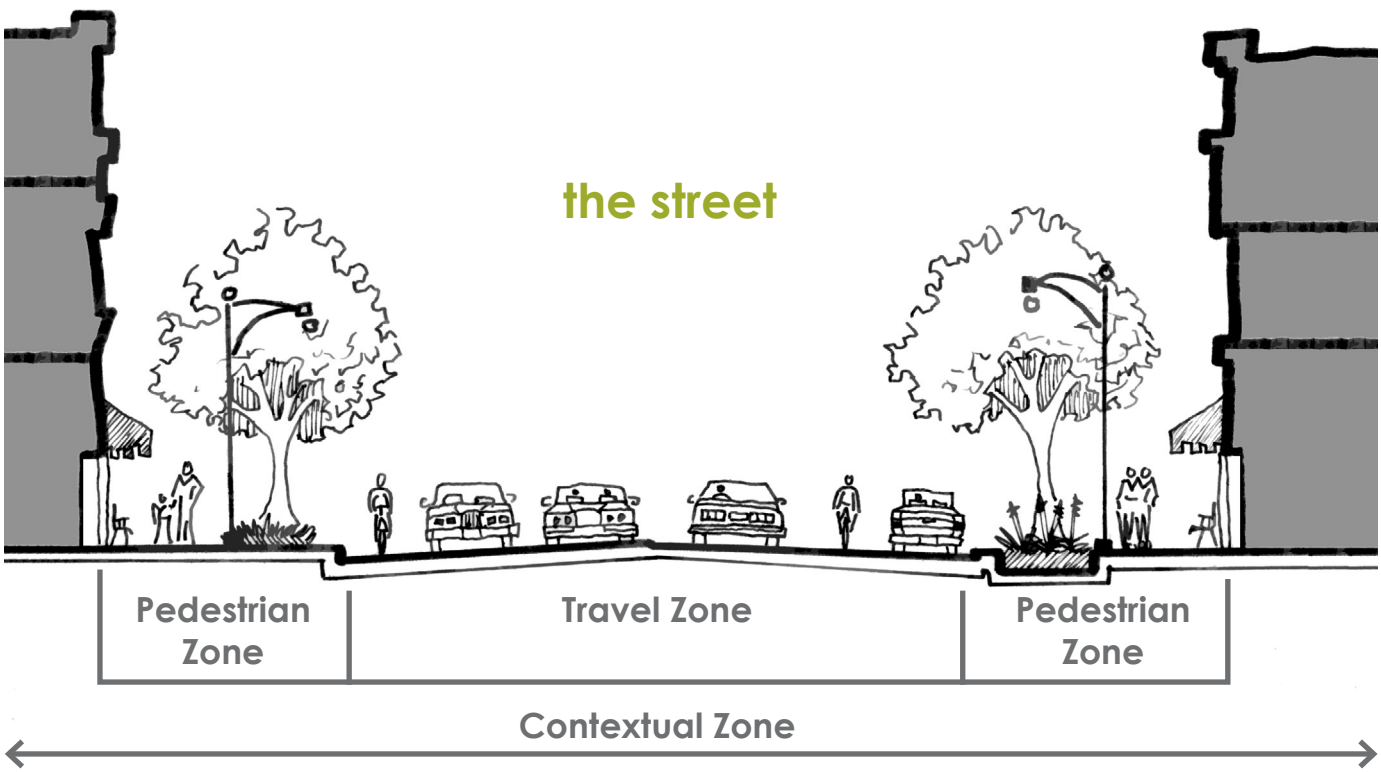


figure 5.1 street zones diagram
(Murner 2011 adapted from: Metropolitan Service District. 2002)

the street zones

pedestrian | travel | contextual

The Street

The street refers to the holistic scope of the Main Street Evolved program. All of the features, guidelines, and scenarios will occur within the boundaries of The Street. Yet, to allow for easy reference and understanding, each of the Main Street Evolved guidelines are grouped based on the Street Zone they fall under. Within The Street, there are three fundamental zones;

+ The Travel Zone
+ The Pedestrian Zone
+ The Contextual Zone

The Travel Zone

The travel zone is composed of all travel lanes, turn/loading lanes, bicycle access, medians, parking, and pedestrian crossings. The primary function of this zone is to accommodate multiple modes of travel ranging from automobile and mass transit access to bicycle passage and safe pedestrian crossing.

The travel zone and its associated elements are one of the most adaptable portions of the street due to the wide range in widths, orientations, and forms the elements can take. Although adaptation will most likely occur, it is vitally important to note that any alteration of the travel zone should not sacrifice the safe and efficient movement of any mode of travel.

The guidelines that fall under the Travel Zone consist of;

+ Travel Lanes
+ Parking
+ Bicycle Lanes
+ Pedestrian Crossings
+ Medians
+ Mass Transit

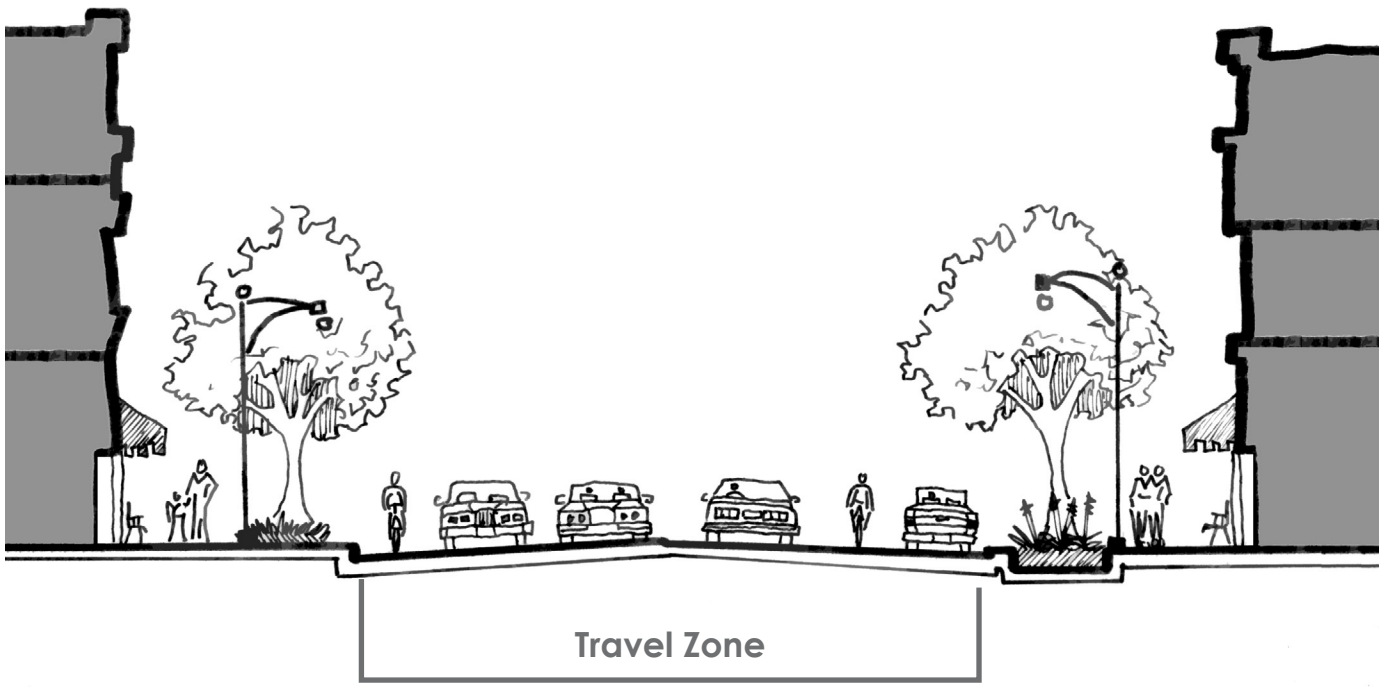


figure 5.2 travel zone diagram
(Murner 2011 adapted from: Metropolitan Service District. 2002)

The Pedestrian Zone

The Pedestrian zone is the space between the building and the curb. Within the pedestrian zone, there are 3 sub-zones that must be accommodated;

+ The Ingress Zone
+ The Sidewalk Zone
+ The Amenity Zone

Each sub-zone must be of adequate size to accommodate the associated functions. Although each zone is important to the safe, comfortable, and efficient travel of pedestrians, it may not be possible to meet the spatial requirements of each zone for the full length of the street.

Due to the ambiguity in street widths, adjacent land uses, and spatial constraints; some sidewalk applications may need focus on merging or omitting a particular sub-zone.

As a rule, all sidewalks must provide a minimum 5ft wide sidewalk for ADA access. Although not ideal, 5ft represents the minimum width that any pedestrian zone can be. For Main Street evolved, an ideal pedestrian zone would, at the very least, incorporate both the sidewalk and a merged ingress/amenity zone.

The basic requirements for a safe and efficient pedestrian zone are;

1. At a minimum, 5' of clear space should always be available for the Sidewalk Zone.
2. The ingress zone, where required for window-shopping & building ingress/egress, should be a minimum of 2' wide.
3. The Amenity zone should be a minimum of 3' wide. Although this is a minimum requirement, it does not represent a space wide enough to accommodate street trees. If street trees are incorporated into this zone, the minimum width should be 6'.
4. It is possible to merge the amenity and ingress zones in areas where street trees are not required. If this situation occurs, the minimum width should be 4'.

The minimum width needed for all sub-zones is 9'

The features that exist within the Pedestrian Zone consist of;

+ Sidewalks
+ Street Trees
+ Curb Extensions
+ Streetscape Amenities
+ Green Infrastructure

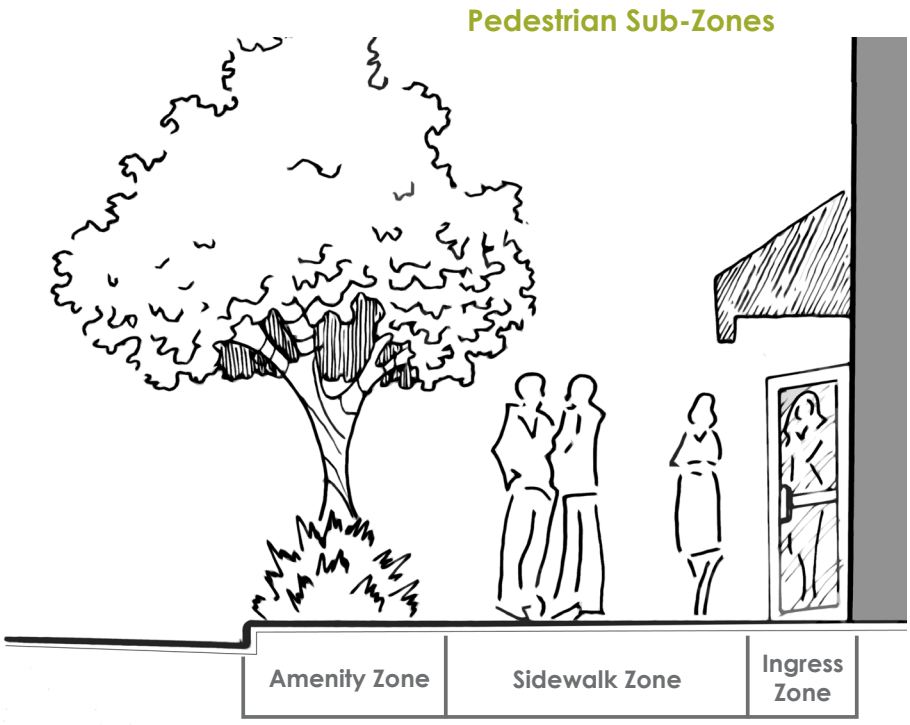


figure 5.3 pedestrian sub-zones
(Murner 2011 adapted from: McCann 2010)

The Contextual Zone

The Contextual Zone encompasses both the Pedestrian and the Travel Zones and even extends beyond. Although the Contextual Zone is a physical street zone, its dimensions are ambiguous and the elements within distinct. The true essence of the contextual zone is the place or sense of place. Many times, sense of place is conceived as a vague or purely subjective concept. Yet, every place is unique and definable to the people who live and visit.

So, how do we define "sense of place"? Many authors have their own definitions for what sense of place means. Kevin Lynch refers to place as Imageability: "that quality in a physical object which gives it a high probability of evoking a strong image in any given observer. It is that shape, color, or arrangement that facilitates the making of vividly identified, powerfully structured, highly useful mental images of the environment. (Lynch 1960 p. 9)" J. B. Jackson refers to place as the "permanent position in both the social and topographical sense, that gives us our identity. (Jackson 1984 p.152)"

With these descriptions as guides, the definition for sense of place in Main Street Evolved is primarily composed around three basic concepts; the natural environment, patterns of settlement, and the social interactions within. Thus, a simple definition for sense of place in Main Street Evolved is; "the quality of a place that evokes physical, psychological, and social connections between people and the environment they inhabit. Murner 2010 (adapted from Lynch 1960 & Jackson 1984)" Figure 5.4

In a general sense, any elements that play a role on creating a sense of place falls under the Contextual Zone. The guidelines considered under the Contextual Zone consist of;

+ Material & Style
+ Plant Selection
+ Snow Management
+ Adjacent Land Use

A basic understanding of the Travel, Pedestrian, and Contextual zones is critical in understanding the spatial requirements of the associated elements. Although each is a separate zone, it is also critical to understand that the modifications made to one zone, have a direct effect on the other zones. Because of the spatial restrictions associated with the redevelopment of a street, it is vital to prioritize what is most important to the community.

For example, if parking is deemed the most important feature, then the selection of a parking orientation that allows for maximum parking spaces is a logical decision. Yet, the spatial requirements needed for maximum parking may limit the space available for the pedestrian zone, reducing the opportunities for pedestrian amenities that aid in creating a visually cohesive street. Often, it is best to understand the trade-offs and compromises associated with optimizing all three street zones.

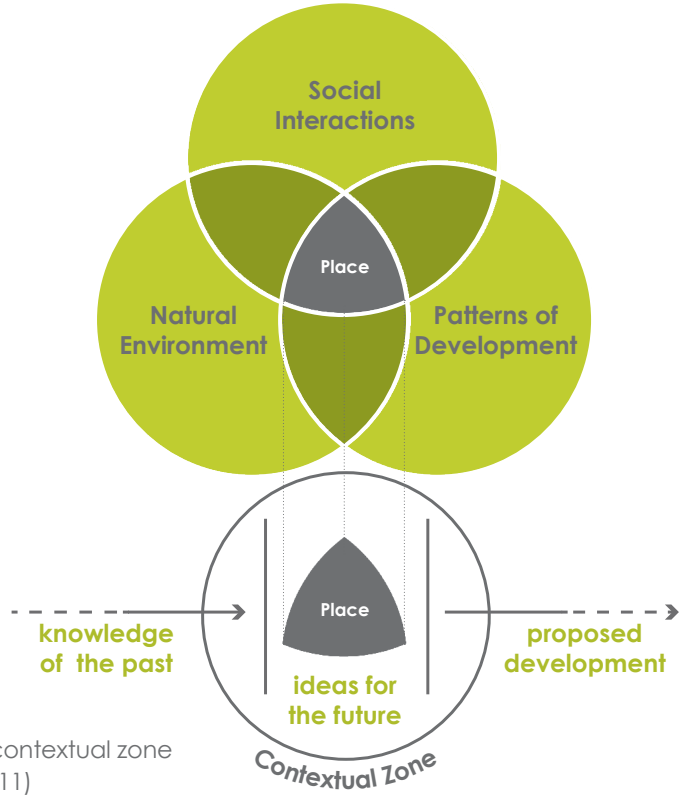


figure 5.4 contextual zone (Murner 2011)

main street evolved process

Introduction

Before introducing the method a design/planner would follow to implement the Main Street Evolved process, I find it important to address why a designer/planner would use the process. For street redevelopment to be successful, it is imperative to establish a dialogue between the designer, stakeholders, and decision makers. The Main Street Evolved process is a systematic approach to Main Street Redevelopment that can be understood by designers and stakeholders alike.

Furthermore, the Main Street Evolved process provides a framework for the design of multiple alternatives and illustrates a means of measuring performance criteria for each alternative. Understanding the alternatives and the trade-offs associated with each can lead to a more comprehensive street design.

Finally, Main Street Evolved introduces a number of concepts and strategies to street design that may be overlooked or neglected in a small Rocky Mountain town context. One of the goals for Main Street Evolved is to illustrate that not only can multi-modal & green infrastructure techniques be integrated together, but that they can be integrated together in small Rocky Mountain communities.

How to Use the Guidelines

The Main Street Evolved framework/process and guidelines should be implemented to achieve two fundamental goals. First, Main Street Evolved should be used to aid/guide the preparation of a comprehensive Main Street redevelopment effort. Results of this process would include masterplans, street cross-sections, illustrative perspectives, and street development policy.

Secondly, the Main Street Evolved process should be introduced at a very early stage to gain consensus among stakeholders, citizens, and city officials. An early consensus of priorities/needs should drastically reduce the troubles and concerns associated with the redesign phase.

The basic steps of the evolving main street process are:

Document Existing Conditions

Designers, Planners, or Community officials using the Main Street Evolved process will collect all the information required in the Feature Key. It should be noted, all the dimensions and information collected for the representative communities was generalized and does not represent the actual information for each street. Thus, all communities must do an initial street investigation to understand the existing conditions

Complete the Feature Key & Fill out the Evolution Table

Once the initial street investigation has been completed, the next step is to compare the existing conditions to the Feature key and discover the associated reference codes. Then, a designer/planner should fill out the Evolution table to compile the reference codes that relate to the community in question

Reference the right-of-way considerations and identify the guidelines to consider

Once the Evolution Table is completed, the next step is to reference the right-of-way considerations. Associated with each right-of-way are a series of guidelines that apply to the specific right-of-way. Each guideline to consider is important to the community in question and should be investigated.

Prioritize the most relevant Guidelines

The guidelines to consider represent a comprehensive approach to main street redevelopment. Although it would be ideal for every community to implement all the guidelines and their associated feature, it is simply not possibly in every situation. Thus, the designer, planner, or community official must prioritize what is relevant to their community.

Develop a Street Design based on the established priorities and relevant guidelines

Once the guidelines are prioritized, decisions must be made on what will be omitted in the final design. This is the step where the individuality of each street must be taken into consideration. What works in one community may not work in another.

The final step in the Main Street Evolved process is to take the decisions made and apply them to a masterplan. Once this step has taken place, it may be discovered that a previously omitted guideline or feature may fit into the street. Thus, a number of scenarios should come out of this application/design phase

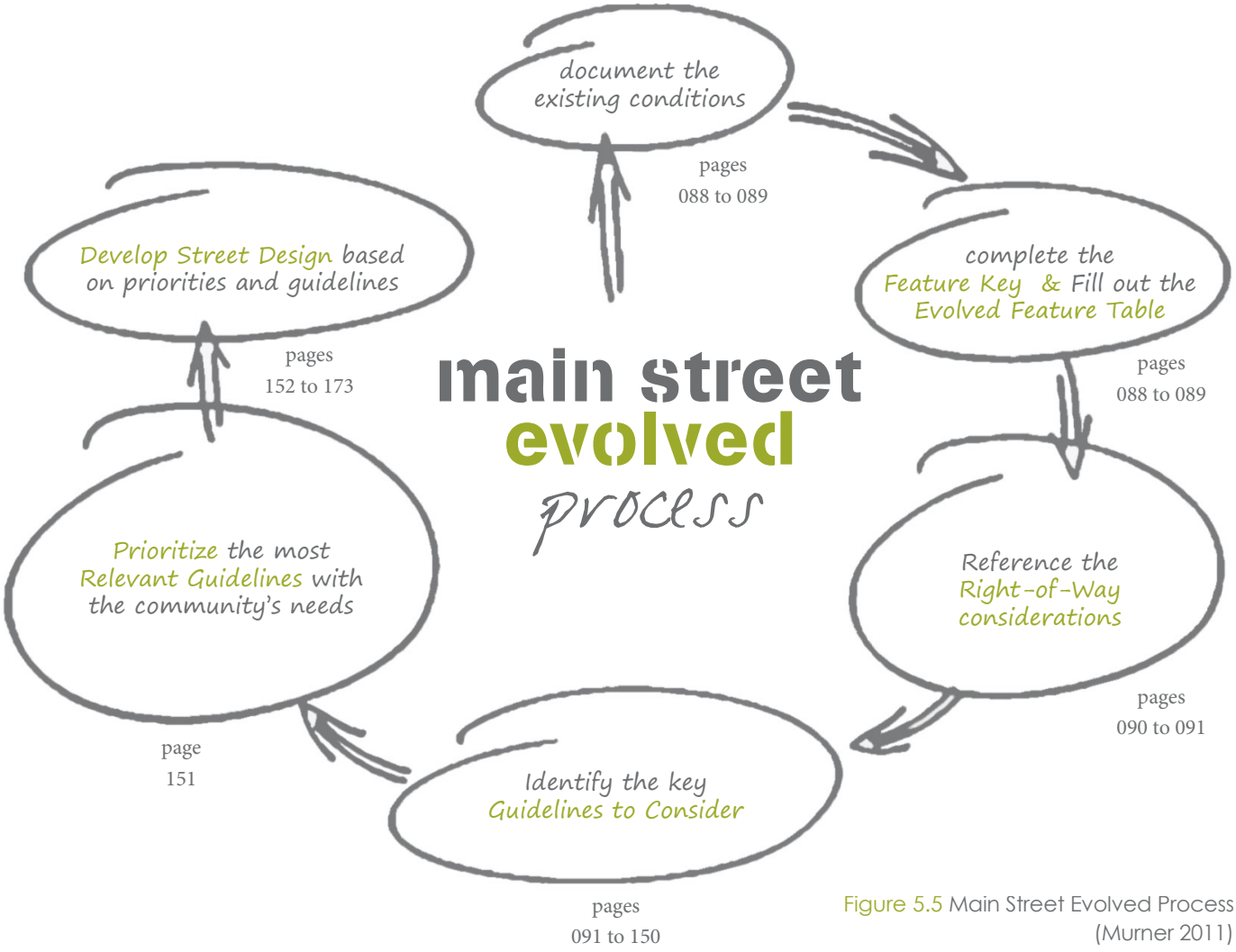


Figure 5.5 Main Street Evolved Process (Murner 2011)

complete the feature key & table

Right-of-Way		
Distance from Building Face to Building Face		
		Code
Narrow	Under 65'	A-1
Average	65' to 90'	A-2
Wide	Over 90'	A-3

Travel Way		
Number of Traffic Lanes & Auxilary Lanes (Including Turn & Delivery Lanes)		
		Code
One Lane	One Traffic lane	B-1
Two Lane	Two Traffic Lanes	B-2
Three Lane	Two Traffic Lanes & One Auxilary Lane	B-3
Four Lane	Four Traffic Lanes	B-4
Five Lane	Four Traffic Lanes & One Auxilary Lane	B-5

Parking		
Parking Orientation & Configuration		
		Code
Parallel	Parallel Parking on Both Sides of the Street	C-1
Angled	Angled Parking on Both Sides of the Street	C-2
Perpendicular	90 Degree Parking on Both Sides of the Street	C-3
Mixed	A Mixture of Parallel & Angled Parking	C-4

Orientation		
General Orientation of the Street		
		Code
N/S	Street Runs Noth to South	F-1
E/W	Street Runs East to West	F-2
NE/SW	Street Runs Northeast to Southwest	F-3
NW/SE	Street Runs Northwest to Southeast	F-4

Topography		
General Topographic Nature of the Street		
		Code
Level	Streets with No Significant Cross or Profile Slope	E-1
Profile	Streets with Significant Grade Change Over the Length of the Street	E-2
Cross-Section	Streets with Significant Grade Change Over the Breadth of the Street	E-3

Pedestrian Zone		
Distance From Building Face to Curb		
		Code
Narrow	Under 7'	D-1
Average	7' to 10'	D-2
Wide	Over 10'	D-3

Elevation		
Elevation at Which the Communitiy is Situated		
		Code
Foothills	Below 7,000'	G-1
Montane	7,000 to 9,500'	G-2
Sub-Alpine	Over 9,500'	G-3

Snowfall		
Average Ammount of Snowfall in a Year		
		Code
Nominal	under 25"	H-1
Nuisance	25" to 50"	H-2
Hinderance	50" to 100"	H-3
Excessive	Over 100"	H-4

Precipitation		
Average Ammount of Rainfall in a Year		
		Code
Semi-Arid Dry	Under 10"	I-1
Semi-Arid	10" to 20"	I-2
Semi-Arid Wet	Over 20"	I-3

How to use the feature key & table

Once I inventoried and assessed the established critical features from the representative communities; I next categorized and assembled them into the Main Street Evolved Feature Key. The purpose of the key is to provide an efficient means of discovering and codifying a community's Main Street.

With general knowledge of a community and some simple research, anyone can quickly identify the reference codes for each of the existing features. Once the codes are identified, they can be referenced to specific guidelines and strategies for developing an Evolved Main Street.

Associated with the Evolved Feature key is the Evolution Table. This Evolution table should be completed by designers/planners and filled in with the associated street feature information. Once the information is documented, the next step is to fill in the associated reference code from the Evolved Feature Key.

By completing this table, designer/planners can gain an understanding of the street in question and identify the reference codes to consider when investigating the relevant guidelines.

Designers/planners should follow the flow of the Feature Key, first documenting the street right-of-way then identifying the category and code associated with it. The final outcome should be a completed Evolution table including all the specific information for a street and the associated reference codes from the Evolved Feature Key.

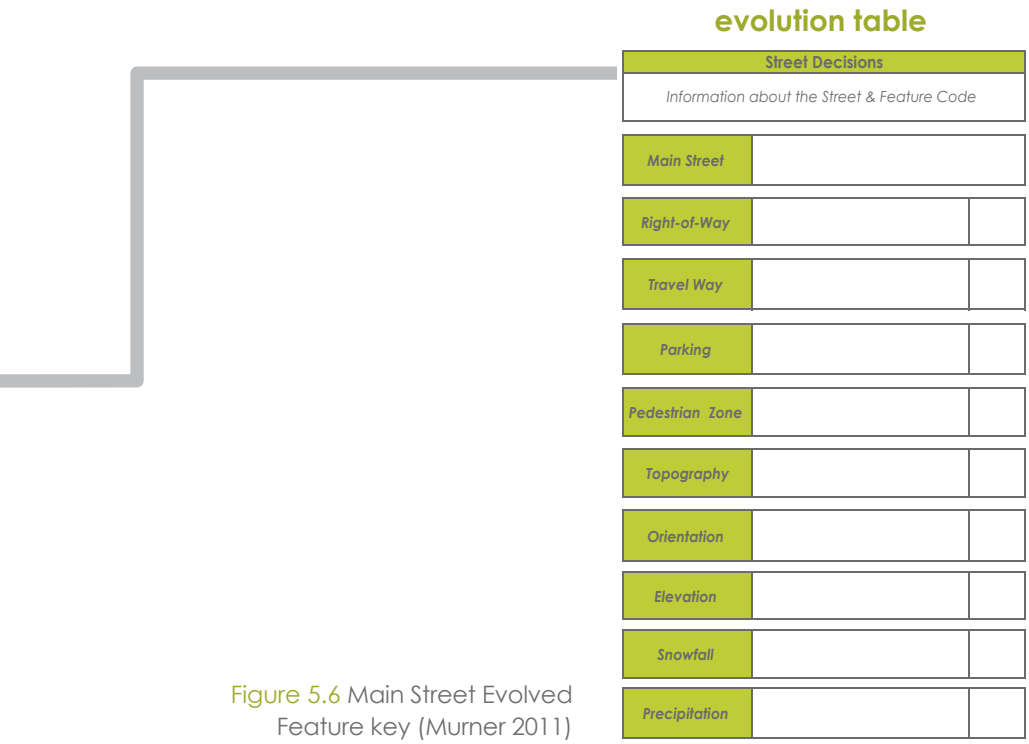


Figure 5.6 Main Street Evolved Feature key (Murner 2011)

reference the right-of-way considerations

Right-of-Way Considerations

Once a street has been documented and the Evolved Feature Key completed, the next step in the process is to address the Right-of-Way Considerations. Each of the Right-of-Way categories in the Main Street Evolved Feature Key has a corresponding Right-of-Way consideration. Each right-of-way consideration includes a basic description of the limitations associated with adaptation and a list of key guidelines to consider.

The intention of this is to ensure that all the critical guidelines for a street are thoroughly reviewed.

The goal of Main Street Evolved is to integrate multi-modal, green infrastructure, and cultural place-making elements into a single street. This requires space that may or may not be available under the existing conditions. It is up to each individual community to understand what their particular needs are and determine where concessions/trade-offs must be made.

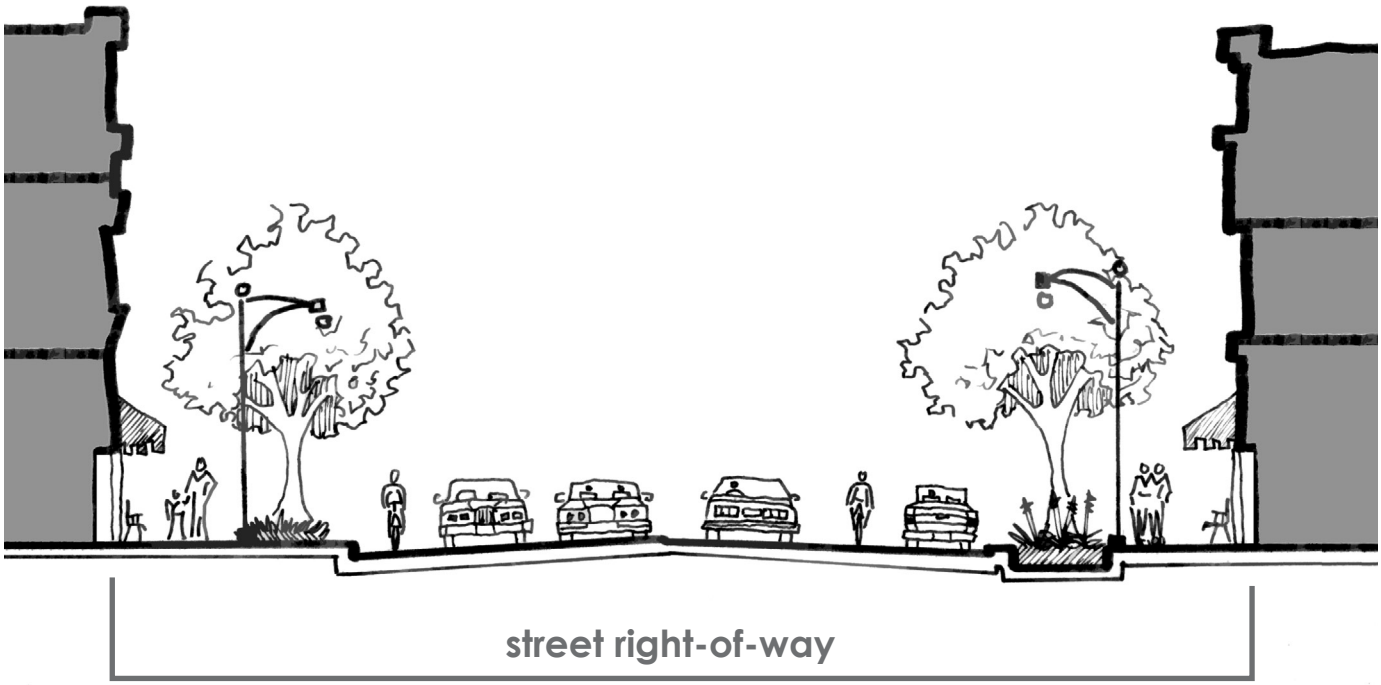


figure 5.7 street right-of-way
(Murner 2011 adapted from: Metropolitan Service District. 2002)

A-1 | Narrow Rights-of-Way

Limitations

With a narrow Right-of-Way, it may not be possible to fit every aspect of the Main Street Evolved program into the redevelopment effort. It must be determined what features fit best within a community and what the primary needs of the community are.

Key Guidelines to Consider

The Travel Zone

- *Travel Lanes*
- *Parking*
- *Bicycle Lanes*

The Pedestrian Zone

- *Sidewalks*
- *Street Trees*
- *Curb Extensions*
- *Streetscape Amenities*
- *Green Infrastructure*

The Contextual Zone

- *Material & Style*
- *Plant Selection*
- *Snow Management*
- *Adjacent Land Use*

A-2 | Average Rights-of-Way

Limitations

With some adaptation, all aspects of the Main Street Evolved program can be incorporated within an average right-of-way. Yet, alteration of multiple street features will need to occur in order to successfully incorporate comfortable pedestrian and cyclist access along with green infrastructure.

Key Guidelines to Consider

The Travel Zone

- *Travel Lanes*
- *Parking*
- *Bicycle Lanes*
- *Pedestrian Crossings*
- *Medians*

The Pedestrian Zone

- *Sidewalks*
- *Street Trees*
- *Curb Extensions*
- *Streetscape Amenities*
- *Green Infrastructure*

The Contextual Zone

- *Material & Style*
- *Plant Selection*
- *Snow Management*
- *Adjacent Land Use*

A-3 | Wide Rights-of-Way

Limitations

Streets with wide right of ways should easily incorporate all aspects of the Main Street Evolved program. It may be necessary to drastically modify a single street feature or slightly modify multiple features in order to incorporate comfortable pedestrian and cyclist access along with green infrastructure.

Key Guidelines to Consider

The Travel Zone

- *Travel Lanes*
- *Parking*
- *Bicycle Lanes*
- *Pedestrian Crossings*
- *Medians*
- *Mass Transit*

The Pedestrian Zone

- *Sidewalks*
- *Street Trees*
- *Curb Extensions*
- *Streetscape Amenities*
- *Green Infrastructure*

The Contextual Zone

- *Material & Style*
- *Plant Selection*
- *Snow Management*
- *Adjacent Land Use*

travel zone

travel lanes | *travel, auxiliary, and turning lanes*

Introduction

Travel lanes include all traffic lanes dedicated to the conveyance of motorized transportation. Although the travel lanes primary function is to convey motorized traffic, they also act as barriers for pedestrian crossings. The number, width, and function of the travel lanes play a critical role on street ambiance and must be addressed when redeveloping any street environment. Although the adaptation of the travel lanes has the potential to provide much needed space for the integration of Main Street Evolved, any modification should only occur after consulting a traffic engineer.

Reference Code/ Issues & Alternatives

B-1|*One Lane*
B-2|*Two Lane*

Limitations

Streets with one or two vehicle lanes already have the minimum number of travel lanes to accommodate efficient vehicular movement. Yet, streets with wide Rights-of-Way may not require any space to fit the Main Street Evolved Program and do not need to narrow the travel lanes. As a rule, the ideal travel lane width is between 10 and 14 feet. This allows safe pedestrian crossing and cyclist travel.

Issues & Alternatives

Narrow & Average Right-of-Way Streets

+ How wide are the Travel Lanes?
  - Any Street with one or two travel lanes must first consider narrowing the traffic lanes. This will allow space to accommodate shared bicycle lanes or to widen the pedestrian zone. See Travel Lane Guideline: Narrowing

Wide Right-Of-Way Streets

+ How wide are the Travel Lanes?
  - Wide streets must take into consideration safe pedestrian crossing. Narrow lanes slow traffic and increase pedestrian safety. With this in mind, it may be necessary to incorporate a median or boulevard.
    See Travel lane: Narrowing & Median/Boulevard Guidelines


figure 5.8

narrow r.o.w + one Lane

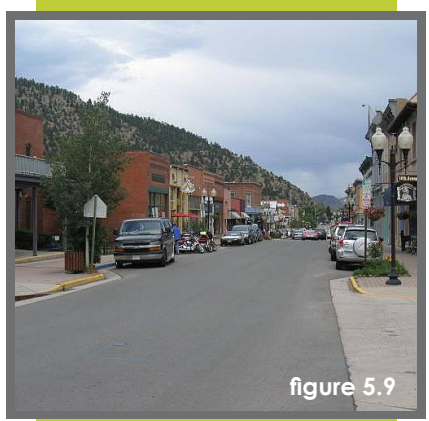


figure 5.9

average r.o.w + two Lane

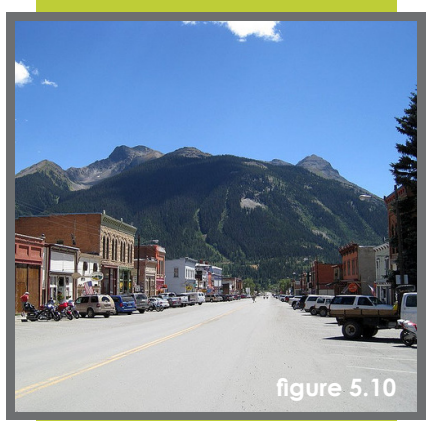


figure 5.10

wide r.o.w + two Lane

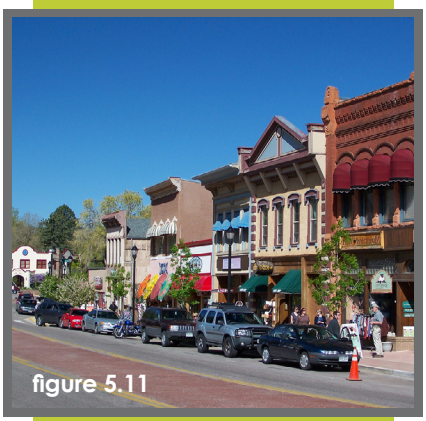


figure 5.11

average r.o.w + three Lane

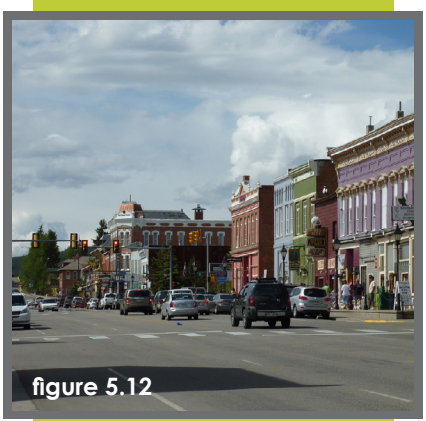


figure 5.12

average r.o.w + four Lane

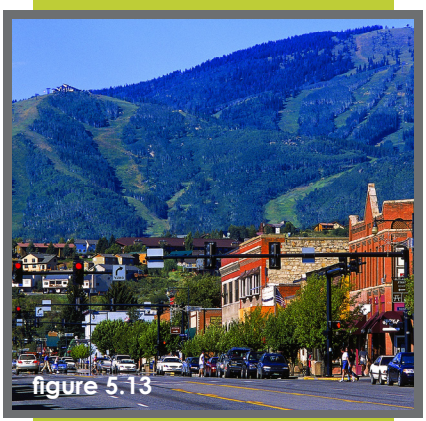


figure 5.13

wide r.o.w + five Lane

B-3|*Three lane*
B-4|*Four Lane*
B-5|*Five Lane*

Limitations

Streets with more than two travel lanes may have the potential to fully accommodate all the spatial requirements needed for Main Street Evolved by adapting this single street feature. It may be possible to remove one of the travel/ancillary lanes.

Issues & Alternatives

Three & Five lanes

+ If an ancillary lane exists (any left turn or service lane), is it needed? If so, is it needed throughout the entire block?
  - On streets with multiple travel and ancillary lanes, a narrowing of both or the interior lane may provide extra space. See Travel Lane Guideline: Narrowing
  - On streets with left-turn lanes, it may be possible to remove or shorten the ancillary lane. This may free up enough space so that adaptation of another street feature is unnecessary. See Travel Lane: Removal & Median/Boulevard Guidelines.

Four lanes

+ How wide are the Travel Lanes?
  - On streets with multiple travel lanes, a narrowing of both/or the interior lane may provide extra space. See Travel Lane Guideline: Narrowing
+ Are the extra travel lanes needed to safely and efficiently convey vehicular traffic?
  - On streets with four dedicated vehicular travel lanes, it may be possible to remove traffic lanes. This may free up enough space so that adaptation of another street feature is unnecessary. See Travel Lane Guideline: Removal

travel zone

travel lanes | *travel, auxiliary, and turning lanes*

Specific Criteria & Dimensions

Narrowing

In a general sense, travel lanes may be narrowed to a width of 11'. (AASHTO 2002) Yet, 11ft is a general standard and can vary depending on the on-street parking orientation and the number of travel lanes.

+ Streets with angled parking should have a minimum of 1ft travel lanes but 12ft is preferred. (Harris et. al 1998) & (AASHTO 2002)
+ Streets with parallel parking may introduce 10ft travel lanes, but 11ft is preferred. (Harris et. al 1998) & (AASHTO 2002)
+ Streets with a mixture of on street parking can mix travel lane widths, but the implementation of travel lanes with a minimum of 11ft is preferred. (Harris et. al 1998 & AASHTO 2002).
    - *Space making and safe pedestrian access are the primary factors influencing the adaptation of the travel lanes. Thus, in most instances the minimum standard should be implemented.*
    - *In Narrow and Average Right-of-way situations, the use of the minimum standards will provide extra space needed to expand the pedestrian zone or implement a bicycle lane.*
    - *In Wide Right-of-Way situations, the use of a maximum of 14ft wide travel lanes is preferred. This will ensure safe pedestrian crossing. (AASHTO 2002)*
+ Streets with more than three travel lanes may narrow both the inside and outside lanes.
    - *All interior lanes should be between 10ft and 11ft wide. (AASHTO 2002)*
    - *All outer lanes should be between 11ft and 14ft wide. (AASHTO 2002)*

Removal

+ If the removal of a travel lane is desired, the extra space should be used to extend the pedestrian zone, implement bicycle lanes, or medians.
+ If a left-turn lane is needed, the removal of the lane between the intersections will provide green space within the street. See The AASHTO A policy on geometric Design of Highways and Streets for further information on the geometric design of left-turn lanes.

Further Considerations

+ The minimum widths for the travel lanes to not take into bicycle lanes. If integrated/ shared bicycle lanes are desired, the travel lanes must be larger than the minimum widths. See the bicycle lane Guideline for shared or dedicated lanes.
+ The removal of a travel lane should only take place to provide needed space for the extension of a pedestrian zone or inclusion of a median. Each case will slow traffic and increase pedestrian safety while crossing the street. See Sidewalk extension and Median/Boulevard Guidelines.

Note: The scenarios illustrated are not specific guidelines. They are examples for reference and visual depictions of the previously stated guidelines. Many more scenarios are possible.

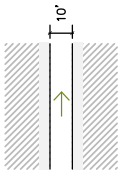
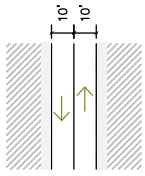
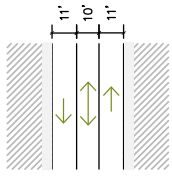
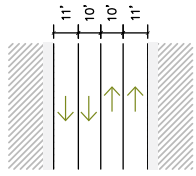
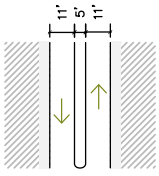
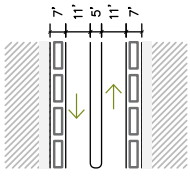
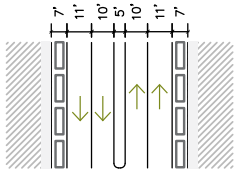
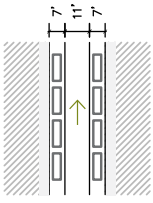
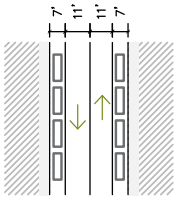
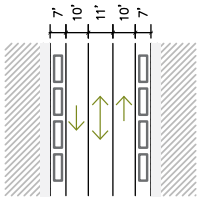
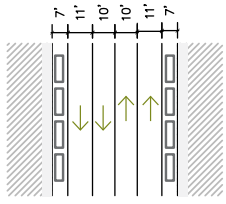
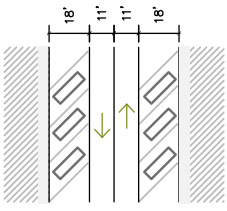
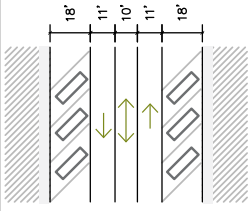
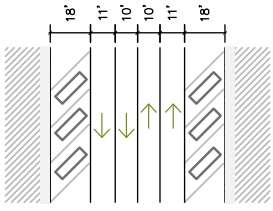
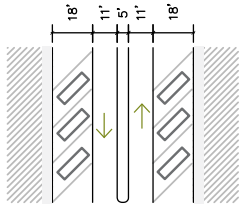
no parking total width of travel way	 10 feet	 20 feet	 32 feet	 42 feet
medians total width of travel way	 27 feet	 41 feet	 61 feet	
parallel parking total width of travel way	 25 feet	 26 feet	 45 feet	 56 feet
angled parking total width of travel way	 58 feet	 68 feet	 78 feet	 63 feet

figure 5.14 Typical Street Types & Widths (adapted from: Steuteville & Langdon 2003)

travel zone

parking | *orientation & dimensions*

Introduction

In all situations, on-street parking should be provided due to its many benefits. Although often considered only an economic benefit, on-street parking has advantages for pedestrians and cyclists as well. In a general sense, on-street parking separates pedestrian activity from the traffic, slows vehicular speed, and increases street activity by providing storefront access. The importance of on-street parking makes it a vital element of any main street. Yet, adaptation of the parking orientation and width can provide space to incorporate other beneficial elements.

Reference Code/ Issues & Alternatives

C-1|*Parallel*

Limitations

Narrow and Average Right-of-Way streets with existing parallel parking have the least potential for space making. Because on-street parking is vital to the success of a downtown district, complete removal is not the best option. Thus, there are limited alternatives when adapting streets existing parallel parking. In wide Rights-of-Way, it may be possible to change to an angled parking orientation to accommodate more on-street parking.

Issues & Alternatives

+ Is extra space still required?
  - *After the adaptation of the travel lanes, can all the desired elements of Main Street Evolved be implemented? If not, continue to the next guideline for further consider.*
  - *If there is currently ample space, it may be possible to change to an angled or mixed parking orientation to accommodate more on-street parking. See Parking Guidelines: Changing Orientation.* *See Parking Guidelines: Changing Orientation*

+ How wide are the parking stalls?
  - *Any street with existing parallel parking should consider narrowing them if possible.* *See Parking Guideline: Narrowing*

+ Are all the parking spaces currently needed?
  - *Although not recommended, the removal of on street parking may be necessary to fully integrate the Evolving Main Street program.* *See Parking Guideline: Removal*

figure 5.15

average r.o.w + parallel

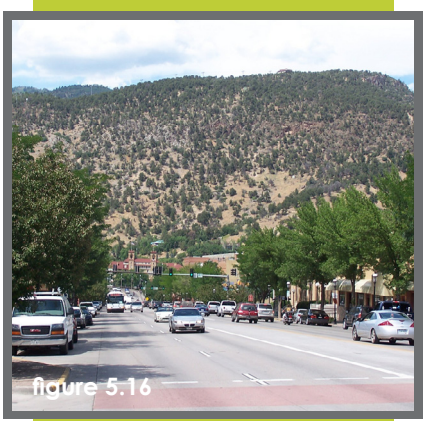


figure 5.16

average r.o.w + parallel

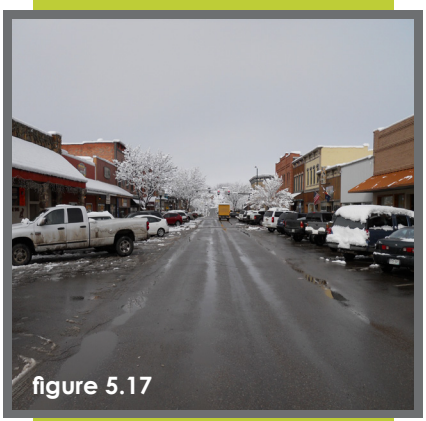


figure 5.17

average r.o.w + angled

C-2|*Angled*

Limitations

Although angled parking allows for a maximum number of parking units to be placed on a street, it also has large spatial requirements. While it is possible to change the degree angle of the street parking, this will result in a loss of on-street parking spaces. If orientation is changed, a simple parking analysis can determine if the current amount of on-street parking is sufficient or abundant.

Issues & Alternatives

+ Is extra space still required?
  - *After the adaptation of the travel lanes, can all the desired elements of Main Street Evolved be implemented? If not, continue to the next guideline for consideration.*

+ Are all the parking spaces currently needed?
  - *If there is abundant parking, it may be possible to change to a parallel parking orientation. This will create extra space for bicycle/pedestrian access and green infrastructure.* *See Parking Guidelines: Changing Orientation*

+ What degree of angled parking currently exists?
  - *If it is determined that a majority of the existing on-street parking is needed, it may be possible to tweak the degree of the angled parking. Although minimal, every foot of space that can be acquired will greatly improve chances of incorporating multiple elements of the Main Street Evolved Program.* *See Parking Guidelines: Changing Orientation*

+ Is there space for off-street parking?
  - *If it is determined that the majority of the on-street parking should be preserved and it is determined that there is inadequate space for bicycle/pedestrian access and green infrastructure; a final option would be to consider complimenting the on-street parking with some adjacent off-street parking. This will allow the orientation of the on-street parking to be changed while still providing parking in a close proximity to the business district*

Reference Code/ Issues & Alternatives Cont.

C-3|*Perpendicular*

Limitations

Due to spatial requirements and safety issues, any street with 90 degree perpendicular parking should change the orientation to either parallel, angled or a mixture of the two.
See Parking Guidelines: Changing Orientation

C-4|*Mixed*

Limitations

Although a mixed parking orientation has the benefit of providing extra space on streets that currently have solely angled parking, streets with existing mixed parking may need to be adapted. If sufficient space has not been achieved with the adaptation of the travel lanes, it may be necessary to consider changing to a solely parallel orientation or complimenting the on-street parking with adjacent off-street parking.

Issues & Alternatives

+ Is extra space still required?
    - *After the adaptation of the travel lanes, can all the desired elements of Main Street Evolved be implemented? If not, continue to the next guideline to consider.*

+ Are all the parking spaces currently needed?
    - *If adequate space has already been created by the modification of the travel way, mixed parking orientation may be retained.*
    - *If there is abundant parking, it may be possible to change to a parallel parking orientation. This will create extra space for bicycle/pedestrian access and green infrastructure.* *See Parking Guidelines: Changing Orientation*

+ What degree of angled parking currently exists?
    - *If it is determined that a majority of the existing on-street parking is needed, it may be possible to tweak the degree angled of the on-street parking. Although minimal, every foot of space that can be acquired will greatly improve chances of incorporating multiple elements of the Main Street Evolved Program.* *See Parking Guidelines: Changing Orientation*

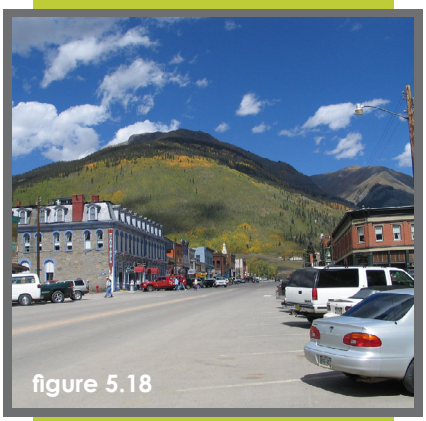


figure 5.18

wide r.o.w + angled

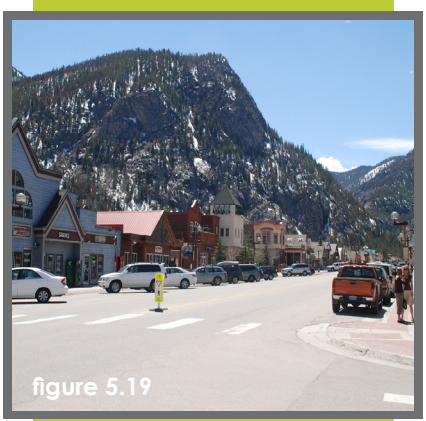


figure 5.19

wide r.o.w + mixed

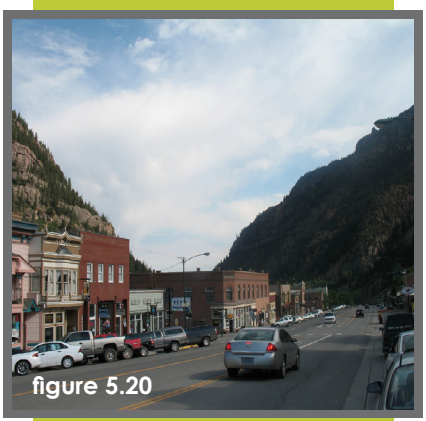


figure 5.20

wide r.o.w + mixed

Specific Criteria & Dimensions

Narrowing & Changing Orientation

If narrowing or changing the parking orientation is determined to be necessary, some spatial standards should be followed. For specific dimensions and diagrammatic explanation, see figure 5.21

Parallel Parking

+ The preferred width for parallel parking is 7ft. If space is available, the maximum width that any parallel parking lane should be is 9ft. (Harris et. al 1998)
+ The preferred length for parallel parking is 22ft. It is best to determine the space available and distribute parking evenly with the maximum stall length being 23ft. (Harris et. al 1998)

Angled Parking

+ The preferred dimensions for angled parking are dependent on the degree angle of the stalls.
+ If angled parking is determined to be the best solution for on-street parking, only stalls with 45 or 60 degree parking should be implemented. All other orientations require excess space or are unsafe for on-street parking due to limited sight lines.

45 Degree Parking

- *The preferred stall width for 45 degree parking is between 8ft and 9ft. (Harris et. al 1998)*
- *The preferred stall length for 45 degree parking is between 18ft and 20ft, depending on the stall width. (Harris et. al 1998)*

60 Degree Parking

- *The preferred stall width for 60 degree parking is 8ft to 9ft. (Harris et. al 1998)*
- *The preferred stall length for 60 degree parking is between 17ft and 19ft, depending on the stall width. (Harris et. al 1998)*

Specific Criteria & Dimensions Cont.

Mixed

+ The spatial standards for mixed parking are the same as the Parallel and Angled parking dimensions described previously.
+ If possible, it is best to vary the angled and parallel parking on a block-to-block basis. This will even the look of the street out and maximize parking frontage on both sides of the street.

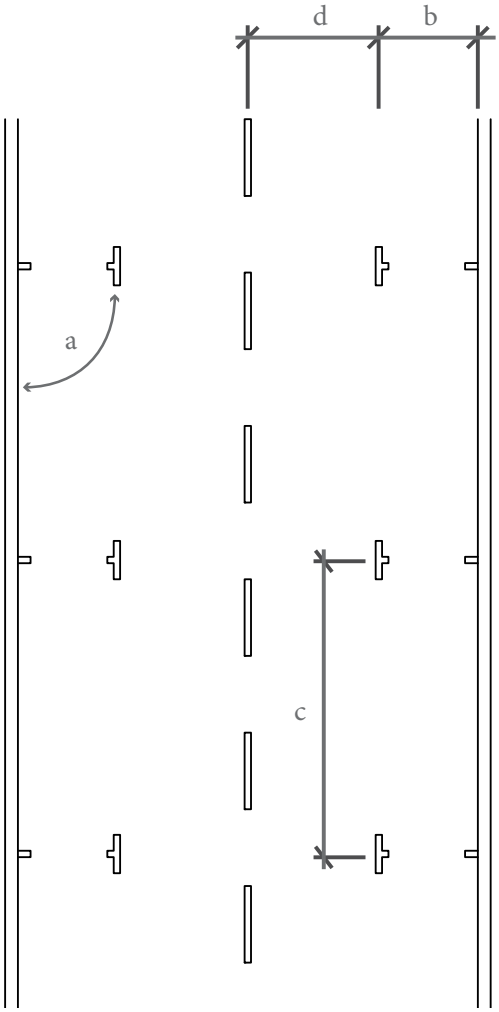
Removal

+ Although not recommended, removal is an option for streets with very narrow Rights-of-Way. If removal is desired, there must be closely adjacent off-street parking to ensure street vivacity.
+ Although spatial requirements may only allow temporary parking of drop-off stations, on street parking should be incorporated on every street
+ If on street parking is removed, 8ft to 10ft drop-off and service lanes should be incorporated. These temporary lanes do not need to extend the length of the street, but should occur at least twice per block.

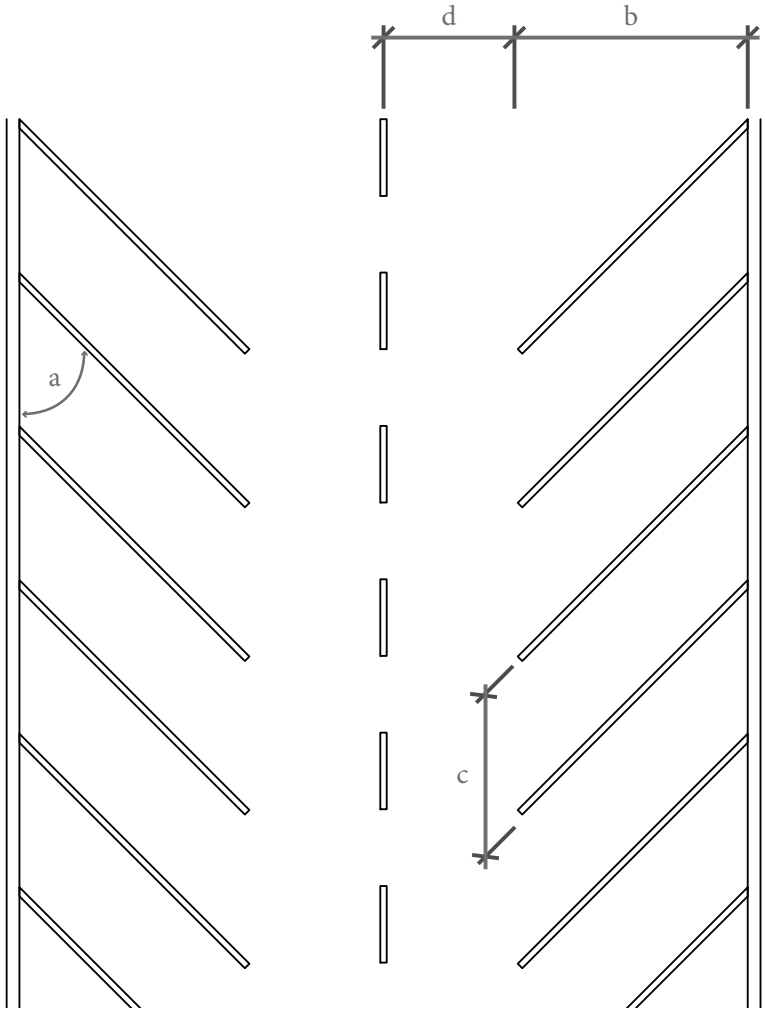
Further Considerations

+ One area of concern is the safety issues associated with the parking and bicycle interaction. To alleviate this issue, well-marked bicycle routes should be implemented. See the Bicycle lane guidelines for more information.
+ To ensure safe pedestrian access, curb extensions that extend out to the length of the parking area must be implemented. This will allow adequate vehicle/pedestrian sightlines and reduce conflict. See the curb extension guidelines for more information.
+ If angled parking is desired, it is important to understand the conflict that exists between angled parking and bicycle lanes. Bicyclists are difficult to see behind a diagonally parked car and accidents can occur. For this reason, bicycle lanes on streets with angled parking should be placed adjacent to the sidewalk and in front of the angled parking. See the Bicycle Lane Guidelines for "Raised" bicycle lanes and figure 5.28.

Parallel Parking



Angled Parking



degree of parking (a)	Stall Width (b)	Stall Depth (c)	Lane Width (d)
90 degree (Parallel)	7ft - 9ft	22ft - 23ft	10ft min
60 degree	8ft - 9ft	17ft - 20ft	11ft min
45 degree	8ft - 9ft	18ft -19ft	11ft min

Figure 5.21 Typical Parking Dimensions (adapted from: Harris et. al. 1998)

travel zone

bicycle lanes | *standards & dimensions*

Introduction

As bicycle travel becomes a popular means of travel, the integration of bicycle facilities into the redevelopment of all streets will be a necessity. The form of these bicycle facilities can take various forms; from wide shouldered highways to separate dedicated bicycle paths. For Main Street Evolved, a bicycle facility is "a portion of the roadway designated for exclusive or preferential use by bicyclists" (Metropolitan Service District 2002 p. 21).

Yet, the integration of the cyclist-oriented facilities into the urban context has some specific considerations and criteria that must be considered. Although these guidelines are directed at implementing bicycle facilities into a Main Street context, a regional bicycle plan is needed to ensure safe bicycle access throughout a community.

Specific Criteria & Dimensions

Shared Lanes

A shared lane is a bicycle lane that occupies the outer portion of a traffic lane. "In order for bicycles and motor vehicles to share the use of a roadway without compromising the level of service and safety for either, the facility should provide sufficient paved width to accommodate both modes. This width can be achieved by providing wide outside lanes or paved shoulders. " (AASHTO 1999 p. 16)

The usable lane width for a street is the distance from the centerline of the road to the edge of the gutter. Described in terms of usable lane width, typical shared bicycle lanes include the travel bicycle lane. If on street parking is present, the usable lane width include the parking stalls and bicycle lane.

+ On streets with no on-street parking, the preferred usable lane width for a shared bicycle lane and traffic lane is 14ft. (Watson et. al. 2003) see figure 5.26
    - *In essence, the usable lane consists of a travel lane of 10ft and a bicycle lane of 4ft.*
+ On streets with parallel parking, the preferred usable lane width for the parking lane and shared bicycle lane is 12ft. (Watson et. al. 2003) see figure 5.27
    - *In essence, the usable lane consists of a parking lane of 7ft and a bicycle lane of 5ft.*

figure 5.22

shared bicycle lane

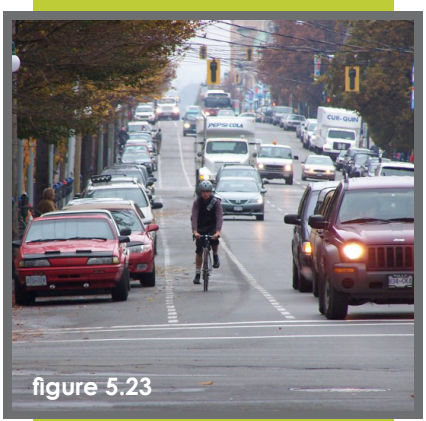


figure 5.23

dedicated bicycle lane

figure 5.24

raised bicycle lane

Separate Lanes

A separate bicycle lane must occur on any street with angled parking. The placement of the separated lane is determined by the amount of space available for development. In terms of separated lanes, bicycle facilities can take two basic forms.

Raised

A raised bicycle lane is typically the most efficient way of integrating bicycle lanes on any street with angled parking. Typically, the bicycle lanes have a 2 inch curb and the pedestrian sidewalk is raised 4 inches above the bicycle lane. (Watson et. al. 2003) See figure 5.28

+ This 5ft width is the minimum width for any dedicated lane and should be applied to any raised lane.

+ Concrete parking-stops must be placed in all parking stall to limit vehicular encroachment onto the bicycle lane.

    - *On Streets with 45 degree parking, the concrete stops should be placed 1ft-9in away from the curb. (Harris et. al 1998)*

    - *On streets with 60 degree parking, the concrete stops should be placed 2ft-3in away from the curb. (Harris et. al 1998)*

Two-Way Path

A two-way path is a separate bicycle facility that may occur on one side of the street that allows for two-way bicycle travel. These two-way paths should only take place on streets with extremely wide Rights-of-Way where space is abundant. see figure 5.29

+ The two-way path should not be included into the calculations of any pedestrian zone widths or uses.

+ If a single two-way path is provided, two way bicycle travel may occur if the path is a minimum of 10ft wide. (Watson et. al. 2003)

Specific Criteria & Dimensions Cont.

Lane and Intersection Demarcation

On all bicycle facilities, lane symbology is required to inform cyclists and motorists of the presence of a bicycle lane. Depending on the type of lane, each symbol is slightly different.

+ All lane markings should be placed 6ft to the far side of an intersection.
+ Shared lanes are delineated by a shared bicycle symbol "Sharrow" See figure 5.25
+ All separated lanes are delineated by a standard bicycle symbol and directional arrow. See figure 5.25
+ 6" lane separators stripes must be placed between the bicycle and vehicular lanes. (AASHTO 1999)
+ 4" lane separators should be placed between the parking lane and the bicycle lane. (AASHTO 1999)
+ Two-way paths are completely separated from other vehicular traffic and lane demarcation is unnecessary unless desired.

Further Considerations

+ As a rule, bicycle lanes should be provided on both sides of a street with intended travel direction being the same as the adjacent vehicular travel flow.
+ If a single multi-use path is provided, two way bicycle travel may occur if adequate width is provided.
+ For more information regarding bicycle facility design, see the AASHTO Guide for Development of Bicycle Facilities.
+ If angled parking is desired, it is important to understand the conflict that exists between angled parking and bicycle lanes. Bicyclists are difficult to see behind a diagonally parked car and accidents can occur. For this reason, bicycle lanes on streets with angled parking should be placed adjacent to the sidewalk and in front of the angled parking. See the Bicycle Lane Guidelines for "Raised" bicycle lanes and figure 5.28.

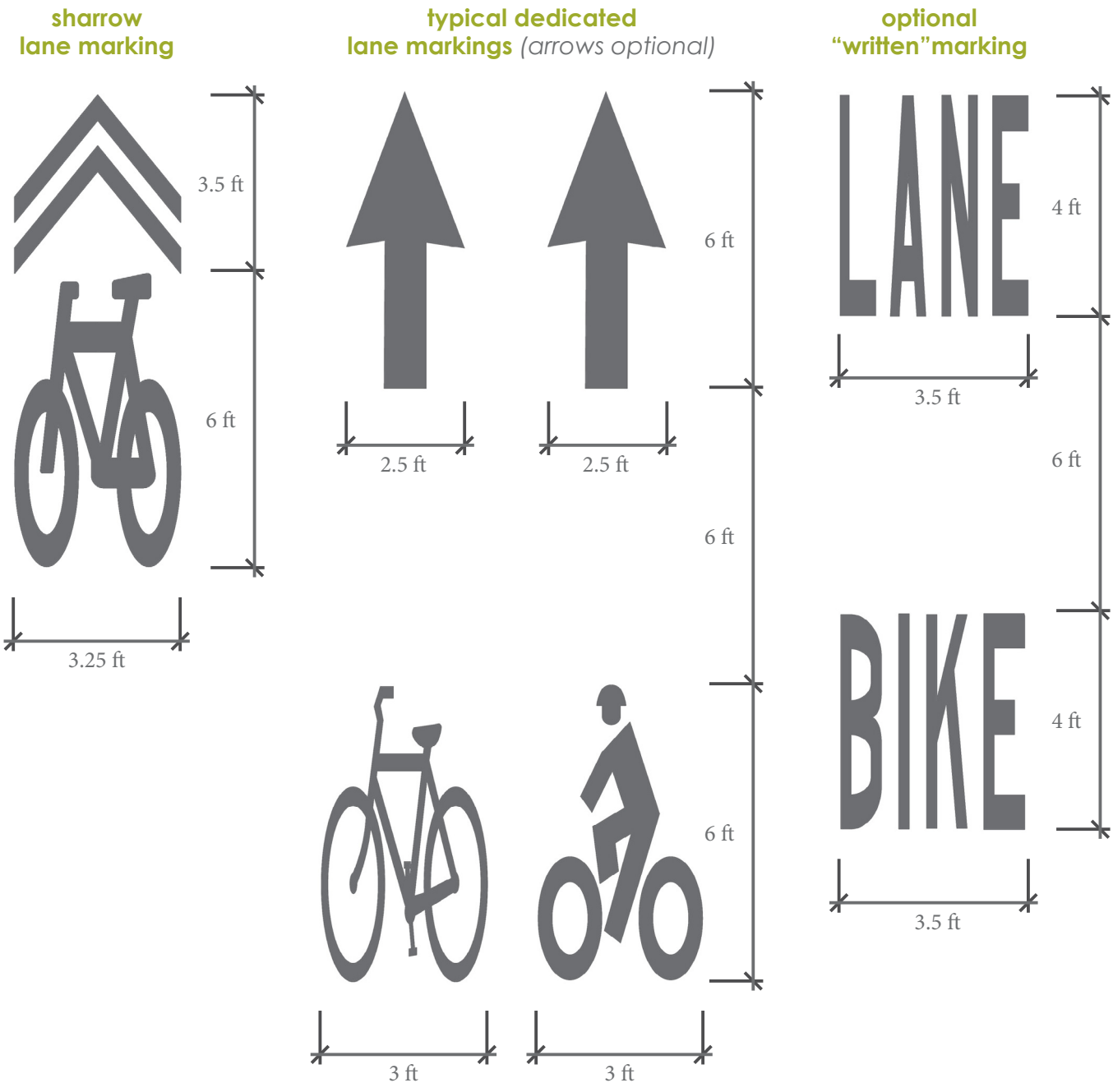


figure 5.25 typical bicycle lane markings (Murner 2011 adapted from FHWA 2009)

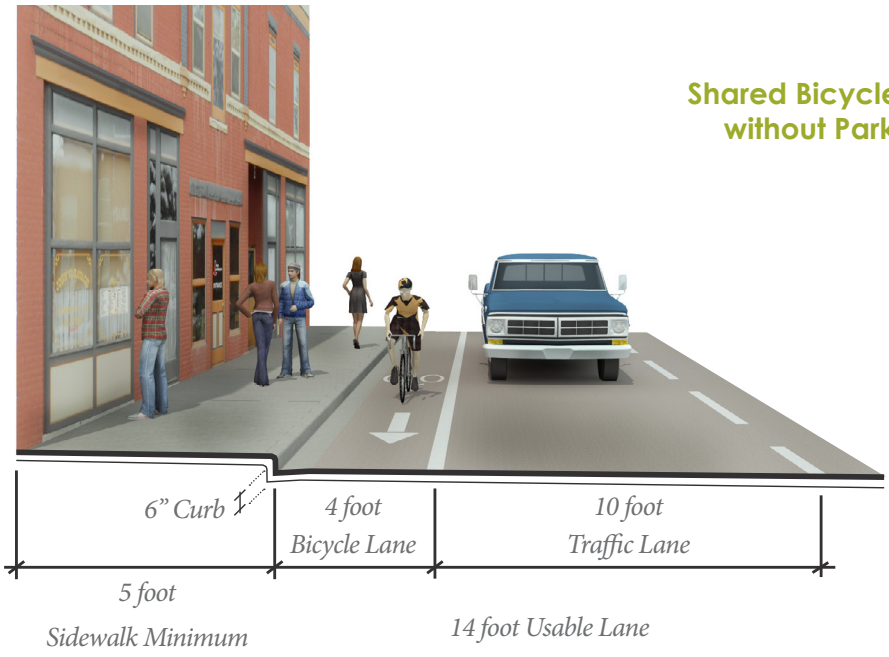


figure 5.26 shared bicycle lane without street parking (Murner 2011)

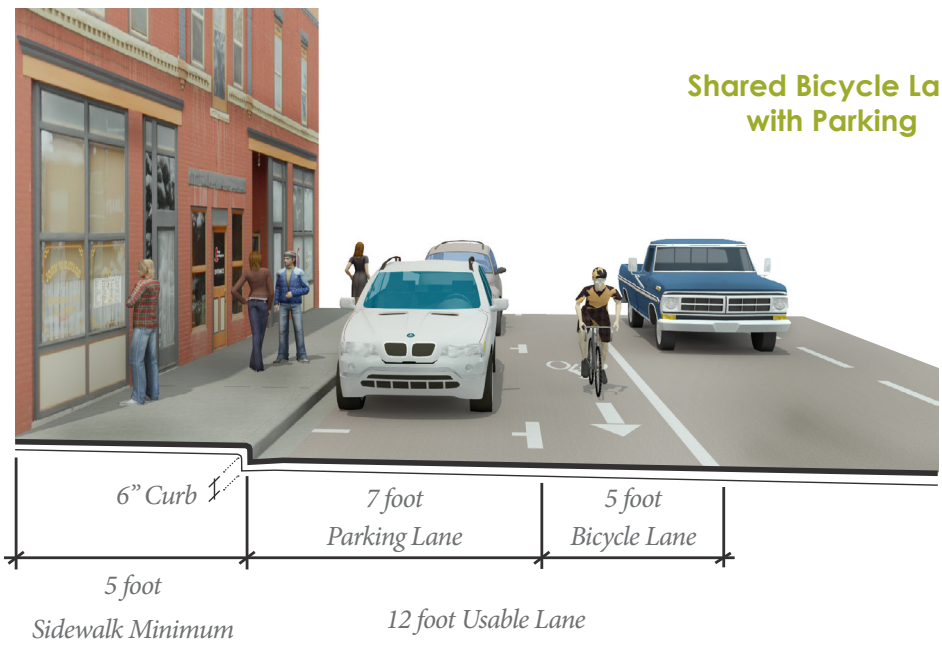


figure 5.27 shared bicycle lane with street parking (Murner 2011)

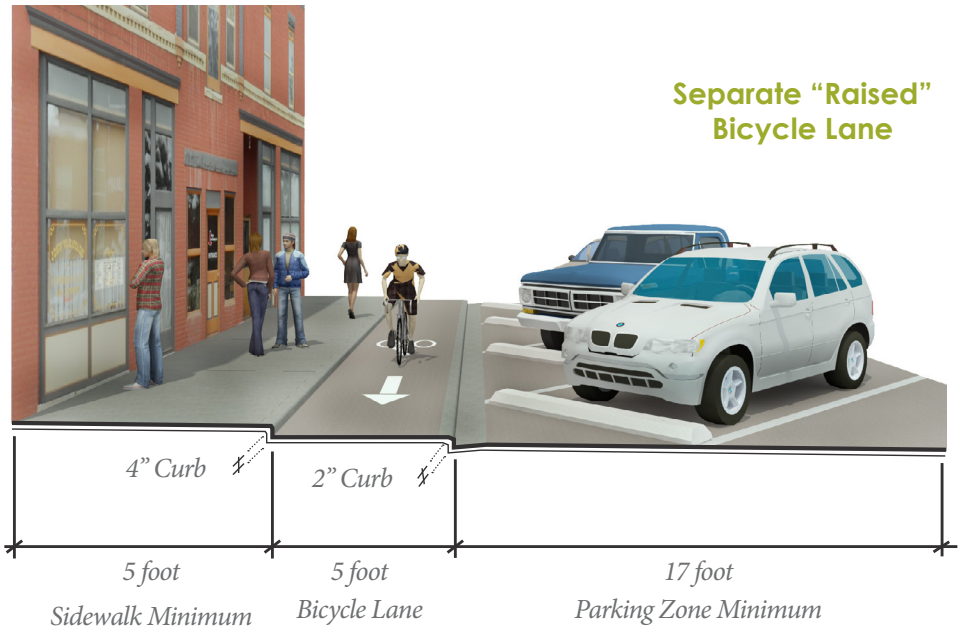


figure 5.28 separate "raised bicycle lanes (Murner 2011)

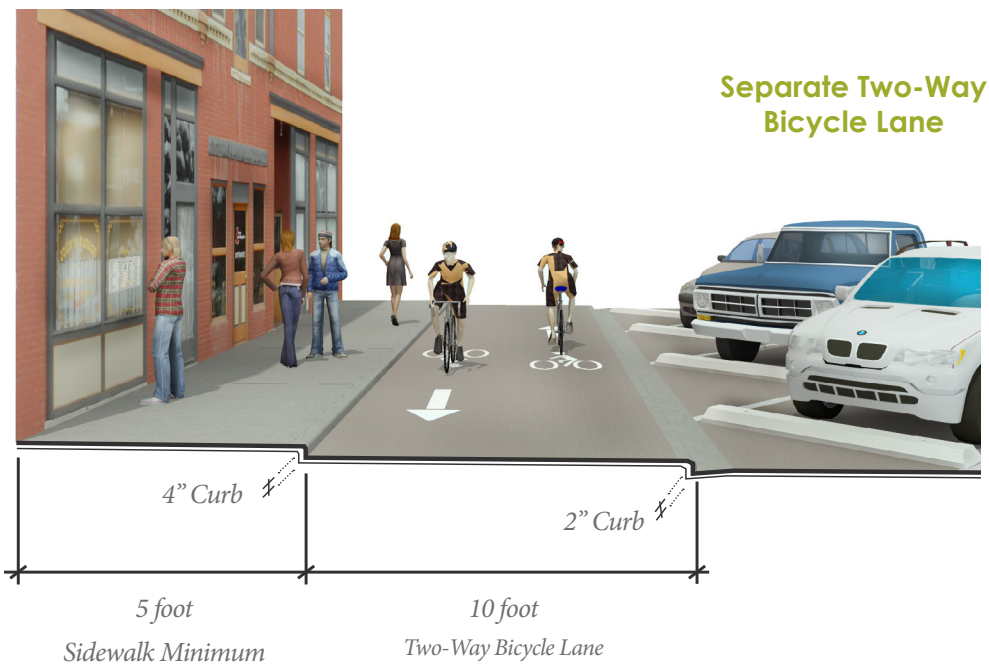


figure 5.29 separate two-way bicycle lane (murner 2011)

travel zone

medians | *standards & dimensions*

Introduction

The integration of medians into a Main Street can provide a multitude of beneficial functions. Medians have the potential to control vehicular access and provide space for turning lanes and vehicular storage. Yet beyond the vehicular benefits, medians also provide a refuge for pedestrian and allow for street vegetation and amenities. There are typically two types of medians; painted and raised. The main differences between the types of medians are the amount of functions they can accommodate. Although not applicable to every street scenario, medians can provide space for street vegetation and lighting where available space in the pedestrian zone is limited.

Specific Criteria & Dimensions

Painted Medians

+ Painted medians control traffic by removing vehicular turning from the travel lanes and providing separation between directions of travel.

+ In some unique cases, a painted median can be used as a service lane for commercial deliveries. These service lanes can provide impromptu pedestrian refuge, but are not intended for such use.

+ Painted medians should be a minimum of 10ft wide to allow for vehicular access and storage.

Raised Medians

Although there is no minimum standard for raised medians, some uses require specific widths. A raised median has the same benefits as a painted median, but also provide space for landscaping, amenities, and pedestrian refuge.

Pedestrian Refuge Medians

+ For medians to accommodate Pedestrian refuge, a minimum of an 8ft wide median is required. This will allow safe pedestrian refuge. If used in conjunction with mid-block crossings, the medians should have an open flat cut and do not ramp up and down due to the short width. (Watson et. al. 2003) See figure 5.30

Vegetated Medians

+ For medians to accommodate street trees and vegetation, a minimum of 6ft is required. Yet, the best widths for tree planting is equal to ½ the mature root zone width. For some street trees this can be up to 20ft. (Watson et. al. 2003) See figure 5.31

Median Left Turn Lanes

+ "Although not equal in width to a normal travel lane, a 10 ft lane with a 2 ft curbed separator or with traffic buttons or paint lines, or both, separating the median lane from the opposing through lane may be acceptable where speeds are low and the intersection is controlled by traffic signals. (AASHTO 2002 p. 720)" See figure 5.32

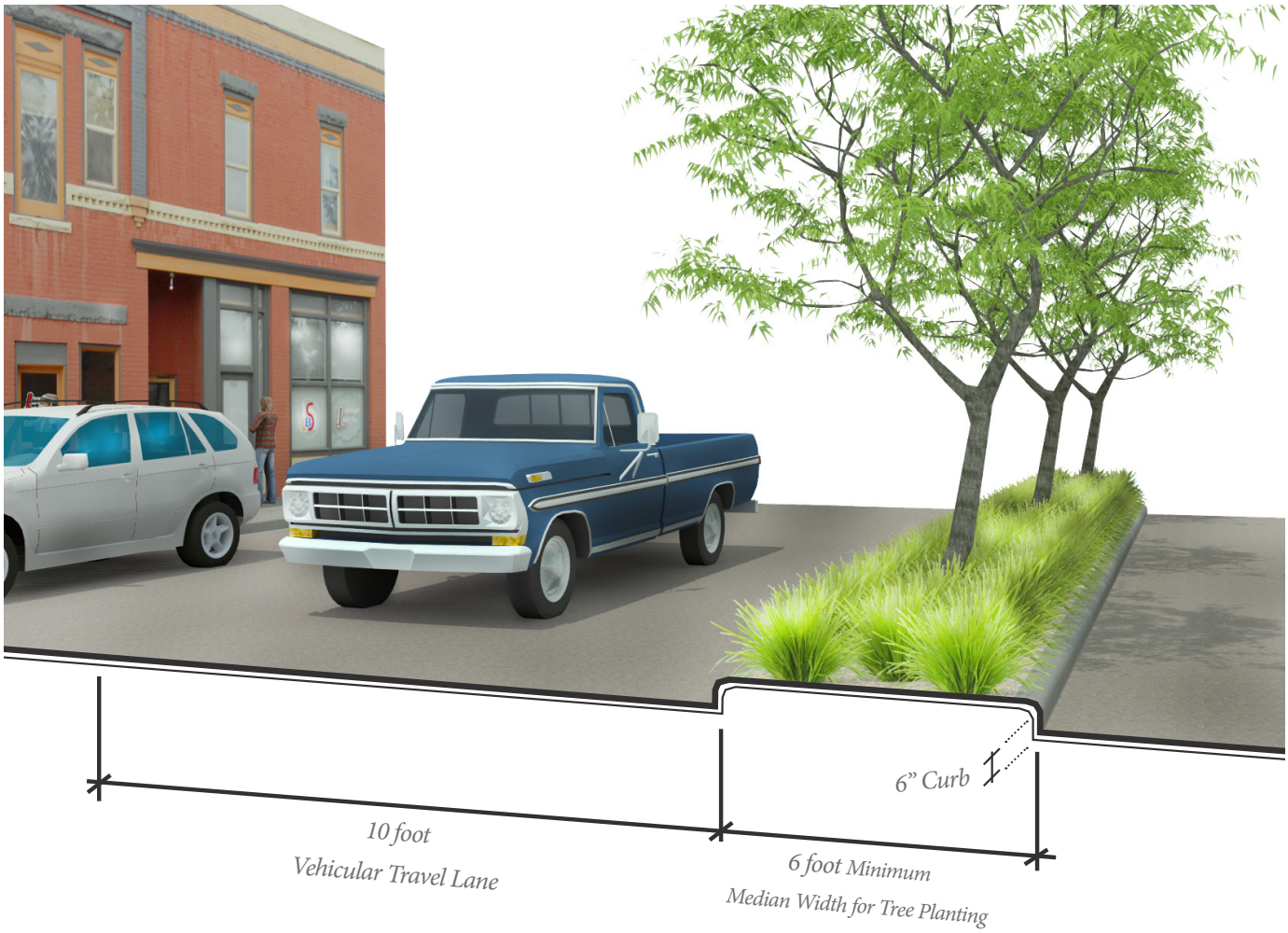
Further Considerations

For more specific Information and design criteria, see;

+ The Colorado Department of Transportation Roadway Design Guide 2005 at (http://www.coloradodot.info/business/designsupport/bulletins_manuals/roadway-design-guide)
+ The AASHTO A policy on geometric Design of Highways and Streets

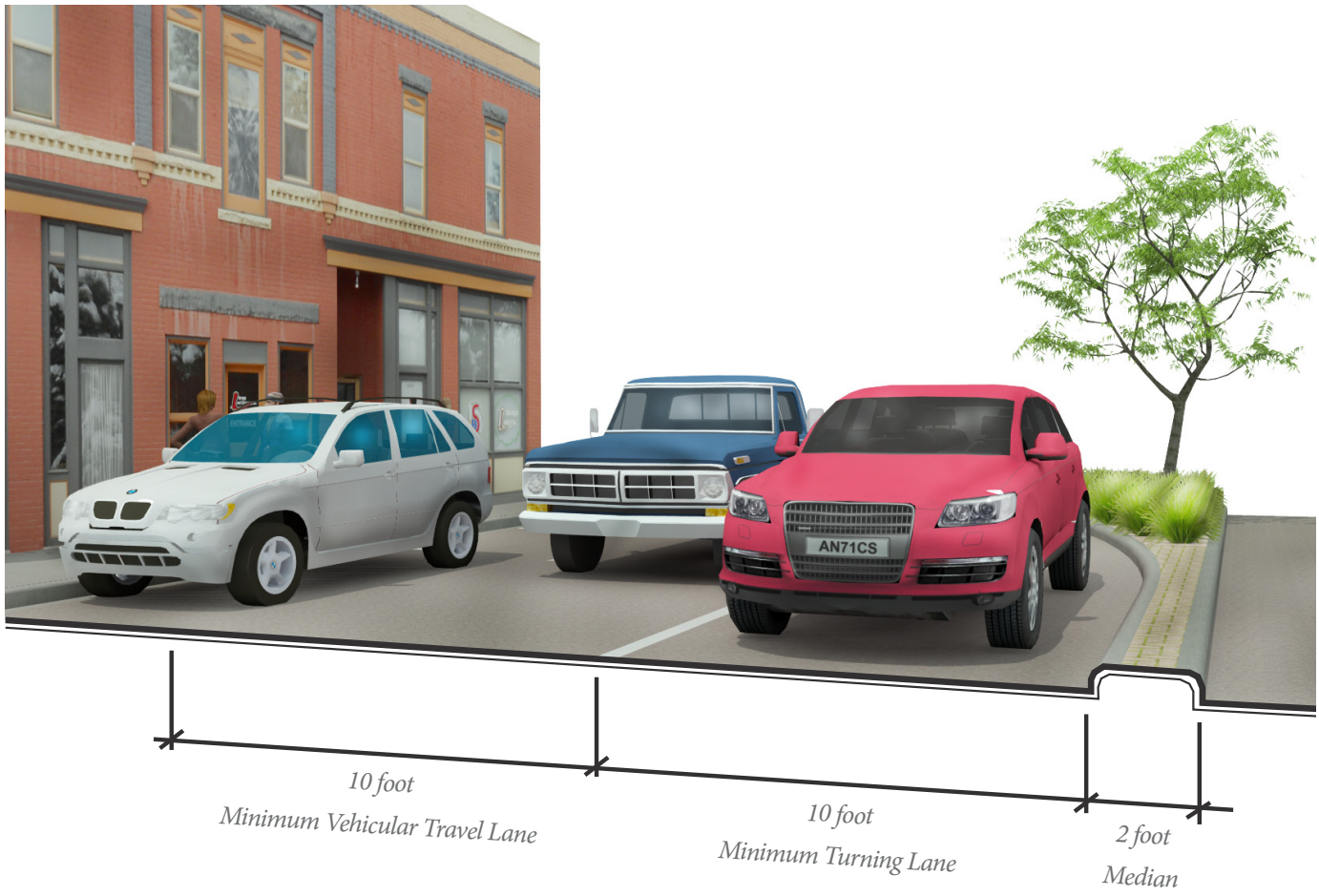
Pedestrian Refuge Median

figure 5.30 pedestrian refuge median (murner 2011)



Vegetated Median

figure 5.31 vegetated median (murner 2011)



Left Turn Median

figure 5.32 left turn median (murner 2011)

travel zone

pedestrian crossings | *standards & dimensions*

Introduction

Pedestrian crossings play a vital role to the street environment. Pedestrian crossings or crosswalks are defined as "the portion of a roadway designated for pedestrians to use in crossing the street" (Institute of Transportation Engineers, 1998). Although not always marked, crosswalks are implied at all intersections by pedestrians and motorists alike. Yet, when crossings are placed in unconditional areas, such as any mid-block location, special considerations must be made.

Although this section will provide basic considerations for designing, placing, and marking all pedestrian crossings, local agencies responsible for roadway design should be consulted to ensure all crossings are optimized for the safety and accessibility of all users. The following guidelines are not meant to address all the issues related to intersection design, but to emphasize the importance of considering all modes of travel.

Specific Criteria & Dimensions

Crosswalks

+ At all street intersections, marked crosswalks must be provided.
+ All crosswalk markings should be a minimum of 6ft wide and extend the full width of the street.
+ If bicycle crossings are incorporated, an additional width matching the bicycle lane must be provided and separately marked. (Zegeer 2002)
+ The sidewalk should provide sufficient space for pedestrian storage while waiting to cross the street. The size of this storage area is dependent on typical pedestrian activity and traffic signal time. (Zegeer 2002)
+ All crossings and curb treatments should meet the state, local or national FHWA, AASHTO, or ITE standards. For typical crosswalk marking considerations, see the Markings section.

Mid-Block Crossings

A mid-block crossing is any defined pedestrian crossing located between the street intersections. Mid-block crossings "provide alternative locations for pedestrians to cross – streets in areas with infrequent intersection crossings or where the nearest intersection creates substantial out-of-direction travel. (Metropolitan Service District 2002)"

Although not uncommon, "midblock crossings present some design challenges because motorists often do not expect pedestrians to be crossing at a midblock location. (FHWA 2010)" With this in mind, sightlines and crossing times are as critical to mid-block crossings as at a typical intersection.


figure 5.33

parinted cross-walk


figure 5.34

brick cross-walk

figure 5.35

inlay cross-walk

All criteria associated with crosswalks are applicable and mandatory for mid-block crossings. Although these guidelines provide some considerations toward the design and placement of mid-block crossings, consult a traffic engineer prior to implementing any mid-block crosswalks.

+ All crosswalk criteria, including standard dimensions, markings, and pedestrian storage considerations, must be considered when implementing any mid-block pedestrian crossing.

+ Mid-block crossings should be used in conjunction with curb-extensions to reduce pedestrian/vehicle conflict. Curb-extensions reduce crossing width and increase visibility for both the pedestrian and motorist alike. See Curb Extensions Guidelines.

+ On streets with low volumes of traffic and three or less traffic lanes, it is best to implement non-signalized mid-block crossings.
  - *Due to the low traffic volumes and speeds, pedestrians should find adequate gaps in traffic without signalized stops. (Zegeer 2002)*
  - *The use of signage warning drivers of approaching mid-block crossings can reduce conflict. (Zegeer 2002)*
  - *Pedestrian refuge medians should be used in conjunction with non-signalized mid-block crossings on any wide high volume streets. This will allow pedestrians to safely wait for traffic gaps. (Zegeer 2002)*

+ On streets with over three travel lanes and high traffic volumes, is it best to implement signalized mid-block crossings.
  - *Push-button pedestrian operated signals with immediate response are usually best to ensure proper use of the crossing. These "quick-response pedestrian push-buttons (Zegeer 2002 p. 33)" will reduce pedestrian and motorist frustration and conflict.*
  - *For in depth information of signalized crossings, consult the FHWA Manual of Uniform Traffic Control Devices. The manual provides specific information on justification for pedestrian signals based on pedestrian volumes.*

Markings

There are multiple styles of crosswalk markings and each has its own standards. This section will illustrate the common marking styles and the typical dimensions for each.

Common marking styles. See figure 5.36

+ Solid
+ Standard
+ Continental
+ Dashed
+ Zebra
+ Ladder

travel zone

pedestrian crossings | *standards & dimensions*

Specific Criteria & Dimensions Cont.

+ Crosswalk lines should extend the full width of the street.

+ In general, all pedestrian crossings must be no less than 6ft wide
    - *For standard and dashed styles, the gap between the markings must be no less than 6ft wide.*
    - *For solid and continental styles, the total marking width must be no less than 6ft wide.*
    - *For zebra and ladder styles, the interior markings must be no less than 6ft wide.*
    - *All parallel lines should be between 6" and 24" wide and spaced 1ft to 5ft apart. (FHWA 2010)*
    - *If diagonal or horizontal lines are used, they should be 12" to 24" wide and spaced 1ft to 5ft apart. (FHWA 2010)*

+ Materiality plays a critical role in crosswalk marking. Typical crosswalks are usually painted. Painted crosswalks are inexpensive but do little for aesthetic or nigh-time safety. Other materials include pavers, cobbles, colored concrete, or reflective tape.

+ *Reflective Tape crosswalks tend to be more durable and provide better visibility during low-light situations. At a minimum, all newly proposed sidewalks should use reflective tape to improve pedestrian safety.*

+ *Pavers, cobbles, and colored concrete provide aesthetic appeal to the traditional pedestrian crossings.*

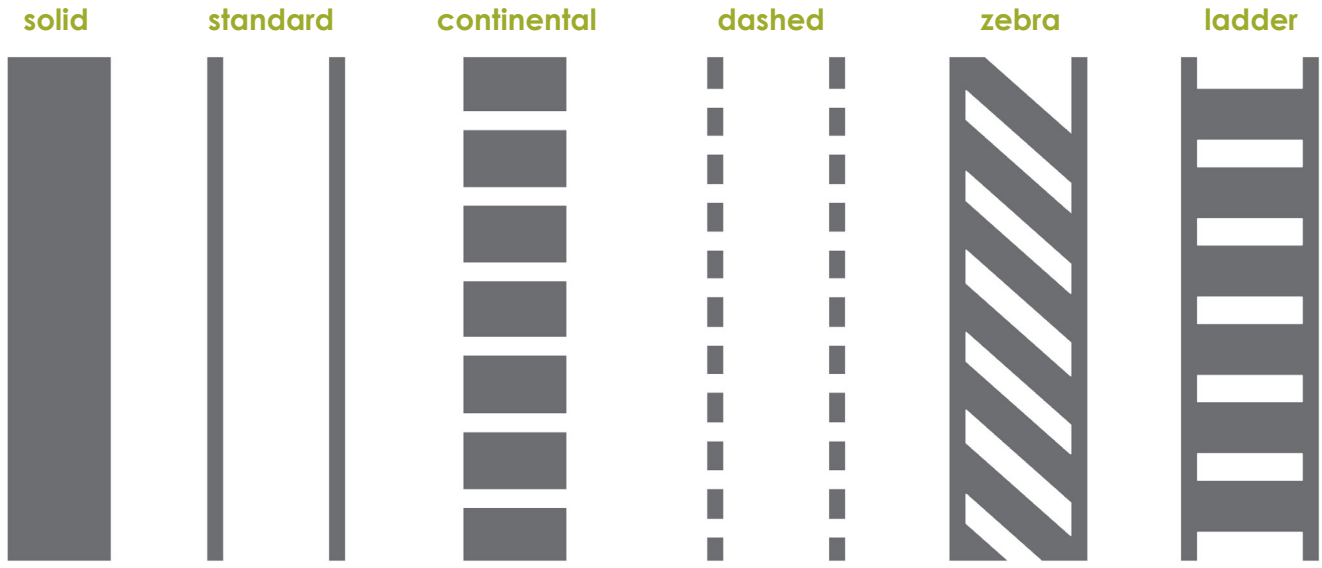
+ *The tactile qualities of these materials also provide way finding for visually impaired users.*

+ *Yet, nighttime visibility may be an issue. If used in conjunction with modern In-Roadway Warning Light systems, low-light visibility issues can be negated.*

Further Considerations

For more specific Information on pedestrian crossings, markings, and mid-block placement; consult the FHWA Pedestrian Facilities Users Guide – Providing Safety and Mobility at (http://permanent.access.gpo.gov/lps28597/peduserguide.pdf)

"Crosswalk markings alone are unlikely to benefit pedestrian safety. Ideally, crosswalks should be used in conjunction with other measures, such as curb extensions, to improve the safety of a pedestrian crossing, particularly on multi-lane roads with average daily traffic (ADT) above about 10,000. (Zegeer 2002 p. 52)" See Curb Extensions and Median Guidelines.



marking style	minimum standards	maximum standards
solid	6ft wide stripe (crosswalk width)	no maximum crosswalk width
standard	6in line width 6ft gap between lines (crosswalk width)	24in line width no maximum crosswalk width
continental	12in line width / 12in line spacing 6ft crosswalk width	24in line width / 5ft line spacing no maximum crosswalk width
dashed	6in line width 6ft gap between lines (crosswalk width)	24in line width no maximum crosswalk width
zebra	12in line width / 12in line spacing 6ft crosswalk width	24in line width / 5ft line spacing no maximum crosswalk width
ladder	12in line width / 12in line spacing 6ft crosswalk width	24in line width / 5ft line spacing no maximum crosswalk width

figure 5.36 typical cross-walk markings (Murner 2011 adapted from FHWA 2009)

travel zone

mass transit | *standards & dimensions*

Introduction

Although not common in most communities under 20,000 in population, many Rocky Mountain communities have local intercity transit systems to consider. The Summit Stage, Eco Transit, and Roaring Fork Transit Authority all have numerous stops within many of the representative communities. These and other regional transit systems can increase user diversity, thus increasing economic opportunities. With this in mind, it is important to consider accommodating these intercity transit systems within a Main Street redevelopment effort. The following guidelines provide some considerations for the design of these mass transit stops within a Main Street.

Specific Criteria & Dimensions

The typical dimensions of a bus stop depend on the location of the stop within the street. Within the minimum distances outlined, there can be no on-street parking. With this in mind, the minimum clear distance needed for nearside cross street mass transit stops is 100ft (TCRP 1996). Within the 100 ft minimum bus stop length;

+ The first 40ft is required for bus transition into the loading zone. (TCRP 1996)
+ The last 60ft is required for stopping and loading. (TCRP 1996) See figure 5.40

The minimum clear distance needed for farside cross street mass transit stops is 90ft. Within the 90 ft minimum bus stop length;

+ The first 40ft is required for stopping and loading. (TCRP 1996)
+ The last 50ft is required for bus transition into the adjacent traffic. (TCRP 1996) See figure 5.40

The minimum clear distance needed for mid-block mass transit stops is 140ft. Within the 140ft minimum bust stop length;

+ The first 40ft for is required for bus transition into the loading zone. (TCRP 1996)
+ The middle 60ft is required for stopping and loading. (TCRP 1996)
+ The last 50ft is required for bus transition into the adjacent traffic. (TCRP 1996) See figure 5.40

figure 5.37

summit stage transit

figure 5.38

ECO transit

figure 5.39

RFTA transit

Placement

The placement of transit stops is important to the safety and convenience of the users. Two major issues should be taken under consideration when placing a transit stop; destination and street crossing.

+ If a single or few major destinations exist within a community, placing the transit stop in a close relationship to these locations is best.

+ If no major destination exists, it is best to place transit stops near pedestrian crossings. Transit stops at major street intersections may be undesirable, thus placement near a mid-block crossing may be the best scenario.

Transit Shelters and Seating

+ Although shelters may be unnecessary for infrequent transit stops, nearby seating and refuge should be incorporated.

+ Associated with all transit stops should be information on schedules, stops, and routes.

+ All seating and shelter designs should match the other street amenity standards. See the Amenities Guidelines.

Further Considerations

+ The design and marking of transit stops should be marked and designated with the national standards set out by the Transit Cooperative Research Program. For more information see the TCRP Report 19: Guidelines for the location and design of bus stops or the regulations of the local transportation authority.

travel zone

mass transit | *stop locations & dimensions*

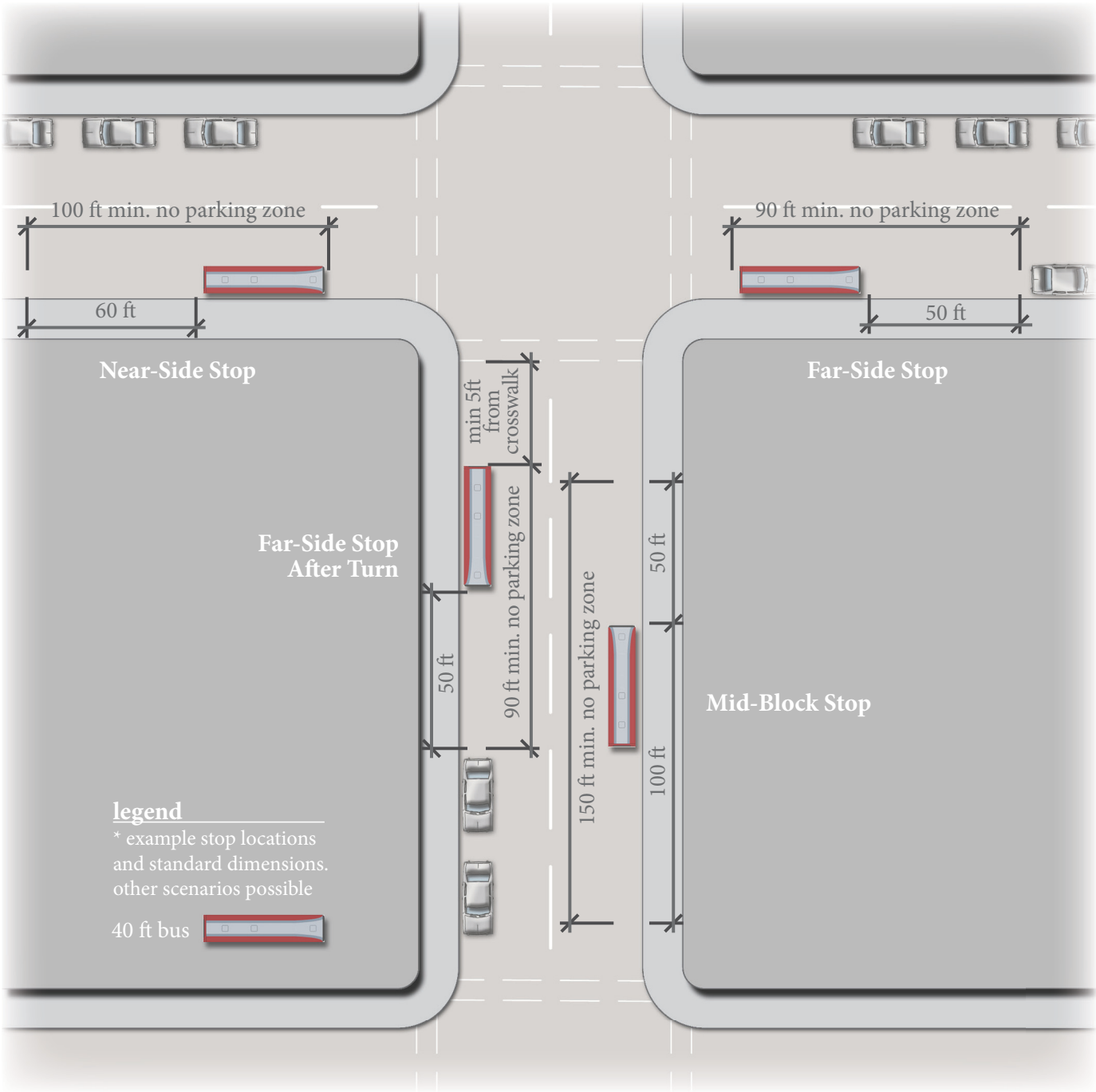


figure 5.40 typical mass transit locations & dimensions (murner 2011 adapted from TCRP 1996)

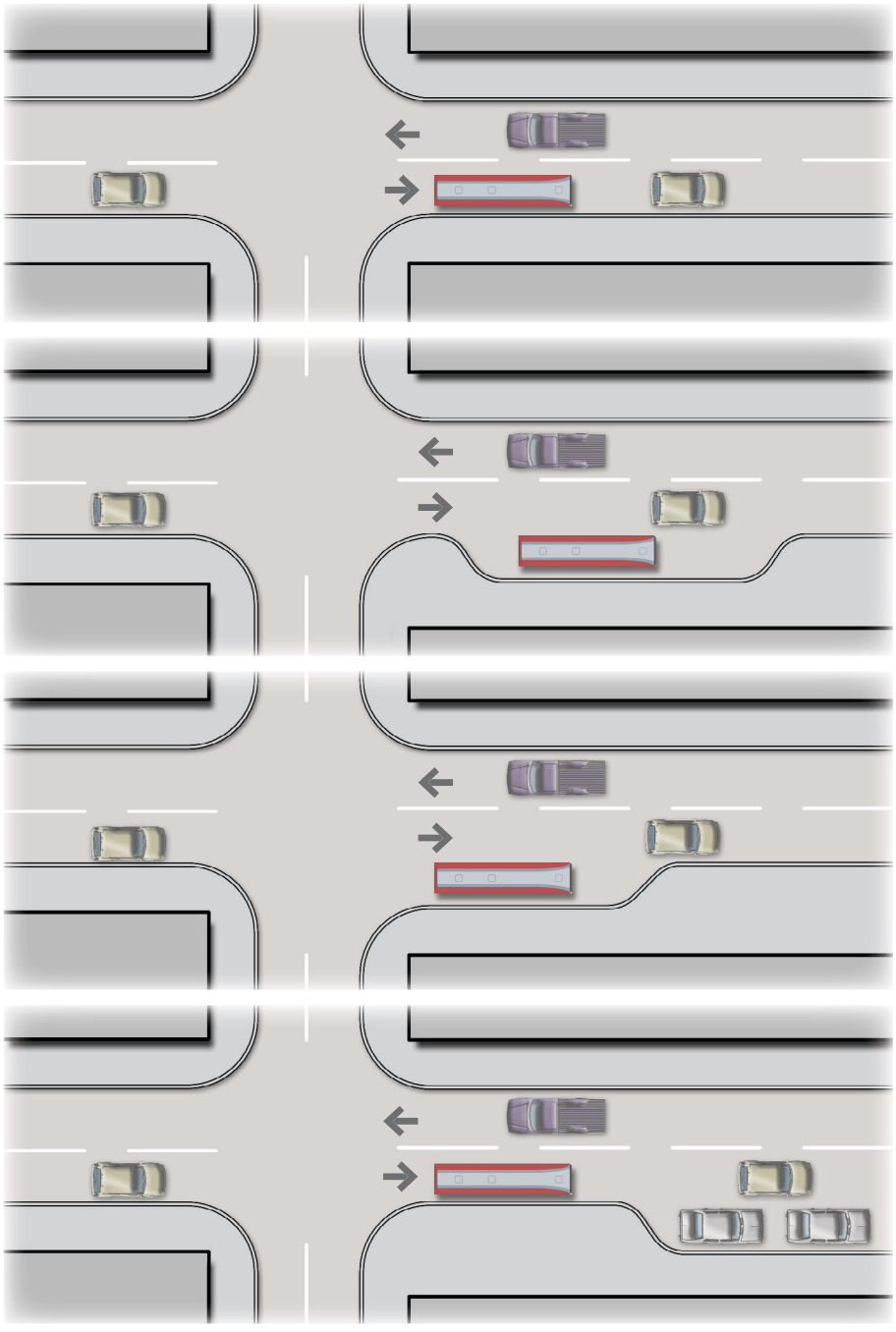


figure 5.41 typical mass transit location types (murner 2011 adapted from TCRP 1996)

pedestrian zone

sidewalks | *standards & dimensions*

Introduction

Sidewalks are critical to the success of any Main Street and are the primary pedestrian feature in all street design. Although sidewalks are typically thought of means of pedestrian movement, many other features and functions occur within them. Street lighting, trash receptacles, benches, vending machines, transit shelters, and café tables are all common features found within the sidewalk.

To accommodate not only free pedestrian movement, but also all the other auxiliary features, the typical minimum sidewalk width of 5ft is not adequate. With this in mind, the most important aspects to determine are the functions the sidewalk will accommodate. The following issues, alternatives, and guidelines provide the minimum and preferred widths for sidewalks. To allow for a variety of situations, the width and preferred dimensions are presented in terms of the pedestrian sub-zones; the Ingress Zone, the Sidewalk Zone, and the Amenity Zone.

Reference Code/ Issues & Alternatives

Pedestrian Zone

D-1| *Narrow*

D-2| *Average*

Limitations

Streets with a Narrow or Average Pedestrian zone must have gained extra space in one of the other street features. It is not possible to reduce the width of a Narrow or Average pedestrian zone, in fact in most cases these zones will require widening. As a rule, if the existing sidewalk width is less than 9ft, extra space is required from the adaptation of the parking or travel lanes features to fully accommodate free pedestrian movement and auxiliary features.

D-3| *Wide*

Limitations

Streets with wide pedestrian zones should not consider the sidewalk a feature where extra space can be gained. Wide pedestrian zones may be able to incorporate the three pedestrian sub-zones without adapting an adjacent land use. Yet, bicycle access is not considered to be part of the pedestrian zone. With this in mind, and streets with a wide pedestrian zone will still require the adaptation of either the travel lanes or parking features to incorporate bicycle lanes or widened vegetation areas.

figure 5.42

mixed two zone sidewalk

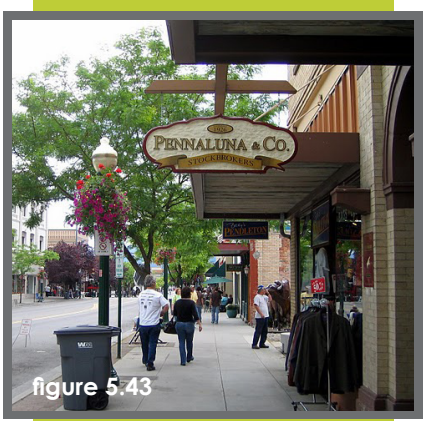


figure 5.43

three zone sidewalk

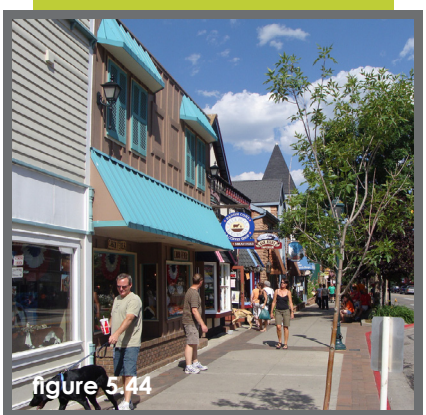


figure 5.44

three zone sidewalk

Specific Criteria & Dimensions

The most efficient way to provide specific criteria for sidewalks is to define specific information and dimensions for each of the pedestrian sub-zones. Thus, the subsequent dimensions are organized around the pedestrian movement, amenity, and ingress sub-zones.

Sidewalk Sub-Zone

+ The minimum sidewalk dimension for an ADA accessible sidewalk is 5ft wide (Harris et. al 1998). With this in mind, the minimum continuous width for the pedestrian movement sub-zone is 5ft.
    - *5ft is the minimum width that must be provided for pedestrian movement. More space is required for any amenity, vegetation, or building ingress.*

Amenity Sub-Zone

+ Depending on the type of amenities intended to occur within the zone, the width can vary.
+ For typical bench style seating, street lighting, and trash receptacles, the minimum amenity zone width is 3ft. (Watson et. al. 2003)
+ For street trees, the minimum amenity zone width is 6ft with a 10ft preferred width.
    - *As a note, for a continuous style planting trench or bed, the same minimum 6ft width is required. (Watson et. al. 2003)*
    - *Curb extensions into the parking zone can be included to reduce the space needed for street tree planting in the amenity zone. See Curb Extension Guidelines.*
+ To incorporate street trees and typical amenity features, the minimum amenity zone width is 6ft. (Watson et. al. 2003)
    + *For café tables and outdoor signage, added width adjacent to the building faced must be included. In all occasions, a minimum width of 5ft must be provided for free pedestrian movement.*

Ingress Sub-Zone

+ The ingress zone, where required for window-shopping and building ingress/egress, should be a minimum of 1.5ft wide. (Watson et. al. 2003)
+ The preferred dimension for the ingress zone is 3ft. This allows adequate space for pedestrian traffic to move unobstructed behind the window shopper. (Watson et. al. 2003)
+ If street trees only occur on occasion, it is possible to merge the amenity and ingress zones. If this situation occurs, the minimum width should be 4ft. (Watson et. al. 2003)

pedestrian zone

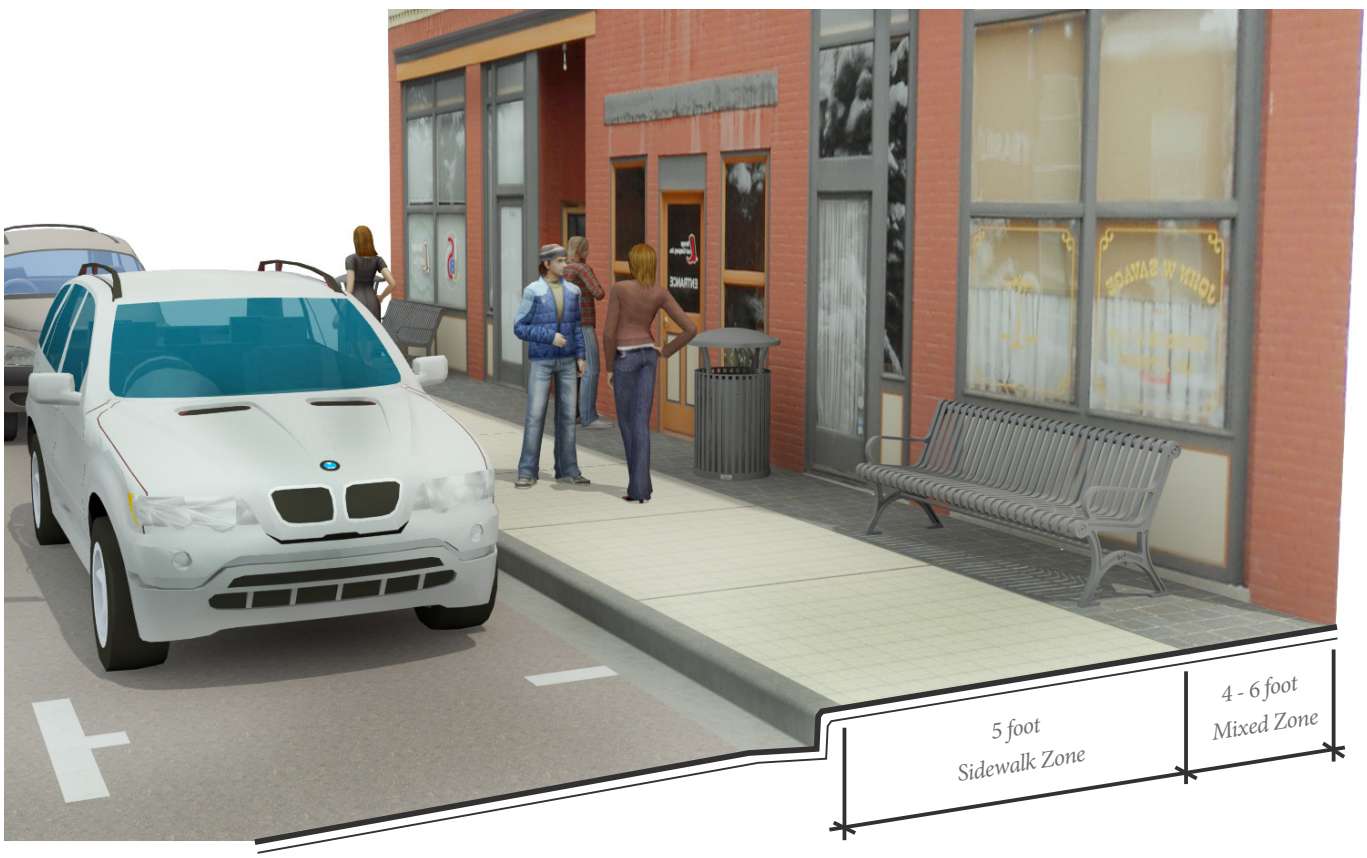
sidewalks | *standards & dimensions*

Specific Criteria & Dimensions Cont.

Pedestrian Zone Totals

+ The preferred minimum width for all pedestrian sub-zones is 9ft. See figure 5.45
  - *5ft wide Sidewalk Zone.*
  - *4ft wide combined ingress and amenity zone.*

+ The preferred width for all pedestrian sub-zones is 14ft. See figure 5.46
  - *5ft wide Sidewalk Zone*
  - *6ft wide amenity zone*
  - *3ft wide ingress zone*
  - *For café seating, another 4-6ft of width would be preferred to allow for removable tables.*



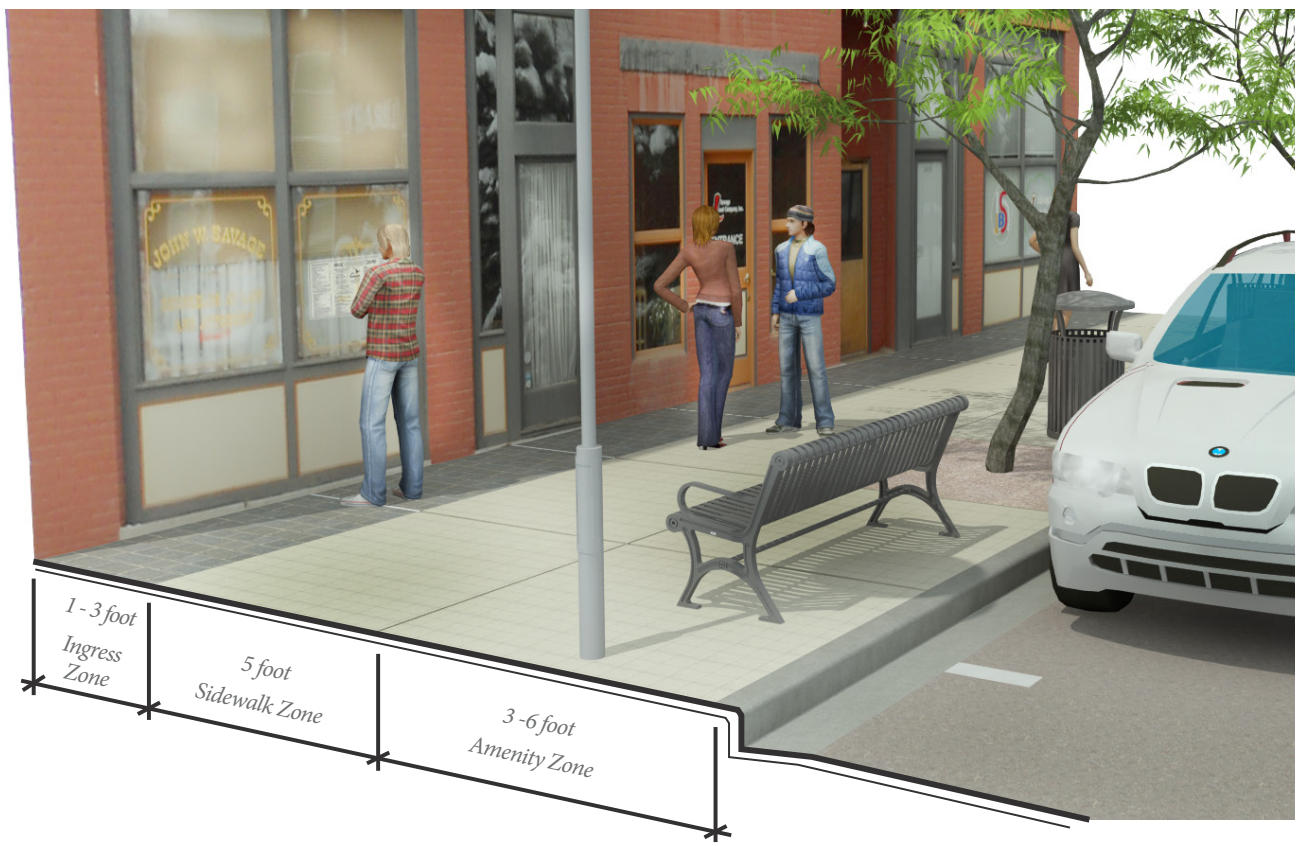
Mixed Zone Sidewalk

figure 5.45 two zone sidewalk diagram (murner 2011)

Further Considerations

In some narrow situations, the minimum 9ft width may not be possible to implement. In these rare situations, the minimum 5ft width for ADA accessible sidewalks must be provided. Curb extensions for street vegetation may also be an option for these narrow situations.

+ For more information on curb extensions, see the Curb Extension guidelines.
+ For specific information on spacing of amenities, see the Amenities guideline.
+ For specific information on the spacing of street trees, see the Street Tree guidelines.
+ An extended amenity zone intended for vegetation can also be used for Green Infrastructure. See the Green Infrastructure Guidelines



Three zone Sidewalk

figure 5.46 three zone sidewalk diagram (murner 2011)

pedestrian zone

curb extensions | *standards & dimensions*

Introduction

Curb extensions or bulb-outs extend the sidewalk out into the parking lane, effectively reducing the width of the street. The implementation of curb extensions not only reduce the pedestrian/traffic conflict by reducing the crossing length and increasing visibility, but curb extensions also offer opportunities for widening the amenity portion of the pedestrian zone. A widened amenity zone allows for street vegetation, benches, lighting, and other pedestrian friendly elements.

Curb Extensions at street intersections can replace turning lanes and mid-block crossing curb extensions can increase pedestrian visibility and reduce crossing distances. This narrowing of the traffic area can calm or slow adjacent traffic and create a more pedestrian friendly environment.

Specific Criteria & Dimensions

The specific dimensions for curb extensions can be ambiguous. The widest curb extensions extend the full width of the parking stall. Yet, in other cases where turning lanes exist, curb extensions may only extend into the travel way a few feet. The following criteria will explain some of the various locations and uses for curb extensions. Specific dimensions should be made on a case-by-case basis and reviewed by a traffic engineer.

Street Intersections

Curb Extensions at street intersections are a common feature. Curb extensions placed at intersections essentially prevent motorists from parking too close to an adjacent pedestrian facility. Although sizes can vary, a critical dimension to consider is the turning radii for various vehicle types. Although each vehicle type has different turning radii, all curb radii should be as tight as is practical. For most passenger vehicle oriented streets;

+ Curb extensions can extend the full width of the parking stall and should extend at least 20ft from the closest cross street intersection. See figure 5.50

+ Consult the AASHTO A policy on Geometric Design of Highways and Streets for more information.

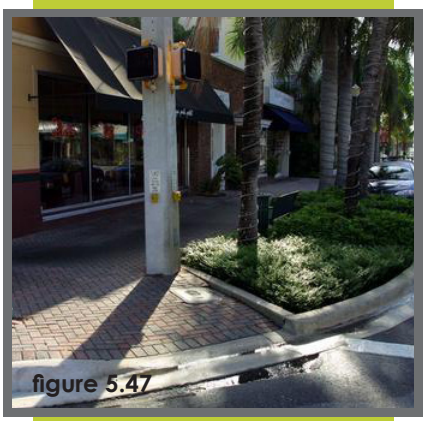


figure 5.47

intersection curb extension


figure 5.48

mid-block curb extension


figure 5.49

bike parking curb extension

Mid-Block Crossings

For Main Street Evolved, it is recommended that all mid-block crossings be incorporated within a curb extension. See figure 5.51

+ All sidewalks within a mid-block crossing curb-extension should have a minimum width of 5ft. (AASHTO 2002)

+ A vegetative buffer of at least 6ft should extend beyond the sidewalk on both sides. (Watson et. al. 2003)

+ The preferred width for a mid-block crossing curb extension is 17ft. This will allow for not only a sidewalk, but also street tree plantings.

    - *Any vegetation included into the design of a mid-block crossing should take into consideration vehicle and pedestrian sightlines. Near the traffic lanes, a 5ft wide sidewalk "T" should be incorporated to allow for sightlines. (AASHTO 2002)*

Parking Breaks

Parking break extensions are an alternative to extending the amenity zone to a minimum dimension for street trees. In essence, parking break extensions replace a painted stall marking. See figure 5.52

+ The minimum preferred width for parking break extensions is 6ft, but can extend the full width of the parking stall to allow for better root growth.

+ Parking break extensions are an effective means of integrating street vegetation, but severely reduce the number of parking stalls.

Further Considerations

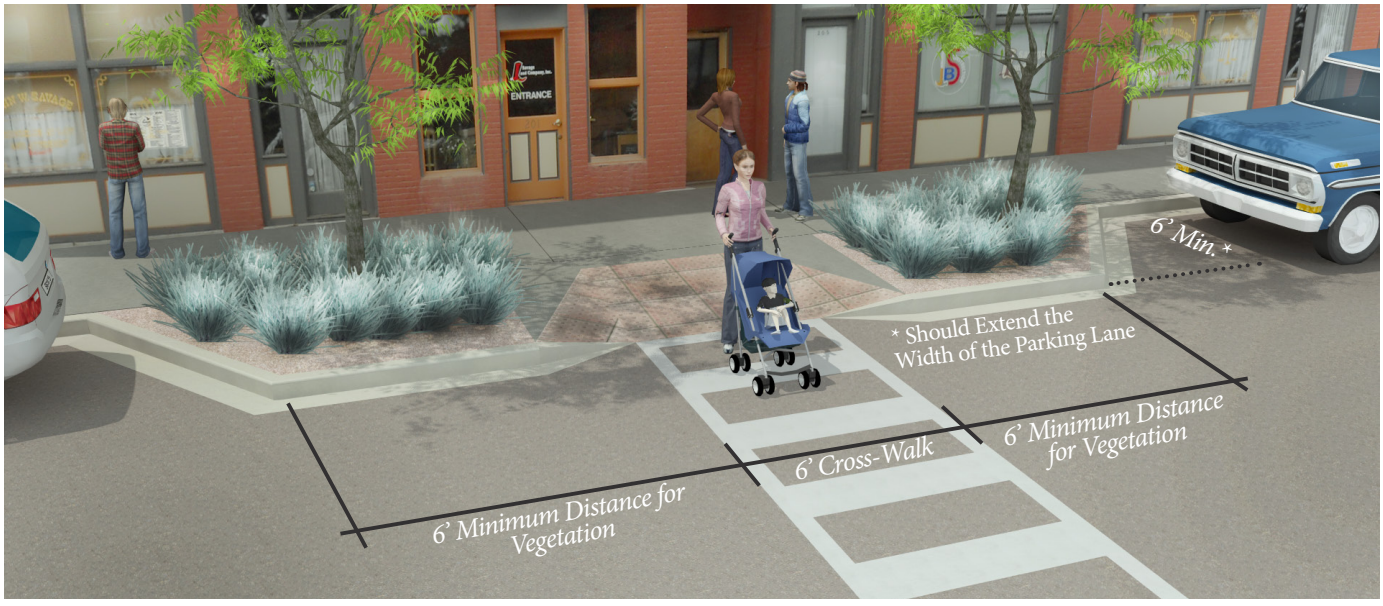
+ Curb extensions are an integral part of the pedestrian realm and should be incorporated into every street. The location and sizes are completely dependent on the street and the desired functions.

+ Curb extensions are only appropriate on streets with on-street parking. Other situations, curb extensions seem arbitrary and do nothing to improve pedestrian safety.

+ Curb extensions can also be used for Green Infrastructure. See the Green Infrastructure Guidelines

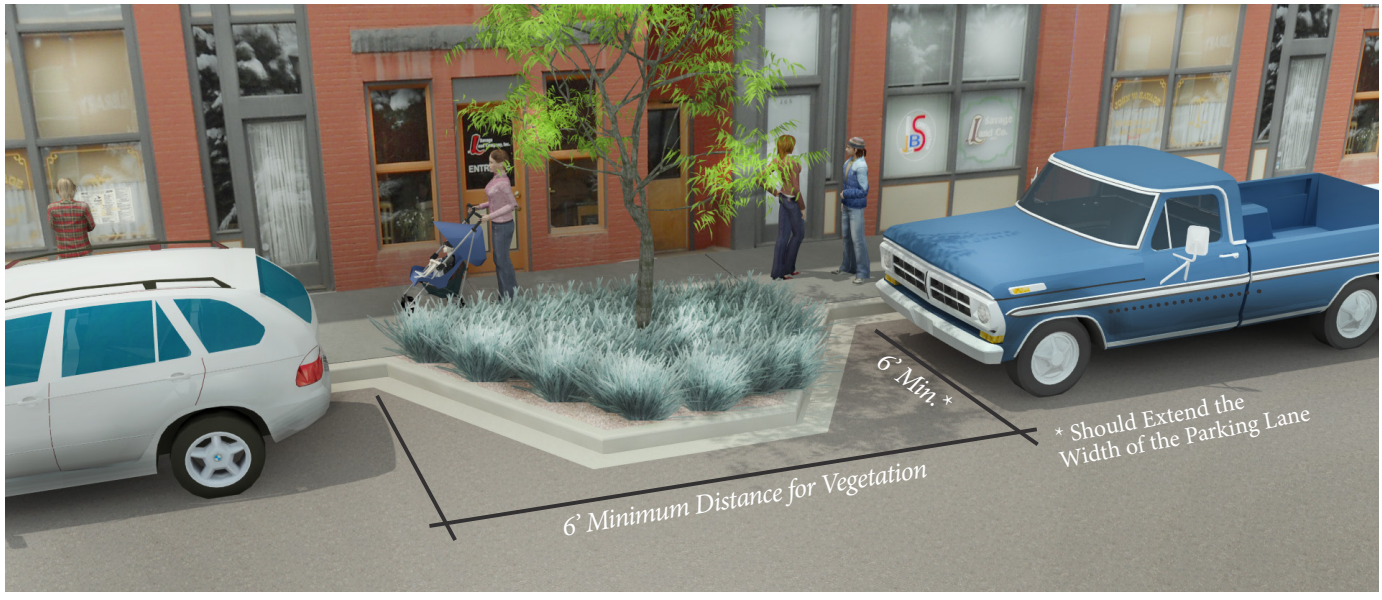
Curb Extensions at Major Intersections

figure 5.50 curb extensions at major intersection (murner 2011)



Mid-Block Curb Extensions

figure 5.51 curb extensions at mid-block locations (murner 2011)



Parking Break Curb Extensions

figure 5.52 parking break curb extensions (murner 2011)

pedestrian zone

street trees | *standards & dimensions*

Introduction

Street trees provide a multitude of benefits to a street environment. Street trees provide shade, moderate the local mico-climate, and aid in creating an aesthetically pleasing streetscape. In the design of modern streets, "the most effective expenditure of funds to improve a street would probably be on trees. (Watson 2003 p.6.3-7)"

Although the benefits of implementing street trees are great, there are some basic things to consider when placing and spacing the plants. In general, "Landscape designs should be arranged to permit a sufficiently wide, clear, and safe pedestrian walkway. (AASHTO 2002 p. 444)" Furthermore, sightlines and spacing are elements of street tree planting that will greatly affect the character and safety of a street.

Specific Criteria & Dimensions

Pit Design

In urban situations, "Inadequate planting structures, particularly ones with too little soil volume, are the leading cause of an epidemic of urban street tree deaths. Watson 2003 p.7.4-7)" The standards dimension for a tree pit has varied over the last few decades. Recent standards determine pit sizing based on soil conditions and mature tree size.

+ In healthy, well-drained soils, a tree pit 6in. deeper than the root ball and at least 6ft. square is adequate for most street tree species. (Watson et. al. 2003) See figure 5.57

Continuous Planter Strips

Although the typical square tree pit is adequate for the survival of most tree species, new designs solutions may increase the health of street trees. Continuous vegetation strips allow tree roots to extend beyond the typical bonding box.

+ Continuous planter strips have the same dimensional standards as a typical tree pit.

+ In healthy, well-drained soils, a planter strip 6in. deeper than the root ball and at least 6ft wide is adequate for most street tree species. (Watson et. al. 2003)

Spacing

Street tree spacing is effectively determined by the amount of space and planter configuration within the amenity sub-zone. See figure 5.56

+ If possible, it is best to incorporate a continuous planter strip to allow for maximum tree coverage within the Main Street.

+ If typical tree pits are desired, spacing can still allow for maximum tree coverage, but sacrifices to other amenity sub-zone functions may need to occur.


figure 5.53

tree lined street


figure 5.54

tree lined street

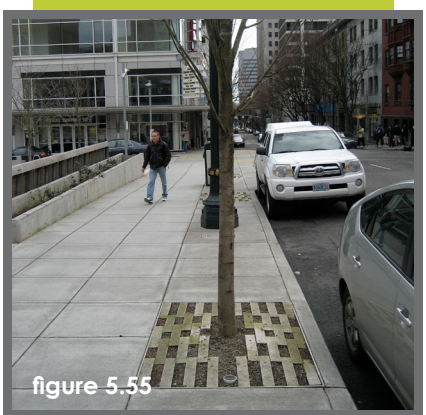


figure 5.55

unique tree pit design

In general, the specific spacing of street trees are subject to community preference and priority, but some standards have been created from other successful streets.

+ Wherever possible, a maximum spacing of 35 ft is an accepted standard for continuous tree lined streets. (Watson et. al. 2003)

+ The minimum spacing for street trees is somewhat ambiguous and can depend on species selection. As a rule, the minimum width for tree spacing should be between 20 and 25 ft. (Urban 2008 p. 348)

Sight Lines and Clear Zones

In urban situations, clear zones and sight lines are always a consideration for implementing any street feature. The American Association of State Highway and Transportation Officials recommends;

+ All planting should be outside an 18in clear zone from the curb, but because of the ambiguous growing habits of plants, 2 ft is better. *(AASHTO 2002)*

+ To ensure adequate sight lines, all tree limbs should be trimmed above 11ft on streets. *(AASHTO 2002)*

+ "Generous sight distances and unobstructed sight lines will allow motorists and pedestrians to detect each other in time to avoid collisions. Motorists also need appropriate sight distances to see traffic signals in time to stop. Sight lines should be designed so that the motorist can observe the movement of the pedestrian for a long enough period of time to accurately determine the pedestrian's speed. (FHWA 2010)"

Further Considerations

For more information on implementing vegetation along a street, consult the AASHTO A Guide for Transportation Landscape and Environmental Design.

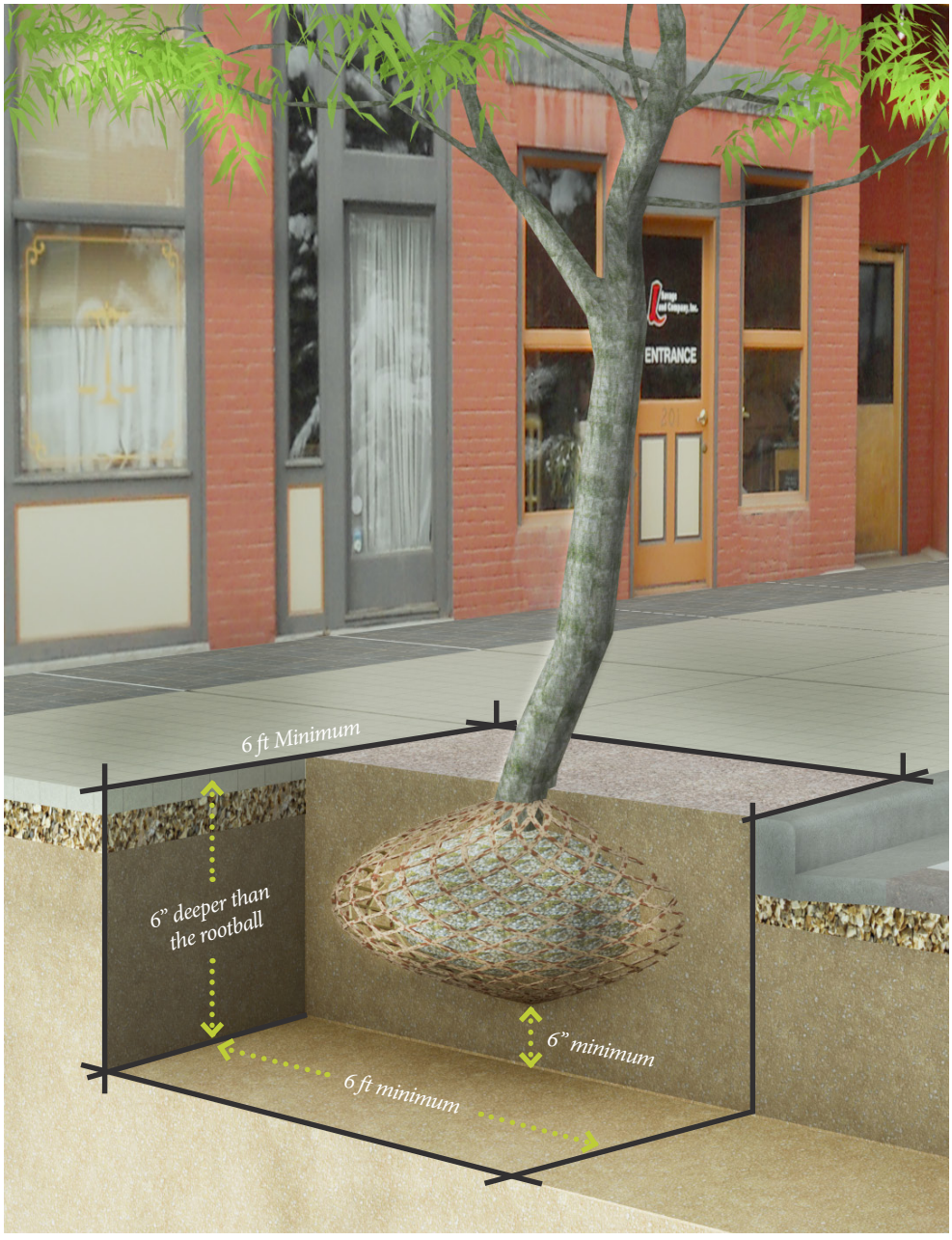
If possible, it is best to use tree planters for green infrastructure. This will maximize the function of the area devoted to the vegetation. See the Green Infrastructure Guidelines.

pedestrian zone

street trees | *standards & dimensions*

Street Tree Spacing

figure 5.56 street tree spacing (murner 2011)



Tree Planting Requirements

figure 5.57 tree pit & planter requirements (murner 2011)

pedestrian zone

streetscape amenities | *standards & dimensions*

Introduction

Streetscape features or amenities are the features that enhance the street environment and increase livability. Including lighting, seating, trash receptacles, signage, and outdoor activity spaces, streetscape amenities serve multiple functions within a street, from serving outdoor activity to increasing safety and comfort for pedestrians and motorists alike. Every street is unique and has its own conditions; the design decisions should reflect this fact.

Although the style and materiality of these elements is important to creating a cohesive streetscape design, these guidelines will focus on the placement and orientation of typical streetscape elements. For more information on style and materiality, see the material selection guidelines.

Specific Criteria & Dimensions

As a rule, it is important to understand a fundamental aspect of streetscape design. Street furniture is beneficial amenity to all streets, but can be an impediment to efficient traffic flow if placed improperly. (Watson et. al. 2003) Thus, it is important to place all streetscape amenities within a dedicated amenity zone; ensuring pedestrian traffic is not impeded.

+ Street furnishings should be placed at regular intervals and located in areas with protection from unpleasant climatic conditions. This will ensure familiarity and fulfill pedestrian expectations of elements.

+ Street furnishing placement should be logical in arrangement to avoid clutter or obstruction from pedestrian areas.

+ The design of any Streetscape feature and its placement should involve both aesthetic, safety, and comfort considerations


figure 5.58

potential bench placement

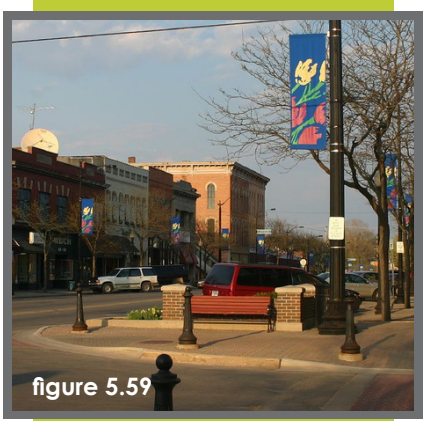


figure 5.59

potential bench placement


figure 5.60

potential trash placement

Seating

Although there is no specific standard for the amount or distance between seating elements, an important aspect to understand is that effective placement of any streetscape element should be derived from existing and perspective patterns of use. (Crankshaw 2009)

Organization is an important aspect of streetscape seating. Seating can be organized of oriented in a variety of ways. Depending on the situation, seating can be organized for;

+ Inward focused for user interaction
+ Outward focused for duel use purposes.
+ Functional seating near transit stops, cafes, or congregation areas.
+ Avoid placing seating only from an aesthetic point of view; this can result in unused or unnecessary elements cluttering a street. (Gibbons 1991)

Basic considerations toward basic human characteristics should be considered when choosing a seating style and size. Most pre-fabricated features will meet these basic human needs. Basic factors to consider when choosing the appropriate style and location for seating elements include;

+ Comfort
+ Sun/Shade effects
+ Maintenance
+ Function
  - *(Gibbons 1991)*

Bicycle Parking

With the inclusion of bicycle lanes, it is vital to provide adequate parking for bicycles. There are no specific standards for the location of bicycle racks, but it is important to locate racks so that they are convenient for cyclists and safe for pedestrians. (Crankshaw 2009) "Bicycle parking may be most appropriately located in larger areas near parking lots, where it may take on a purely utilitarian form. In other situations, it may be distributed throughout a commercial district, where the sculptural character of the racks may become more important. (Crankshaw 2009)

For more information on the design and placemnt of bicycle facilities, see the AASHTO Guide for the Development of Bicycle Facilities.

pedestrian zone

streetscape amenities | *standards & dimensions*

Specific Criteria & Dimensions Cont.

Trash Receptacles

Much like seating elements, there are few specific standards for the amount or placement of trash receptacles. This is most likely due to the various circumstances and conditions of an individual street. With this in mind, some basic considerations toward visibility and location should be understood.

+ A fundamental standard for the placement of trash receptacles is every 90 ft. If adjacent land uses result in large quantities of debris such as fast food retail, it may be prudent to provide trash receptacles more frequently. (Gibbons 1991)

+ Trash receptacles may be placed in various locations. In some cases, hanging refuse bins can be fixed to light poles, wall mounted, or freestanding. All scenarios are viable and specific placement is at community discretion. (Gibbons 1991)

+ Generally, refuse bins should be evident and opportune, but not obtrusive or problematic to street patrons. (Gibbons 1991)

Lighting

Streetscape lighting serves two basic functions to a street; safety and design. Safety lighting is meant to provide adequate lighting for both pedestrian and motor vehicle use during low light situations. Design lighting is typically used to accent specific locations, features, or evoke emotion. In both cases, light selection and placement is critical to success.

+ Local and state transportation boards set the minimum safety lighting illumination standards for roadways. For more information, contact your local agency or consult the AASHTO A policy on geometric Design of Highways and Streets. (Gibbons 1991)

+ For pedestrian areas, a higher level of illumination is needed than in street scenarios. It is best to provide pedestrian scale lighting elements in these situations. (Crankshaw 2009)

+ Design lighting is subjective to each street and feature scenario. To provide focus to a feature, flood and spot lighting should be implemented. (Gibbons 1991)

figure 5.61

potential light placement

figure 5.62

potential bike rack placement

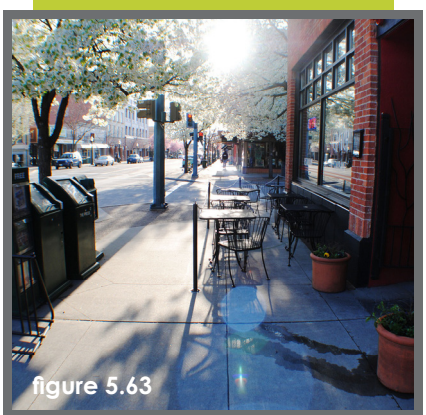


figure 5.63

potential dining placement

Height and Placement

+ In general, the height of all pedestrian lighting elements should be set to a height below that of 12 to 15 ft. In essence, it is best to ensure lighting elements do not shine into second-floor windows. (Crankshaw 2009)

+ If dual street/pedestrian lighting is implemented, design the height and cutoff angle to prevent light shining into the second floor windows of adjacent buildings. (Crankshaw 2009)

+ Make sure all lighting fixtures have appropriate shielding to prevent night sky light pollution.

+ It is best to create even lighting throughout a streetscape, in most cases this is best achieved by increasing the number of fixtures and decreasing the light intensity. (Crankshaw 2009)

Signage and Outdoor Dining

There are two primary forms of street signage; public and private. Public signage typically includes any way-finding, transportation, and community "image" graphics. Private sector signage and seating typically is directly related to an adjacent business. In both situations, it is imperative that the signage features do not encroach upon the pedestrian sidewalk. (Gibbons 1991)

+ The main consideration towards the placement of any signage or outdoor dining feature is its relationship to the sidewalk. There must always be a minimum of 5 ft of unobstructed sidewalk available for pedestrian movement. (Harris et. al 1998)

+ For public signage, utilizing existing light or signage poles will reduce street cutter. (Gibbons 1991)

Further Considerations

Unity in streetscape elements is essential to a street. In most cases, coordinating streetscape elements by style and materially will create a more cohesive street design. For more information, see the Material & Style selection Guideline.

pedestrian zone

green infrastructure | *standards & dimensions*

Introduction

Main Streets, even in the smallest of Rocky Mountain communities, need to accommodate a wide range of users and functions from pedestrians, motorists, cyclists, and on-street parking to pedestrian furniture, lighting, and vegetation. The goal of Main Street Evolved is to accommodate not only all of the previously mentioned users and functions, but also integrate on-street stormwater management. Finding the space to collect and manage stormwater in conjunction with the other street functions can seem like a daunting task.

Yet, there are a number of stormwater solutions that can be incorporated within some of the previously discussed street features. Curb extensions, vegetated planters, tree pits, and even on street parking areas can be used to collect, clean, and manage on street stormwater. With this in mind, limitations related to the street topography and orientation should be considered.

Reference Code/ Issues & Alternatives

Topography

E-1|*Level*

Limitations

Streets with a Level topography have the potential of integrating green infrastructure features to both sides of the street. Yet, the orientation of the street should be considered. Any street with an E/W orientation should consider only placing green infrastructure on the north side of the street due to sun/shade patterns and spring snow melt.

E-2|*Profile*

Limitations

Streets with profile topography have the same potentials and drawbacks for integrating green infrastructure as streets with a level topography. Yet, streets with significant profile topography must consider slowing stormwater velocity prior to it entering any green infrastructure feature. If left unchecked, high velocity stormwater can degrade any green infrastructure feature.

E-3|*Cross-Section*

Limitations

Streets with significant cross-section topography are limited to placing green infrastructure features only on the downhill side of the street. Cross-section topography limits the placement of any green infrastructure features and considerations toward street orientation may need to be negated if green infrastructure is consider a primary objective. Special care should be given to plant selection within a shaded portion of the street.


figure 5.64

stormwater treatment train

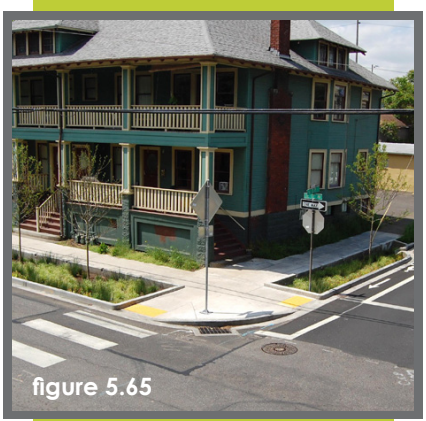


figure 5.65

curb extension system


figure 5.66

sidewalk system

Orientation

F-1|*N/S*

Limitations

Streets with a North/South orientation allow sun to reach both sides of the street throughout the year and as such represent the ideal situation. If on-street snow storage is desired, there is potential to distribute it on both sides of the street.

F-2|*E/W*

Limitations

Streets with an East/West orientation only allow direct sunlight to the north side of the street. This orientation results in poor snow melt and vegetation damage issues during the winter months. If on-street snow storage is desired, it should be focused on the north side of the street to expedite the melting process on fair days. In addition, any green infrastructure elements should also be focused to the north side of the street to reduce the potential for winter vegetation damage from snow storage.

F-3|*NE/SW*

Limitations

Streets with a Northeast/Southwest orientation allow direct morning sunlight to both sides of the street and limited afternoon exposure on the northeastern side of the street. If on street snow storage is desired, it should be focused on the northeastern side of the street to expedite the melting process on fair days. In addition, a majority of the green infrastructure elements should also be focused to the northeastern side of the street to reduce the potential for winter vegetation damage from snow storage.

F-4|*NW/SE*

Limitations

Streets with a Northwest/Southeast orientation allow direct afternoon sunlight to both sides of the street and limited morning sunlight on the northwestern side of the street. If on street snow storage is desired, it should be focused on the northwestern side of the street to expedite the melting process on fair days. In addition, a majority of the green infrastructure elements should also be focused to the northwestern side of the street to reduce the potential for winter vegetation damage from snow storage.

pedestrian zone

green infrastructure | *standards & dimensions*

Specific Criteria & Dimensions

Although there are multiple green infrastructure types that can be integrated into various street types, in most urban commercial applications, curb extensions, stormwater planters, and permeable paving are the standard.

Stormwater Planters

Stormwater Planters are typically "long, narrow landscaped areas with vertical walls and flat bottoms, typically open to the underlying soil. -- Water flows into the planter, absorbs into the plants and topsoil, fills to a predetermined level, and then, if necessary, overflows into a storm sewer system. (USEPA 2009 p. 4) See figure 5.70

The size of a stormwater planters somewhat depends on the space available, type of vegetation to be planted, and quality of the urban soil. But, in general;

+ Stormwater planters are typically between 12 and 18in. below the surface of the sidewalk. For safety reasons, all stormwater planters include a raised curb of at least 4 in. (City of Eugene 2008)
    - *For communities wishing to increase safety measures, a 4ft railing may be incorporated into the curb to reduce falling concerns.*

+ Once lowered to the desired finished height, the removal of existing soil to a depth of at least 18 in is required. Replace the removed 18in with either top or structured soil. (Metropolitan Service District 2002)
    - *The replaced 18in will provide adequate growing medium for new plants and temporary storage of rainwater.*
    - *For areas with poor, clayey soils, additional depth may be required to increase water-holding capacity. (Metropolitan Service District 2002)*

+ The width of the stormwater planter can vary. In modern applications, the width varies from between 3ft to 10ft. Although not required, for any stormwater planter strip that integrates street trees; a width of over 4 ft is best. (City of Portland 2008)

+ Stormwater Planter principles can be applied to tree pit design as well. The same conditions used to determine sizing for a stormwater planter should be used to size a stormwater tree pit.


figure 5.67

mid-block extension system


figure 5.68

curb extension system


figure 5.69

curb extension system

Stormwater Curb Extensions

Stormwater curb extensions essentially are street based "rain gardens typically located near the corners that can also provide the pedestrian with a more comfortable crossing. Curb extensions can also be located mid-block by converting one or more parking spaces. (USEAP 2009 p.5) Stormwater Curb extensions typically are vegetated depressions that retain and treat urban stormwater from the street, rooftops, and sidewalks. See figure 5.71

The design and sizing of a curb-extension "rain garden" is unique to the particular street and surrounding conditions. Yet, there are five basic things to consider when sizing a rain garden;

+ Total area and Volume of the Curb extensions
+ Stormwater catchment area
+ Stormwater event intensity
+ Native soil infiltration rate
+ Imported Medium infiltration rate

For more information on sizing a Curb Extension rain garden, consult "Urban Waterways: Designing Rain Gardens (Bio-Retention Areas)" at http://www.bae.ncsu.edu/stormwater/PublicationFiles/DesigningRainGardens2001.pdf

Permeable Paving

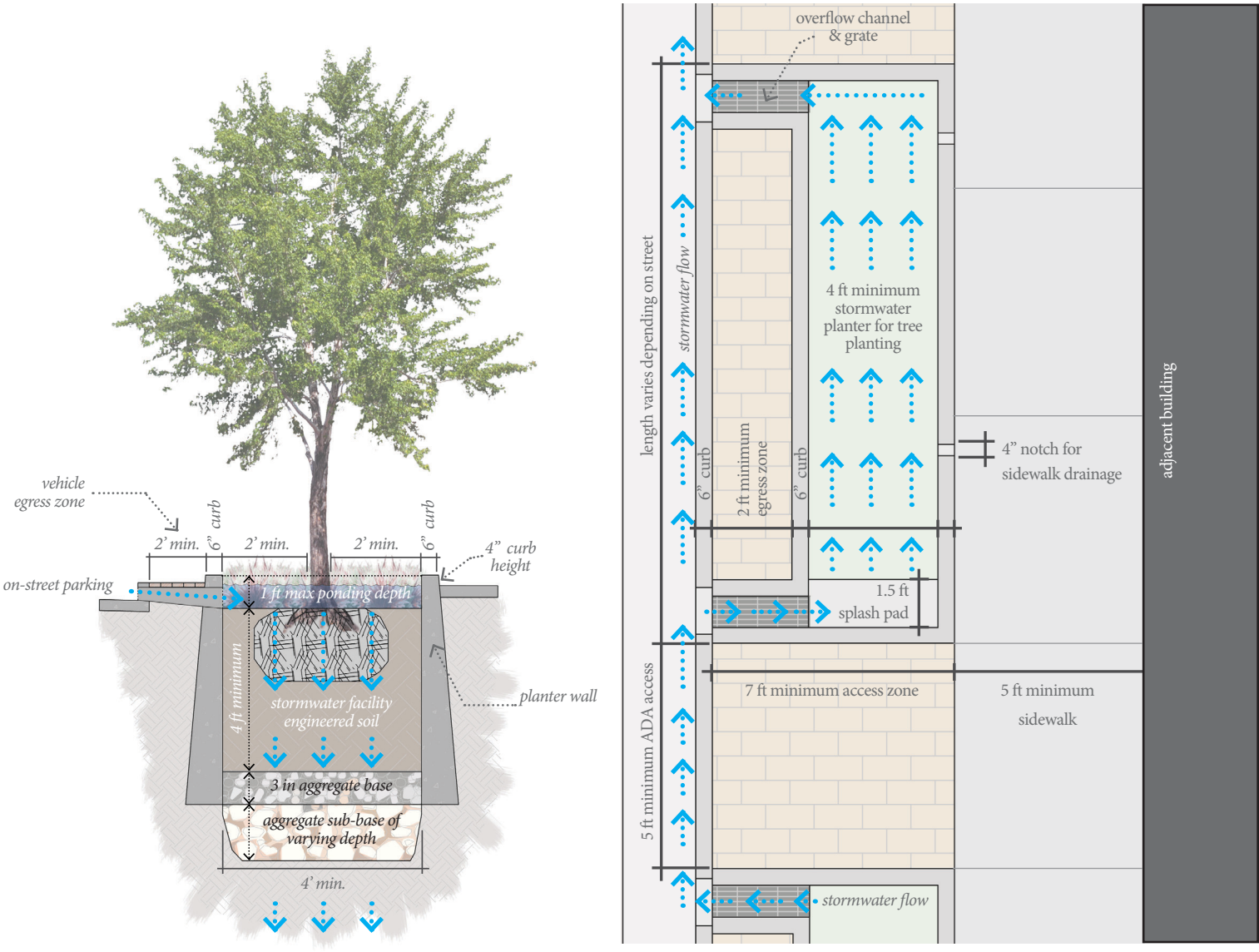
Permeable paving is a common technique used in many urban situations. Although permeable paving has the potential to treat urban stormwater, due to icing, snow management, and salt/sand use; permeable paving in cold climates may become clogged and have a severe reduction in stormwater infiltration. With this in mind, the use of permeable paving in a Rocky Mountain context should be limited.

Further Consideration

The United States Environmental Protection Agency has a plethora of information on green infrastructure at http://cfpub.epa.gov/npdes/home.cfm?program_id=298.

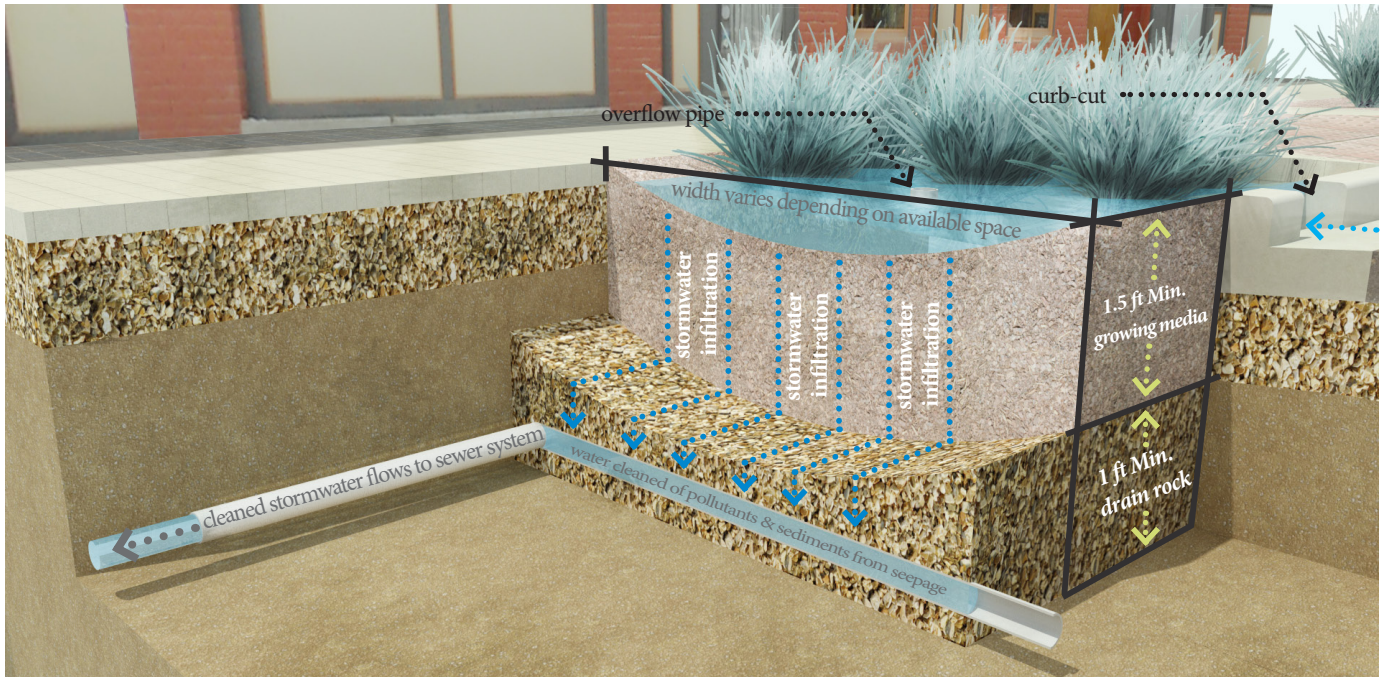
For more information on policy, codes, vendors, and other stormwater management techniques, see the City of Portland Oregon Stormwater Management Manual at http://www.portlandonline.com/bes/index.cfm?c=47952

For information on selecting plants to utilize with any green infrastructure feature, consult the Plant Selection: Green Infrastructure guideline.



Stormwater Planter for Tree Planting

figure 5.70 stormwater planter plan & section for tree planting (murner 2011 adapted from City of Portland 2008)



Curb Extension Stormwater Infiltration & Cleaning Process

1. Rainwater enters the system through curb cuts
2. Water spreads & ponds while plants collect debris
3. Rainwater infiltrates through the growing media & drain rock where pollution & sediments are trapped.
4. Cleaned stormwater flows into a perforated drain tile and is transported into the adjacent storm sewer
   *overflow pipe should be placed at a low enough elevation to prevent flooding

Stormwater Curb Extension

figure 5.71 stormwater infiltration curb extension (murner 2011 adapted from City of Portland 2008)

contextual zone

material & style | *standards & dimensions*

Introduction

Within the contextual zone, the guidelines focus on creating, continuing, or restoring the image of a place. In many cases, a strong historical sense remains, yet in others a majority of this historical image has been lost. In both of these situations, it may be prudent to recreate or modernize the historical character. If there is little historical character remaining, a community can begin to create their own identity or image from new.

In each scenario, the selection of the material and style for streetscape features can play a critical role in creating or recreating this identity. With this in mind, there are some fundamental issues to consider when selecting materiality and style for any paving, street furniture, lighting, or signage feature.

Specific Criteria & Dimensions

Materiality & Style

For communities with a strong historical presence, care must be taken when selecting any modern historic replacement feature.

+ It is prudent to document the historical or traditional materials and styles remaining on the main street before selecting a replacement. (Crakshaw 2009)
+ Once documented, use the historical features as a model for the selection of contemporary replacements. (Crankshaw 2009)
+ Contact a manufacturer with specific dimensions or images to recreate the historic feature and then implement the features in a manner that is similar to their original purpose and location. (Crankshaw 2009)
+ If specific historical documentation is unavailable, select a modern feature that complement the existing architectural style. It is not recommended to select any imitation or mock street feature that may or may not have been similar to historical features.
    - This can result in a false image or "Disney" quality to the community. (Crakshaw 2009)

figure 5.72

sample seating

figure 5.73

sample lighting

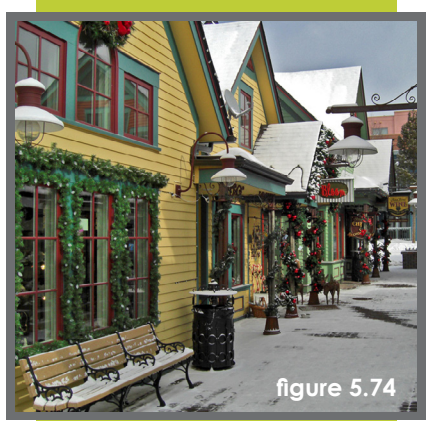


figure 5.74

sample sidewalk

figure 5.75

sample seating

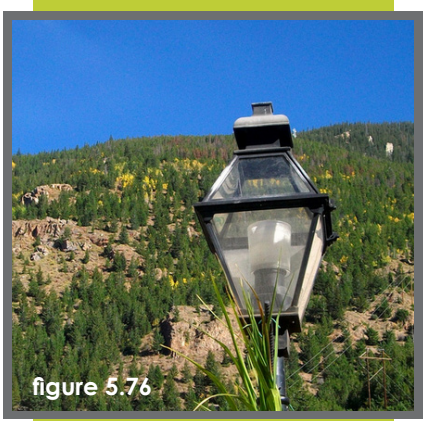


figure 5.76

sample lighting

figure 5.77

sample sidewalk

For communities without a strong historical presence, an opportunity exists to create a completely new standard for materials.

+ If a style is prevalent within the adjacent architecture, it may be best to find a complimentary material that begins to tie the architecture to the street. (Crankshaw 2009)

+ If there is no major architectural character or style, the selection of a standard material and style will begin to create a sense of unity within an otherwise ambiguous street.

+ In these situations, the designer, planner, or official has a prime opportunity to create a image for their community. This opportunity should not be taken lightly and community involvement is strongly recommended.

Further Considerations

The material and style of street features can begin to evoke connections to the historical past of a community. Yet, street feature material and style alone may not evoke the strong physical, psychological, and social connections between people and the surrounding environment. Integration of locally identifiable planting material is needed to integrate not only the built environment, but also the ecological environment. See the Plant Selection Guideline.

contextual zone

plant selection | *standards & dimensions*

Introduction

Due to the semi-arid climate of Colorado, it is important to rethink the method of selection plants for a streetscape. To reduce water needs, input costs, and increase plant life expectancy, it is necessary to select plantings that will survive without a large quantity of supplementary irrigation. Yet, it is also important to understand that due to the semi-arid nature of Colorado's climate, supplemental irrigation is necessary even for native vegetation. Even within stormwater planters, it will be necessary to provide supplemental irrigation.

Reference Code/ Issues & Alternatives

Elevation

G-1|*Foothills*
G-2|*Montane*
G-3|*Sub-Alpine*

Limitations

Although plants natively occur at specific elevation ranges, due to the urban context of each community, limiting plant choice to only those found naturally at the existing elevation zone may not be desirable. For example, most native tree species make poor street trees. If possible, the use of native plants is best if they fit the intended use.

Precipitation

I-1|*Semi-Arid Dry*
I-2|*Semi-Arid*
I-3|*Semi-Arid Wet*

Limitations

Although each community has varying amounts of yearly rainfall, irrigation will be required to sustain plant life. This includes any standard street vegetation and green infrastructure feature. Considerations toward plant selection will be critical to ensure minimal irrigation requirements.

Specific Criteria & Dimensions

It is important to understand some basic principles to minimize irrigation needs. To maximize irrigation efficiency, it is best to group plantings by water needs. Plants requiring the highest amount of water should be placed on the lowest elevation of a planter. Plants requiring the lowest amount of water, should be placed in the highest elevation within a planter.

Further Consideration

Although native plant choices are preferred, non-invasive/non-native plants may be the best choice in certain situations. For assistance and further information on plant selection, contact the Colorado State University Extension office at http://www.ext.colostate.edu/

Non-Native Trees for Mountainous Areas

Scientific Name	Common Name	Planting Altitude	Life Zone	Moisture	Evergreen/ Deciduous
Acer ginnala	Amur Maple	To 8,500	Plains - Montane	M	D
Acer tataricum	Tatarian Maple	To 8,500	Plains - Montane	M	D
Alnus glutinosa	European Alder	To 8,000	Plains - Montane	H	D
Amelanchier canadensis	Shadblow Serviceberry	To 8,000	Plains - Montane	M	D
Celtis occidentalis	Common Hackberry	To 7,000	Plains - Montane	L - M	D
Crataegus ambigua	Russian Hawthorn	To 9,000	Plains - Montane	L - M	D
Crataegus crus-galli	Cockspur Hawthorn	To 8,000	Plains - Montane	L - M	D
Crataegus x mordenensis 'Torba'	Toba Hawthorn	To 8,500	Plains - Montane	L - M	D
Fraxinus pennsylvanica	Green Ash	To 7,500	Plains - Montane	L - M	D
Gymnocladus dioica	Kentucky Coffeetree	To 7,500	Plains - Montane	L - M	D
Malus 'Dolgo'	Dolgo Crabapple	To 8,000	Plains - Montane	M	D
Malus 'Radiant'	Radiant Crabapple	To 8,000 -8,500	Plains - Montane	M	D
Malus 'Spring Snow'	Spring Snow Crabapple	To 8,000	Plains - Montane	M	D
Malus 'Thunderchild'	Thunderchild crabapple	To 8,000	Plains - Montane	M	D
Populus alba	silver poplar	To 8,500	Plains - Montane	M - H	D
Populus tremula 'Erecta'	Upright European Aspen	To 8,500	Plains - Montane	M	D
Prunus virginiana 'Schubert'	Schubert Chokecherry	To 8,500	Plains - Montane	L - M	D
Prunus cerasifera 'Newport'	Newport Plum	To 7,000	Plains - Montane	M	D
Pyrus ussuriensis	Ussurian Pear	To 8,000	Plains - Montane	L	D
Salix alba	White Willow	To 7,500	Plains - Montane	H	D
Sorbus aucuparia	European Mountainash	To 8,500	Plains - Montane	M	D
Syringa reticulata	Japanese Tree Lilac	To 7,000-7,500	Plains - Montane	L - M	D

1. Planting altitudes are estimates, plants may be planted at lower or higher zones with supplemental irrigation.
2. Moisture Requirement: L - Low, M - Moderate, H - High
3. In most cases, plants prefer full sun to part shade
4. For an extensive list of Colorado Native Trees, consult Appendix | table A.1 Colorado Water Wise Plant List

table 5.1 non-native trees for mountainous areas (murner 2011 adapted from Klett et.al. 2005)

Non-Native Shrubs for Mountainous Areas

Scientific Name	Common Name	Planting Altitude	Life Zone	Moisture	Evergreen/ Deciduous
Aronia arbutifolia melanocarpa	Red Chokeberry	To 7,500	Plains - Montane	M - H	D
Aronia melanocarpa	Black Chokeberry	To 8,000-8,500	Plains - Montane	M - H	D
Berberis thunbergii	Japanese Barberry	To 7,500-8,000	Plains - Montane	L - M	D
Caragana arborescens	Siberian Peashrub	To 10,000	Plains - Subalpine	L - M	D
Cotoneaster lucidus	Hedge Cotoneaster	To 10,000	Plains - Subalpine	L	D
Euonymus alatus	Burning Bush	To 7,500	Plains - Montane	M	D
Forsythia x hybrida	Forsythia	To 7,500	Plains - Montane	M	D
Juniperus horizontalis	Creeping Juniper	To 7,000	Plains - Montane	L	E
Juniperus sabina	Savin Juniper	To 8,000	Plains - Montane	L - M	E
Ligustrum vulgare 'Cheyenne'	Cheyenne Privet	To 7,500	Plains - Montane	L	D
Lonicera korolkowii	Blueleaf honeysuckle	To 8,000	Plains - Montane	L	D
Philadelphus lewisii	Lewis Mockorange	To 8,000	Plains - Montane	L - M	D
Physocarpus opulifolius	Common Ninebark	To 8,500	Plains - Montane	L - M	D
Prunus tomentosa	Nanking Cherry	To 8,500	Plains - Montane	L - M	D
Prunus x cistena	Purpleleaf Sand Cherry	To 8,000	Plains - Montane	M	D
Rhus typhina	Staghorn Sumac	To 7,500	Plains - Montane	L - M	D
Ribes alpinum	Alpine Currant	To 9,000	Plains - Montane	L	D
Sambucus canadensis	Elderberry	To 8,000	Plains - Montane	M-H	D
Sorbaria sorbifolia	Ash-leaf Spirea	To 8,000	Plains - Montane	M	D
Spiraea x vanhouttei	Vanhoutte Spirea	To 8,000	Plains - Montane	L - M	D
Symphoricarpos orbiculatus	Coralberry	To 7,500	Plains - Montane	L - M	D
Syringa vulgaris	Common Lilac	To 9,000	Plains - Montane	L - M	D
Syringa x prestoniae	Canadian Lilac	To 9,000	Plains - Montane	L - M	D
Viburnum lantana	Wayfaringtree Viburnum	To 8,000	Plains - Montane	L - M	D
Viburnum lentago	Nannyberry Viburnum	To 8,000	Plains - Montane	L - M	D
Viburnum opulus	European CranberryBush	To 8,000	Plains - Montane	M	D
Viburnum trilobum	American CranberryBush	To 8,000	Plains - Montane	L - M	D

1. Planting altitudes are estimates, plants may be planted at lower or higher zones with supplemental irrigation.
2. Moisture Requirement: L - Low, M - Moderate, H - High
3. In most cases, plants prefer full sun to part shade
4. For an extensive list of Colorado Native Shrubs, consult Appendix | table A.1 Colorado Water Wise Plant List

table 5.2 non-native shrubs for mountainous areas (murner 2011 adapted from Klett et.al. 2005)

Native Grasses for Colorado

Scientific Name	Common Name	Planting Altitude	Life Zone	Moisture	Season
Achnatherum hymenoides	Indian Rice Grass	To 9,000	Plains - Montane	VL	Cool
Andropogon gerardii	Big Bluestem	To 7,500	Plains - Montane	L - M	Warm
Andropogon saccharoides	Silver Beard Grass	To 7,500	Plains - Montane	L	Warm
Bouteloua curtipendula	Sideoats Grama	To 9,000	Plains - Montane	VL	Warm
Bouteloua gracilis	Blue Grma	To 9,500	Plains - Montane	VL	Warm
Eragrostis trichodes	Sand Lovegrass	To 6,500	Plains - Montane	L	Warm
Festuca arizonica	Arizone Fescue	To 10,000 +	Plains - Subalpine	L	Cool
Koeleria macrantha	June Grass	To 11,000	Plains - Subalpine	L - M	Cool
Schizachyrium scoparium	Little Bluestem	TO 7,500 +	Plains - Montane	L - M	Warm
Sporobolus airoides	Alkali Sacaaton	To 7,500	Plains - Montane	L	Warm
Sorghastrum nutans	Indian Grass	To 6,500	Plains - Montane	M	Warm

1. Planting altitudes are estimates, plants may be planted at lower or higher zones with supplemental irrigation.
2. Moisture Requirement: L - Low, M - Moderate, H - High
3. In most cases, plants prefer full sun.
4. For a more extensive list, consult Appendix | table A.1 Colorado Water Wise Plant List

table 5.3 Native Grasses for Colorado (murner 2011 adapted from Shonle 2009)

contextual zone

snow management | *standards & dimensions*

Introduction

In all Rocky Mountain communities, on-street snow management is a major consideration. Narrower streets translate into less on-street snow, simply because there is less area for snow accumulation. Larger multi-lane streets require advanced planning for snow storage. In some cases, parking areas and stormwater management areas can be used for snow storage. Yet, most of the time, parking and stormwater management areas can only temporarily handle minimal amounts of snow.

With these considerations in mind, it is important for communities to make plans for snow management during the design phase of a street redevelopment project. At first, it is important to understand annual snowfall averages. Next, it is important to understand how and where snow storage will occur.

Reference Code/ Issues & Alternatives

Snowfall

H-1|*Nominal*

Limitations

Communities with nominal yearly snowfall have multiple options for snow management. Depending on the number of the travel lanes and parking orientation, it is possible to have on-street snow storage or simply remove the snow to an off-site location. Although not advised because of vegetation damage, some snow storage may be placed within the green infrastructure features. Considerations should be given to street orientation.

H-2|*Nuisance*

Limitations

Communities with Nuisance level of yearly snowfall still have multiple options for snow management. Depending on the number of the travel lanes and parking orientation, it may be possible to utilize both on-street snow storage and remove to an off-site location. Considerations should be given to street orientation.

H-3|*Hindrance*

H-4|*Excessive*

Limitations

Streets with either a Hindrance or Excessive level of yearly snowfall have very limited options for snow management. Although temporary on-street storage may be possible, a majority of snow fall should be removed to an off-site location to reduce safety and street degradation issues.

Specific Criteria & Dimensions

Although there is no standard criteria for on-street snow management, some basic considerations are important to understand.

+ The design of the street is important

+ What type of equipment will be used to manage on-street snow accumulation?
  - *Large plows may damage non-traditional paving material such as brick and pavers.*
  - *Curb extensions can create acute angles on streets, making it difficult for large plows to maneuver. Additional equipment may be required.*

+ Where will the snow be stored?
  - *Some on-street storage can occur in parking areas or center auxiliary lanes. In most cases, these types of on-street snow storage efforts are only temporary and need to be cleared eventually.*
  - *In areas with nominal or low amounts of annual snowfall, it may be possible to use stormwater management areas for some snow storage.*
  - *Only utilize stormwater management areas for snow management with the understanding that plant damage may occur. Initial considerations toward plant selection must be made if stormwater management areas are intended to be used for snow management. Only plants that can withstand extreme cold and snow inundation should be implemented.*

+ Make a snow management plan
  - *Define the responsibilities of the city and the owners of adjacent property.*
  - *Define the levels of response to snowfall*
  - *Snowfall totals and level of response associated with them.*

Further Consideration

Even if stormwater management facilities are not intended for snow storage, accumulation will occur. This nominal amount of snow will most likely have little effect on the functions of the facility. Yet, stormwater management facilities designed to function effectively in the summer are typically disrupted by winter and spring events. Scheduled maintenance during spring snow melt periods should be a mandatory aspect of stormwater management facilities in cold climates. Typical maintenance activities include street and facility cleaning in early spring prior to major snow melt. (CWP 1997)

For further information on the design and maintenance of stormwater management facilities in cold climates, consult the Center for watershed protection's Stormwater BMP Design Supplement for Cold Climates.

contextual zone

adjacent land use | *standards & dimensions*

Introduction

Typically, building faces extend to the edge of the right-of-way in most Rocky Mountain Main Streets. This building lined scenario has been addressed up to this point in the Main Street Evolved guidelines. In some cases, buildings are set back or park space is adjacent to the right-of-way. Although uncommon, these non-typical scenarios must be considered when redesigning a street. If left to their own design, these open adjacent areas can degrade the cohesion desired through a redesign effort. With this in mind, some basic issues should be considered for adjacent open space.

Specific Criteria & Dimensions

Ownership and Land Use type are the two most important things to understand when addressing non-building line scenarios.

Depending on ownership of the adjacent space, integration into the overall street design can be difficult or trivial.

+ If city owned park space is adjacent, a transition zone from street to park should be integrated into the redesign of the street. This will ensure cohesion between the two municipal areas.

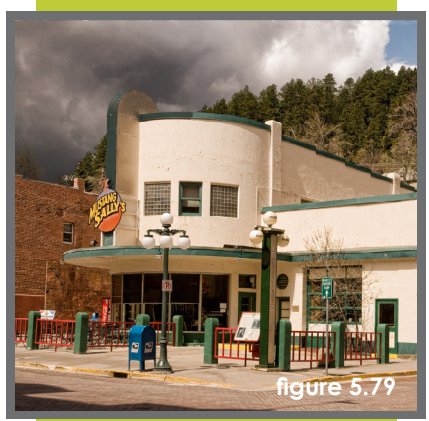
+ If not owned and maintained by the local municipality, the local landowner should be involved in the design process from the beginning.
  - *Early involvement can encourage land owners to adopt the street redevelopment efforts as their own, allowing design efforts to mix with adjacent land use.*
  - *Offering incentives to integrate street design efforts will help to create a cohesive street design.*

Further Considerations

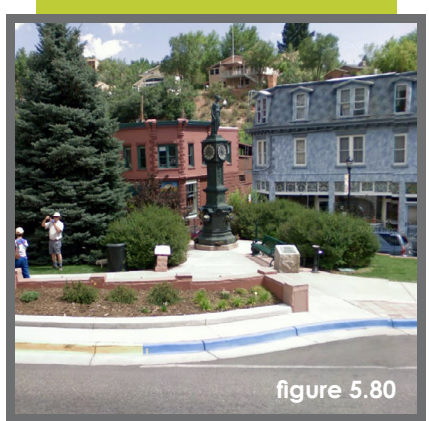
It is always best to incorporate local business and landowners into the redesign efforts at a very early stage. Early involvement will encourage locals to adopt the design efforts as their own and not feel "forced" into the cities plan. "Local leaders must have the will and desire to mobilize local resources and talent. That means convincing residents and business owners of the rewards they'll reap by investing time and money in Main Street — the heart of their community. Only local leadership can produce long-term success by fostering and demonstrating community involvement and commitment to the revitalization effort." (NHTP 2011)

For more information on the involvement of local residents into redesign efforts, see the National Trust for Historic Places: Main Street website at http://www.preservationnation.org/main-street/.

sample pocket plaza



sample outdoor dining



sample pocket park

prioritize the key guidelines

Introduction

Once a designer/planner has documented and inventoried a streets existing conditions, reference the right-of-way considerations, and identified the key guidelines to consider; the next step is to investigate the community's needs and then prioritize the most relevant guidelines. This step is quite possibly the most important in the process. The priorities established by the designer/planner will dictate how the relevant guidelines are implemented and ultimately the outcome of the final street design.

Prioritize

The prioritization of a community's needs is a process that each community must undertake during the process to guide specific design decisions. Each community and street has its own benefits and limitations based on a number of factors and influences. One of the most important things a community leader, planner, or designer can do is to incorporate community involvement at a very early phase. Charrette designs, surveys, and even simple town hall meetings can provide valuable information relating to community desire, opinion, and consensus. As a word of caution, although these types of mass community involvement can provide valuable input, they may not represent a full cross-section of the community. Business owners may outnumber other citizens or vice versa and the input received may not represent the actual community's needs.

Once an understanding of the general population's desires and concerns are collected, it is ultimately up the planner, designer, or local government to make a final decision on how that input will influence the priorities based on current need and future visions for the community. For more information regarding the establishment of a Main Street Program and achieving community involvement, see the National Trust for Historic Places: Main Street website at http://www.preservationnation.org/main-street/ or Revitalizing Main Street: A practitioner's Guide to Comprehensive Commercial District Revitalization, available at http://www.preservationnation.org/main-street/resources/public/Revitalizing-Main-Street.html

application

Introduction

The following pages are a representation of how to apply the Main Street Evolved process to an actual street. Once the relevant guidelines are determined and the needs of the community prioritized, the final step in the Main Street Evolved process is to develop a street design based on the established priorities and relevant guidelines. This final step is the most difficult illustrate in general terms. Although each main street is different and the final designs for each will be unique, an example application of the Main Street Evolved process is important to demonstrate. The importance of this step cannot be exaggerated; the priorities established by the community play a direct roll on the outcome of the final design. With this in mind, a schematic redesign of Rifle, Colorado represents the application phase of the Main Street Evolved process. The following section briefly steps through the entire Main Street Evolved process and illustrates three schematic design solutions. The schematic design solutions illustrate how different community priorities can greatly affect the look and functionality of a final design solution.

Background

Located approximately 27 miles west of Glenwood Springs, Rifle Colorado is a small community on the western slopes of the Colorado Rockies. Recent population and economic growth, driven by an increasing oil industry and demand for workforce in neighboring resort communities, has led the local government to reinvest in Rifles' downtown. (Vanderwalle 2008) At the center of Rifles' downtown core is 3rd street, the representative "Main Street" for the community. As Rifle begins to adapt to meet the predicted population and economic expansion, the redesign of 3rd street has the potential to dictate the standards of all other expansion efforts. With this in mind, the redesign of 3rd street using the Main Street Evolved process has the potential to not only reshape the downtown area, but also integrate multi-modal and green infrastructure principles throughout the community.

Existing Conditions

Centralized between East and West Avenue, the 3rd street economic core houses a variety of restaurants and shops within historic buildings and still represents the social heart of the community. In some respects, 3rd already has some foundational elements of an evolved Main Street. Curb extensions, unified streetscape elements, and even mid-block crossings are all an integral part the 3rd street design. This foundation begins to allude to the potentials of the street, yet do not take into account other aspects of multi-modal transportation and stormwater management.


figure 5.81

3rd street existing conditions


figure 5.82

3rd street existing conditions

figure 5.83

3rd street existing conditions

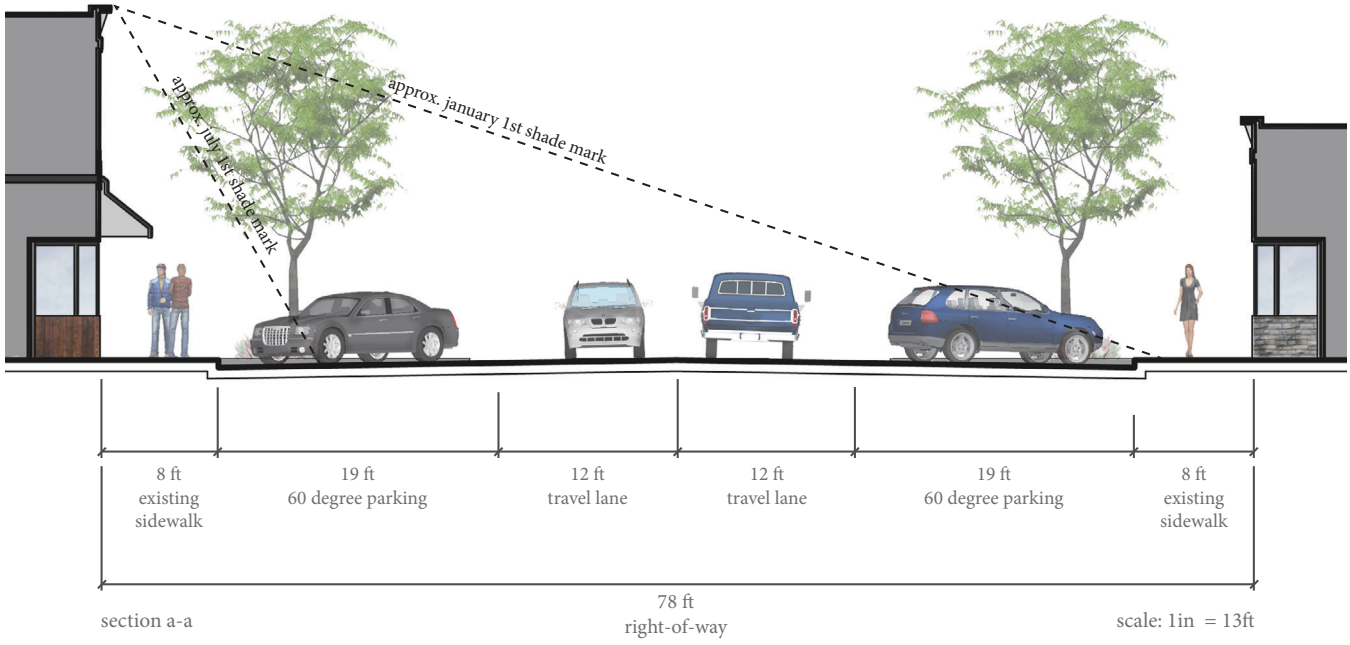
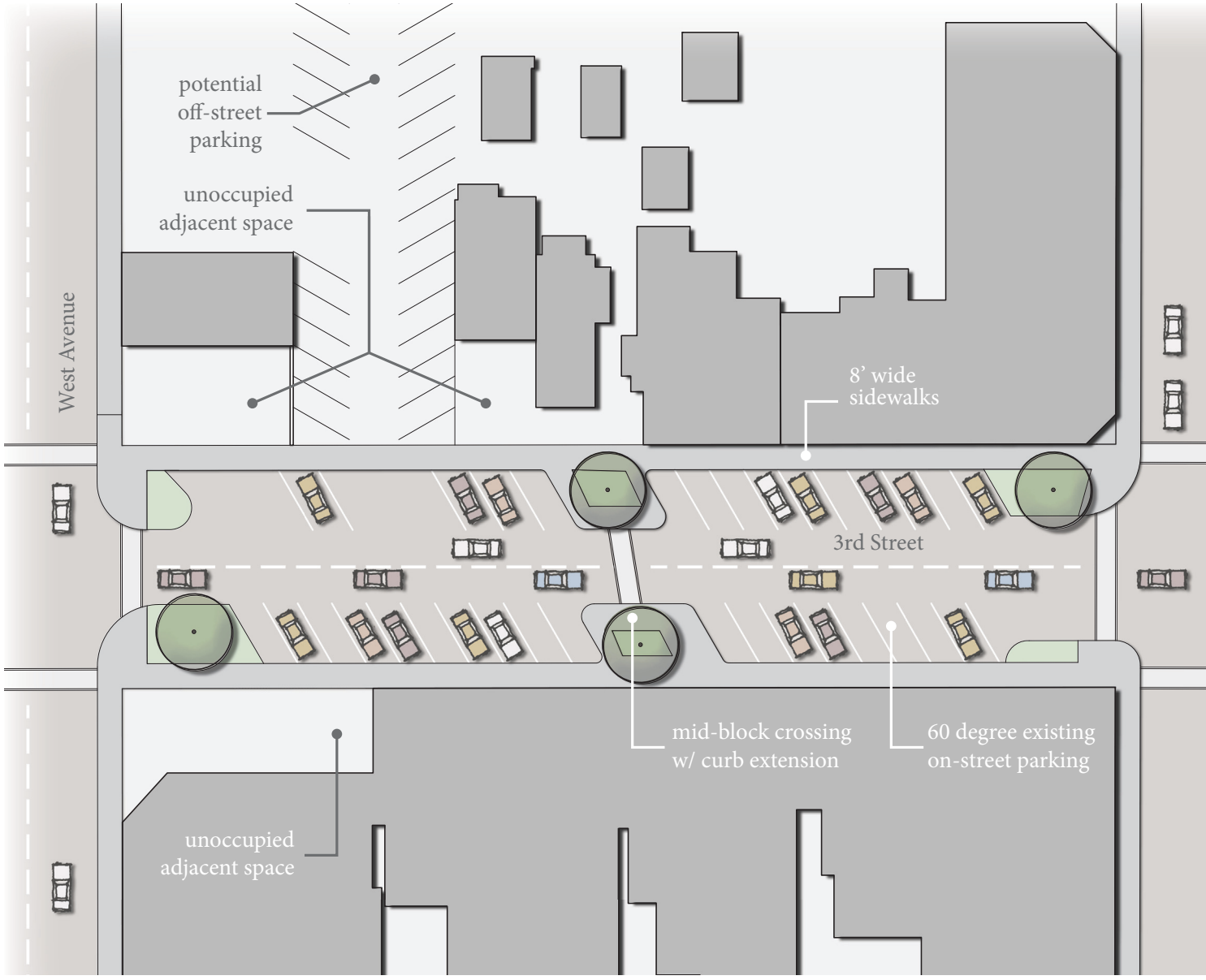


figure 5.84 3rd street existing conditions cross-section(murner 2011)

figure 5.85 3rd street existing conditions (murner 2011)

application

existing conditions | *document existing conditions*



Design Scenario	Parking Spaces	Street Trees	Stormwater Management (sq ft)	Street Vegetation Area (sq ft)	Intersection Crossing Distance (ft)
Existing	69	8	0	2,951	40

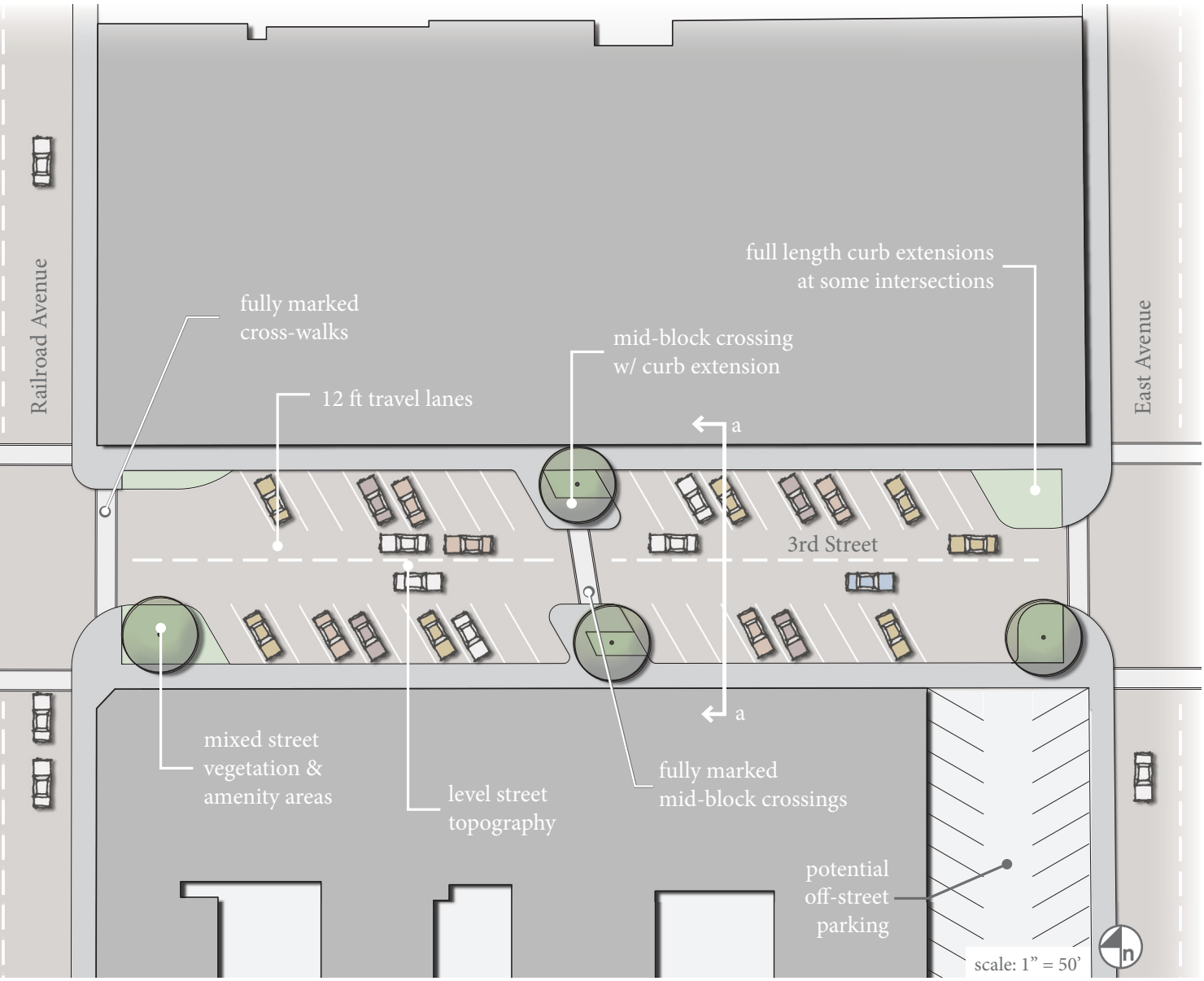


figure 5.86 3rd street existing conditions base map (murner 2011)

application

Rifle, Colorado | *completed evolution table*

Right-of-Way		
Distance from Building Face to Building Face		
		Code
Narrow	Under 65'	A-1
Average	65' to 90'	A-2
Wide	Over 90'	A-3

Travel Way		
Number of Traffic Lanes & Auxilary Lanes (Including Turn & Delivery Lanes)		
		Code
One Lane	One Traffic lane	B-1
Two Lane	Two Traffic Lanes	B-2
Three Lane	Two Traffic Lanes & One Auxilary Lane	B-3
Four Lane	Four Traffic Lanes	B-4
Five Lane	Four Traffic Lanes & One Auxilary Lane	B-5

Parking		
Parking Orientation & Configuration		
		Code
Parallel	Parallel Parking on Both Sides of the Street	C-1
Angled	Angled Parking on Both Sides of the Street	C-2
Perpendicular	90 Degree Parking on Both Sides of the Street	C-3
Mixed	A Mixture of Parallel & Angled Parking	C-4

Orientation		
General Orientation of the Street		
		Code
N/S	Street Runs Noth to South	F-1
E/W	Street Runs East to West	F-2
NE/SW	Street Runs Northeast to Southwest	F-3
NW/SE	Street Runs Northwest to Southeast	F-4

Topography		
General Topographic Nature of the Street		
		Code
Level	Streets with No Significant Cross or Profile Slope	E-1
Profile	Streets with Significant Grade Change Over the Length of the Street	E-2
Cross-Section	Streets with Significant Grade Change Over the Breadth of the Street	E-3

Pedestrian Zone		
Distance From Building Face to Curb		
		Code
Narrow	Under 7'	D-1
Average	7' to 10'	D-2
Wide	Over 10'	D-3

Elevation		
Elevation at Which the Communitiy is Situated		
		Code
Foothills	Below 7,000'	G-1
Montane	7,000 to 9,500'	G-2
Sub-Alpine	Over 9,500'	G-3

Snowfall		
Average Ammount of Snowfall in a Year		
		Code
Nominal	under 25"	H-1
Nuisance	25" to 50"	H-2
Hinderance	50" to 100"	H-3
Excessive	Over 100"	H-4

Precipitation		
Average Ammount of Rainfall in a Year		
		Code
Semi-Arid Dry	Under 10"	I-1
Semi-Arid	10" to 20"	I-2
Semi-Arid Wet	Over 20"	I-3

Following the Main Street Evolved process, the first step in developing a street design is to understand the existing conditions. At a minimum, an investigation into each of the aspects covered in the Main Street Evolved Feature key must occur. These features include:

+ Right-of-Way Width
+ Travel Way Width
+ Parking Orientation
+ Pedestrian Zone Width
+ General Topography
+ Street Orientation
+ Elevation
+ Average Annual Snowfall
+ Average Annual Precipitation

For this conceptual application, the Evolved Feature Key and Table are completed in the same manner that a planner, designer, or community official would follow. The following Main Street Evolved Feature Key represents the information relevant to 3rd street in Rifle Colorado.

evolved feature table

Street Decisions		
Information about the Street & Feature Code		
Main Street	3rd Street	
Right-of-Way	78 Feet	A-2
Travel Way	2 Travel Lanes	B-2
Parking	Angled	60 Degree	C-2
Pedestrian Zone	9 Feet	D-2
Topography	Level	E-1
Orientation	E/W	F-2
Elevation	5,345	G-1
Snowfall	38.6 in	H-2
Precipitation	11.6 in	I-2

figure 5.87 completed main street evolved feature key (Murner 2011)

application

Rifle, Colorado | *reference the right-of-way considerations & key guidelines*

With a basic understanding of the existing conditions, the next step in the process is to reference the Right-of-way considerations and identify the key guidelines to consider. 3rd Street has an approximately 78-foot right-of-way, which is an Average right-of-way in terms of the Main Street Evolved program.

A-2|Average Rights-of-Way

Limitations

With some adaptation, all aspects of the Main Street Evolved program can be incorporated within an average right-of-way. Yet, alteration of multiple street features will need to occur in order to successfully incorporate comfortable pedestrian and cyclist access along with green infrastructure.

Key Guidelines to Consider

The Travel Zone

- *Travel Lanes*
- *Parking*
- *Bicycle Lanes*
- *Pedestrian Crossings*
- *Medians*

The Pedestrian Zone

- *Sidewalks*
- *Street Tree*
- *Curb Extensions*
- *Streetscape Amenities*
- *Green Infrastructure*

The Contextual Zone

- *Material & Style*
- *Plant Selection*
- *Snow Management*
- *Adjacent Land Use*

application

Rifle, Colorado | *develop a street design*

Introduction

The final two steps of the Main Street Evolved process are to prioritize the community's needs and then develop a street design based on the needs and relevant guidelines. For this example application portion, I needed to develop a series of priorities for the community of Rifle. Instead of developing a single design solution based around a few priority assumptions, I decided to develop three schematic design solutions that cover a number of priorities.

The first alternative focuses on integrating a maximum number of ecological strategies. The second alternative focuses on maximizing parking and access. The third alternative focuses on bringing together the first two alternatives into a single design. The three design alternatives illustrate the application portion of the Main Street evolved process that a design/planner would follow.

My hope is that, even after the prioritization phase has been completed, multiple design alternatives will be developed that integrate some strategies that might not be considered of high priority, but benefit the community or final design.

The three different alternatives show the effect that different priorities play on the outcome of a design solution. An understanding of priority trade-offs and their effect on a final design is something that is hard to illustrate in general terms, but it is important to understand when creating an Evolved Main Street. With this in mind, the three design alternatives are;

+ The Green Main Street Alternative
+ The Parking Focus Alternative
+ The Evolved Main Street Alternative

Each alternative is accompanied by a basic introduction to what the major priorities were, and then describes what guidelines were used to modify the street. Although all the key guidelines should be considered when designing a main street, the design alternatives focus on the major moves and less on the detailed elements of amenity placement, materiality, plant selection, and snow management. In order to evaluate the advantages and drawbacks of each alternative, I have included an example comparative analysis as a conclusion. Designers/Planers should use a similar strategy to help facilitate discussion, decision making, and the benefits of alternative design solutions.

application alternatives

Rifle, Colorado | *green main street alternative*

The Green Main Street Alternative

In the Green Main Street alternative, the major priorities were to maximize green infrastructure, street trees, and vegetated curb extensions. To meet these green priorities, multiple street features needed modification.

Travel Lanes

Both east and westbound travel lanes were narrowed to 10ft to maximize allowable space for other Main Street Evolved features. Although the minimum standard, these 10ft lane will slow traffic and create a safer street environment.

Parking

The existing 60 degree angled parking was removed and replaced with approximately 7ft wide parallel parking lanes on both the north and south side of the street. Although this removes almost half of the on-street parking spaces, it also increases the space available on both the north and south sides of the street for wider pedestrian zones.

Bicycle Lanes

Currently, there are no marked bicycle lanes. As the incorporation of multi-modal transportation is one of the primary goals of Main Street Evolved, shared bicycle lanes have been placed on both the north and south side of the street.

Sidewalks

The existing 8ft sidewalks were extended to 17ft pedestrian zones. Within this 17ft, all three pedestrian sub-zones are accommodated. The proposed 17ft pedestrian zone is composed of a 3ft Ingress zone, 5 ft sidewalk zone, 7ft amenity zone, and a 2ft vehicle egress strip.

Street Trees

To increase canopy coverage, street trees are spaced approximately 35ft apart. This spacing resulted in 38 street trees being incorporated within the streets right-of-way.

Curb Extensions

Curb extensions at mid-block locations and all major intersections maximize pedestrian space and minimize crossing distances. These extensions create a safer and more pedestrian friendly environment. All curb extensions extend the full 7ft of the adjacent parking lane.

Green Infrastructure

Due to the East/West orientation of 3rd Street, all green infrastructure features had to be placed on the northern half of the street. This will reduce winter damage due to snow storage and increase plant vitality. The 6ft amenity zone and curb extensions areas on the northern side of the street all have the potential to incorporate vegetated stormwater management facilities. In total, there is approximately 3,335 sq ft of potential stormwater management area incorporated into the Green Main Street Scenario.

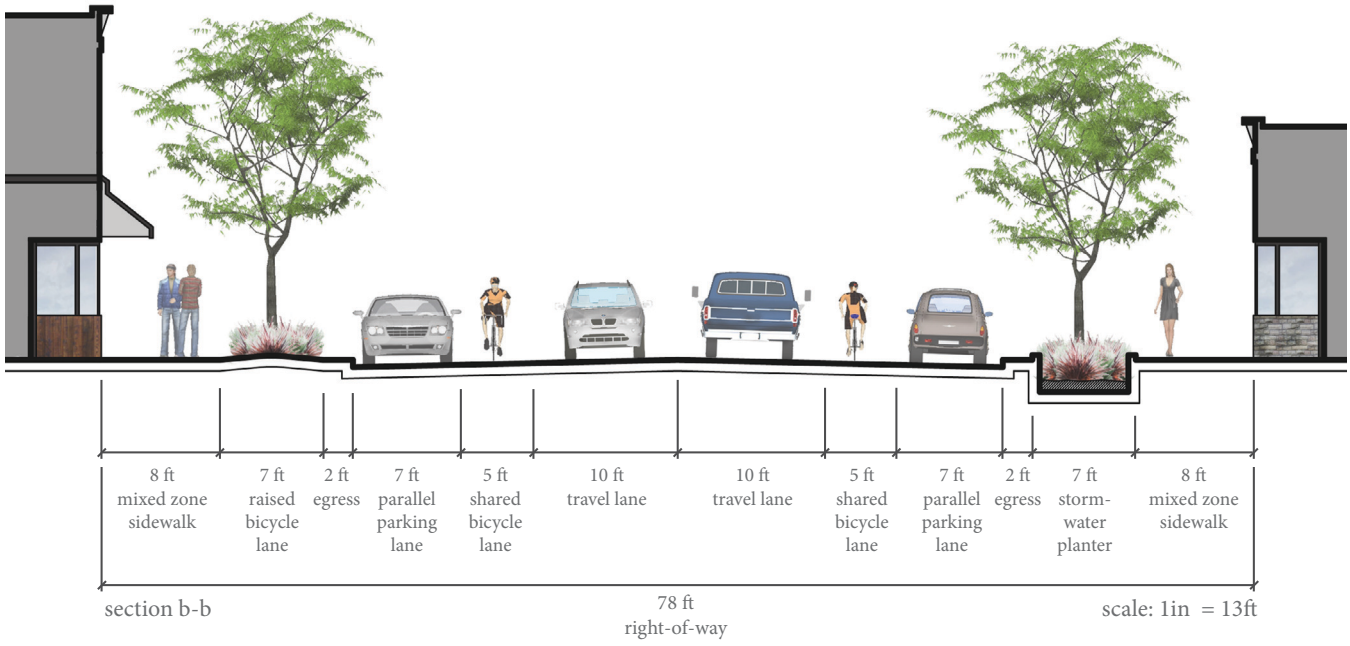
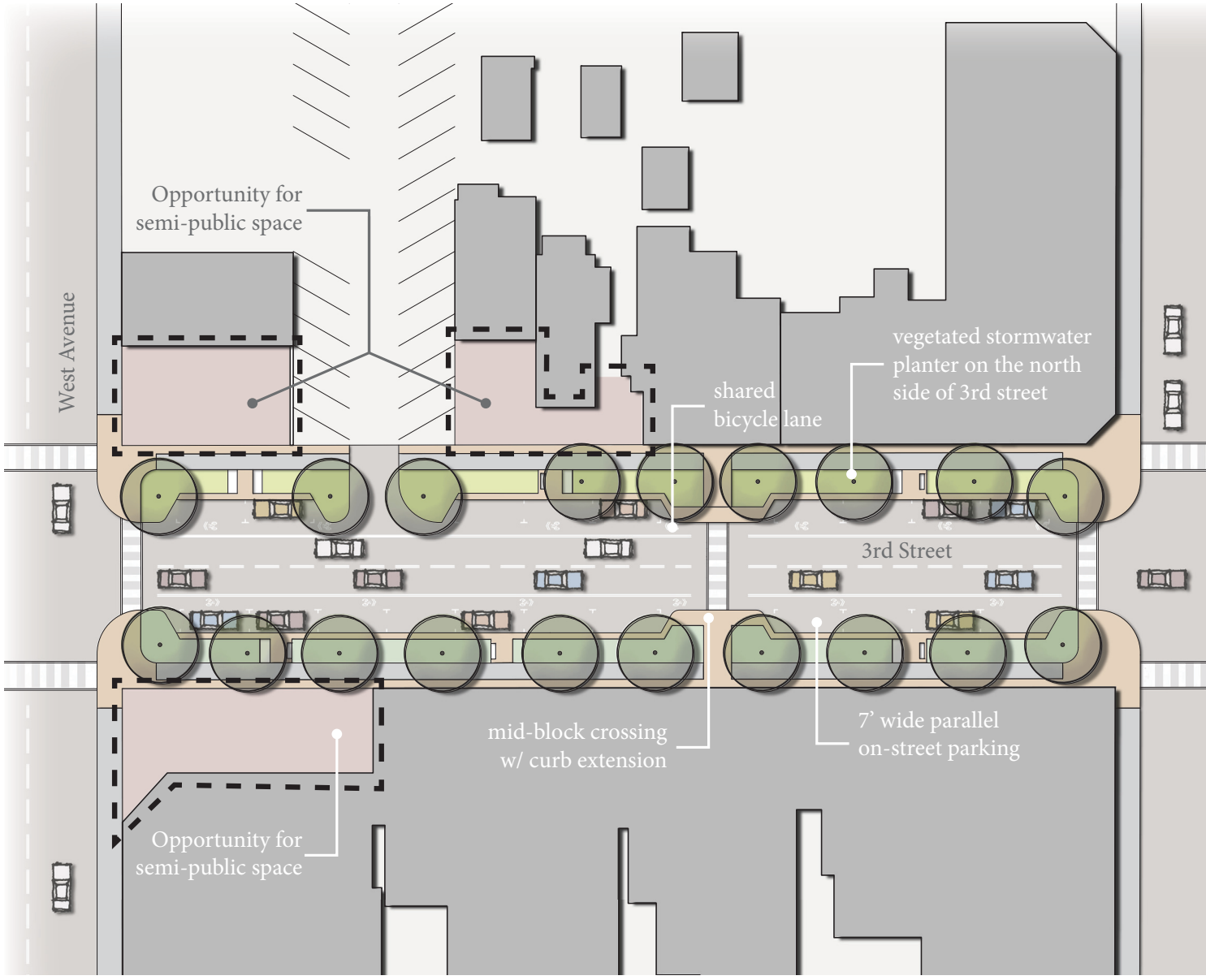


figure 5.88 green main street alternative cross-section (murner 2011)

figure 5.89 green main street alternative perspective(murner 2011)

application alternatives

Rifle, Colorado | *green main street alternative masterplan*



Design Scenario	Parking Spaces	Street Trees	Stormwater Management (sq ft)	Street Vegetation Area (sq ft)	Intersection Crossing Distance (ft)
Green	38	38	4,538	4,608	30

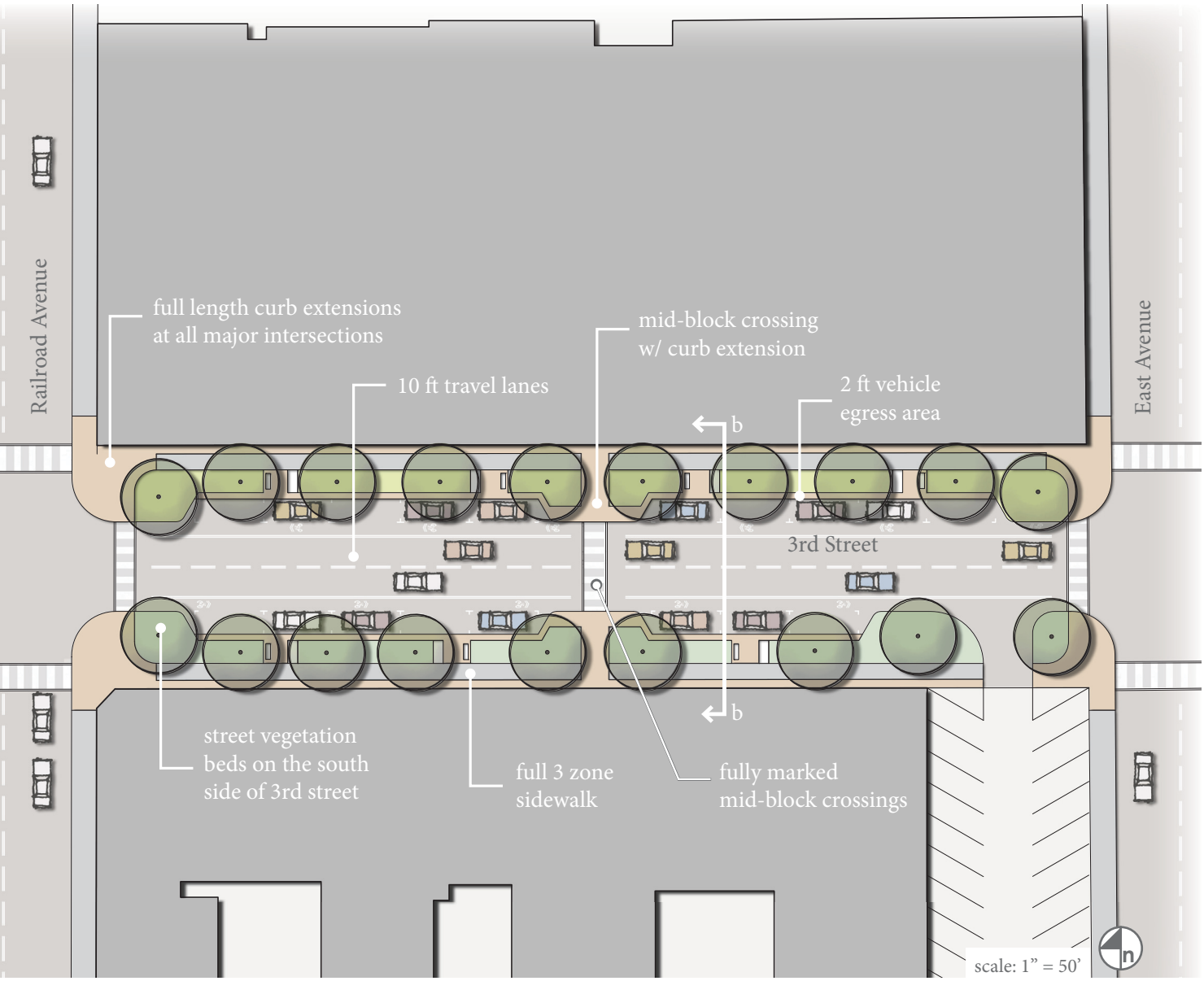


figure 5.90 green main street alternative masterplan (murner 2011)

application alternatives

Rifle, Colorado | *parking focus alternative*

The Parking focus Alternative

In the Parking focus alternative, the major priorities were to maximize parking, pedestrian circulation, and space for streetscape amenities. To meet these traditional street design priorities, a number of slight modifications were required.

Travel Lanes

Both east and westbound travel lanes were narrowed to 11ft to maximize allowable space for other Main Street Evolved features. Although the minimum standard, these 11ft lane will slow traffic and create a safer street environment.

Parking

The existing 60 degree angled parking was kept and narrowed to 17ft wide. The parking stalls were narrowed to 8ft, adding approximately 11 parking stalls to the existing amount.

Bicycle Lanes

Currently, there are no marked bicycle lanes. As the incorporation of multi-modal transportation is one of the primary goals of Main Street Evolved, raised bicycle lanes have been placed on both the north and south side of the street adjacent to the pedestrian zones.

Sidewalks

Due to the spatial requirements of the angled parking, the existing 8ft sidewalks were narrowed to 6ft. The proposed 6ft pedestrian zone is composed of a 1ft mixed ingress/amenity zone and a 5ft sidewalk zone.

Street Trees

Due to the limited space available in the mixed ingress/amenity zone, street tree planting was limited to placement within the proposed curb extensions. This placement resulted in approximately 16 street trees, approximately double the existing amount.

Curb Extensions

Curb extensions at mid-block locations and all major intersections maximize pedestrian space and minimize crossing distances. These extensions create a safer and more pedestrian friendly environment. All curb extensions extend the full 17ft of the adjacent parking stalls.

Green Infrastructure

Due to the East/West orientation of 3rd Street, all green infrastructure features had to be placed on the northern half of the street. This will reduce winter damage and increase plant vitality. The six curb extensions locate on the northern side of the street all have the potential to incorporate vegetated stormwater management facilities. In total, there is approximately 1,932 sq ft of potential stormwater management area incorporated into the Parking focus Scenario.

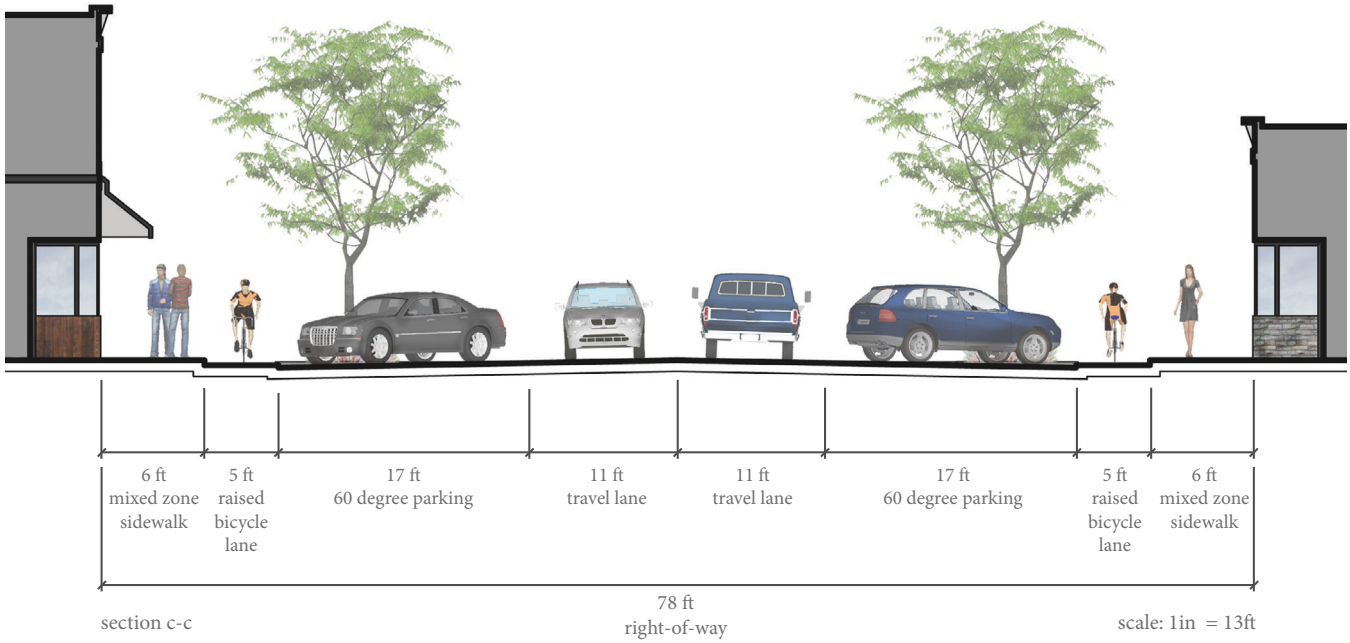
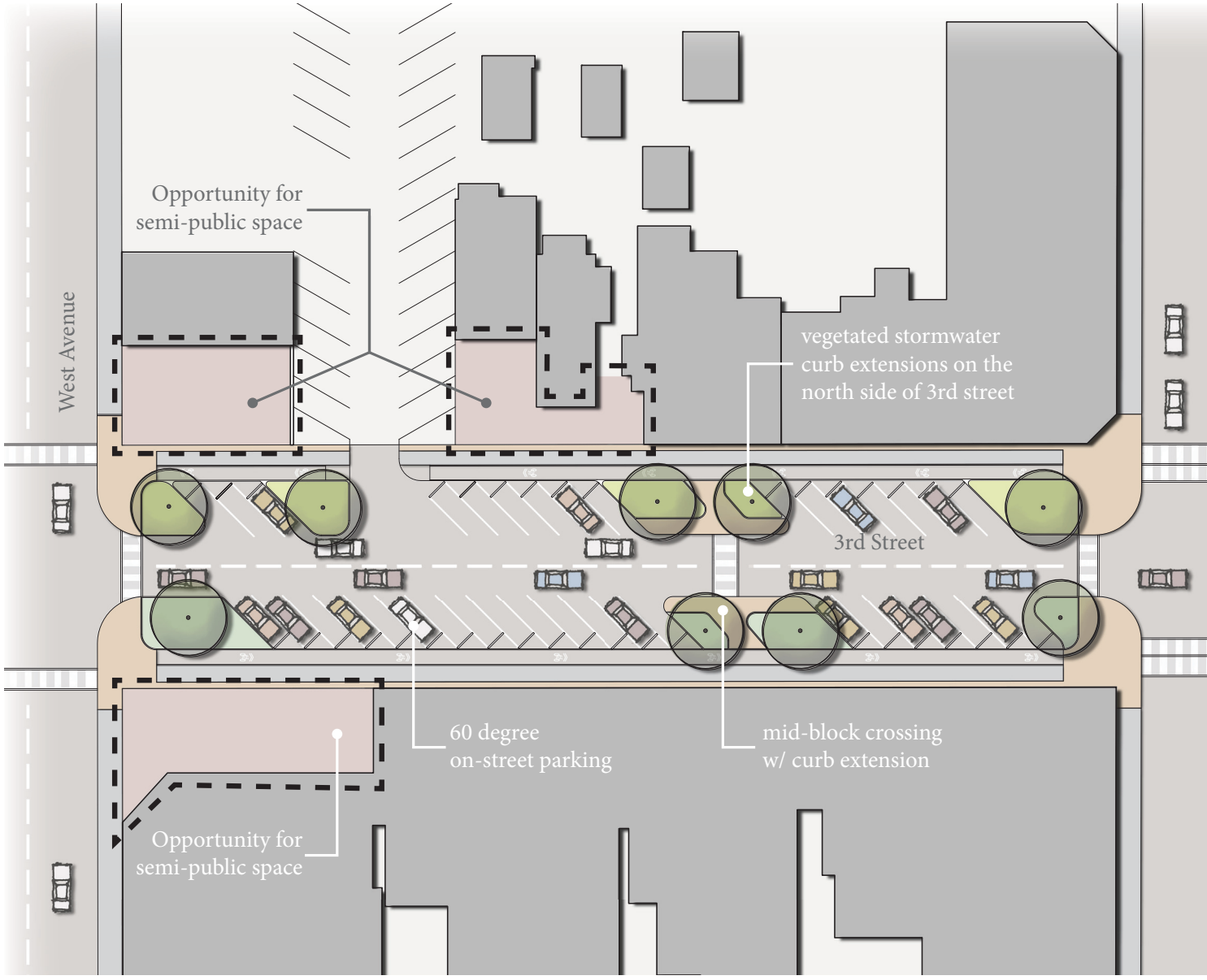


figure 5.91 parking focus alternative cross-section (murner 2011)

figure 5.92 parking focus alternative perspective(murner 2011)

application alternatives

Rifle, Colorado | *parking focus alternative masterplan*



Design Scenario	Parking Spaces	Street Trees	Stormwater Management (sq ft)	Street Vegetation Area (sq ft)	Intersection Crossing Distance (ft)
Parking Focus	76	17	2,636	2,155	22

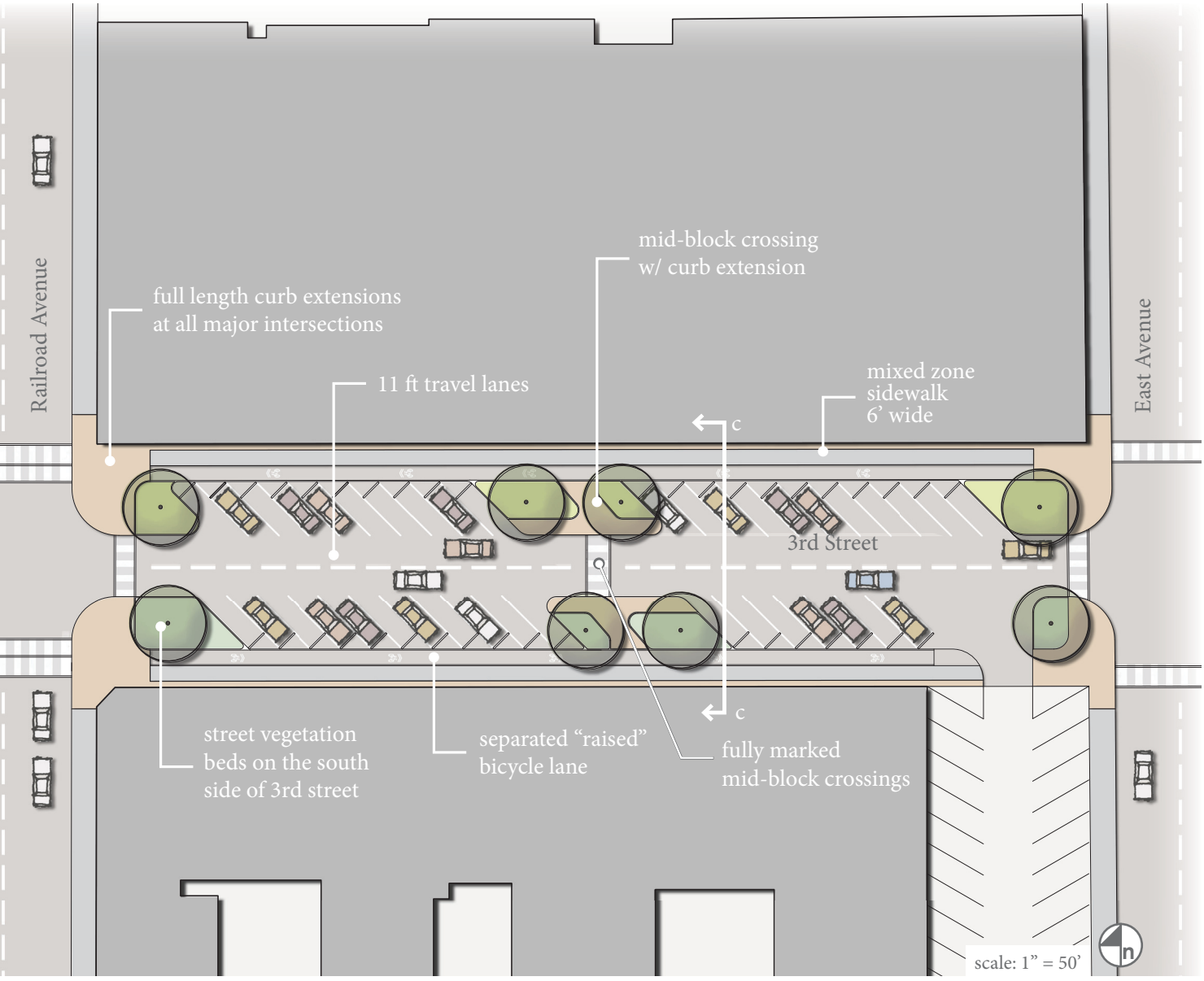


figure 5.93 parking focus alternative masterplan (murner 2011)

application alternatives

Rifle, Colorado | *evolved main street alternative*

The Evolved Main Street Alternative

In the Evolved Main Street alternative, a mixture of the first two alternatives was the focus of this alternative. Integrating maximum parking, green infrastructure, and pedestrian circulation, while considering the trade-offs necessary to optimize the street was the major focus. To meet these Evolved priorities, almost all of the existing street features needed modification.

Travel Lanes

Both east and westbound travel lanes were narrowed to 10ft with a 4ft shared bicycle lane on the northern lane and 11ft on the southern lane to maximize allowable space for other Main Street Evolved features.

Parking

On the north side of 3rd street, the existing 60 degree angled parking was removed and replaced with an approximately 7ft wide parallel parking lane. On the south side, the existing 60 degree angled parking was kept and narrowed to 17ft wide with 8ft stalls. This mixed approach resulted in 59 parking spaces, approximately 10 less spaces than the existing conditions.

Bicycle Lanes

To meet the multi-modal goals of Main Street Evolved, a shared bicycle lane was placed on the north side of the street, with a raised bicycle lane on the south side of the street.

Sidewalks

On the north side of 3rd Street, the existing 8ft sidewalks were extended to a17ft three zone sidewalk. The proposed 17ft pedestrian zone is composed of a 3ft Ingress zone, 5 ft sidewalk zone, 6ft amenity zone, and a 3ft vehicle egress strip. On the South side of 3rd Street, the existing 8ft sidewalks were only extended an extra foot. The proposed 9ft pedestrian zone is composed of a 4ft mixed ingress/amenity zone and a 5ft sidewalk zone all allow for the extra space needed by the adjacent angled parking.

Street Trees

On the north side of 3rd street, trees are spaced approximately 35ft apart. This spacing resulted in approximately 19 street trees plantings. On the south side of 3rd street, the limited space available lead to street trees only being proposed within the curb extensions. This placement resulted in approximately 8 street tree plantings. In total, 27 street trees were placed within the 3rd street right-of-way; approximately 19 more than are existing.

Curb Extensions

Curb extensions at mid-block locations and all major intersections maximize pedestrian space and minimize crossing distances. All curb extensions on 3rd Street extend the full width of the adjacent parking stalls. 7ft on the north side, and 17ft on the south side of 3rd street.

Green Infrastructure

Due to the East/West orientation of 3rd Street, all green infrastructure features had to be placed on the northern half of the street. The 6ft amenity zone and curb extensions areas on the northern side of the street all have the potential to incorporate vegetated stormwater management facilities. In total, there is approximately 3,335 sq ft of potential stormwater management area incorporated into the Evolved Main Street Scenario.

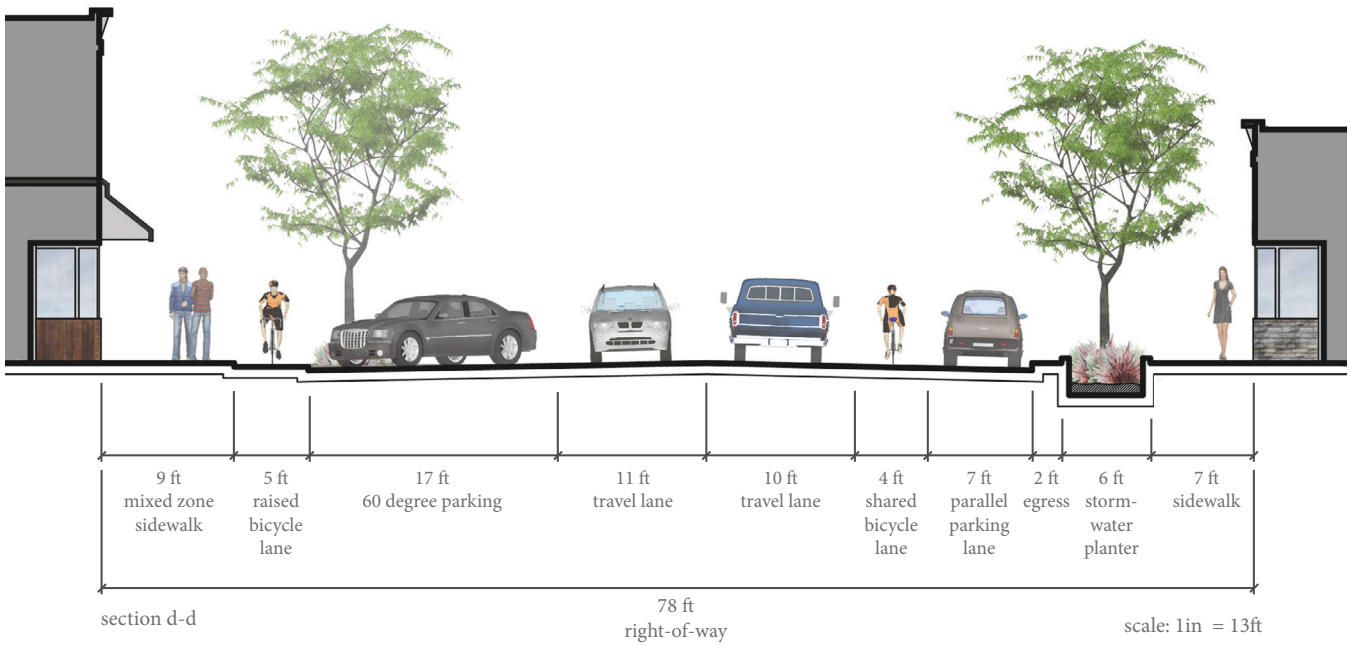
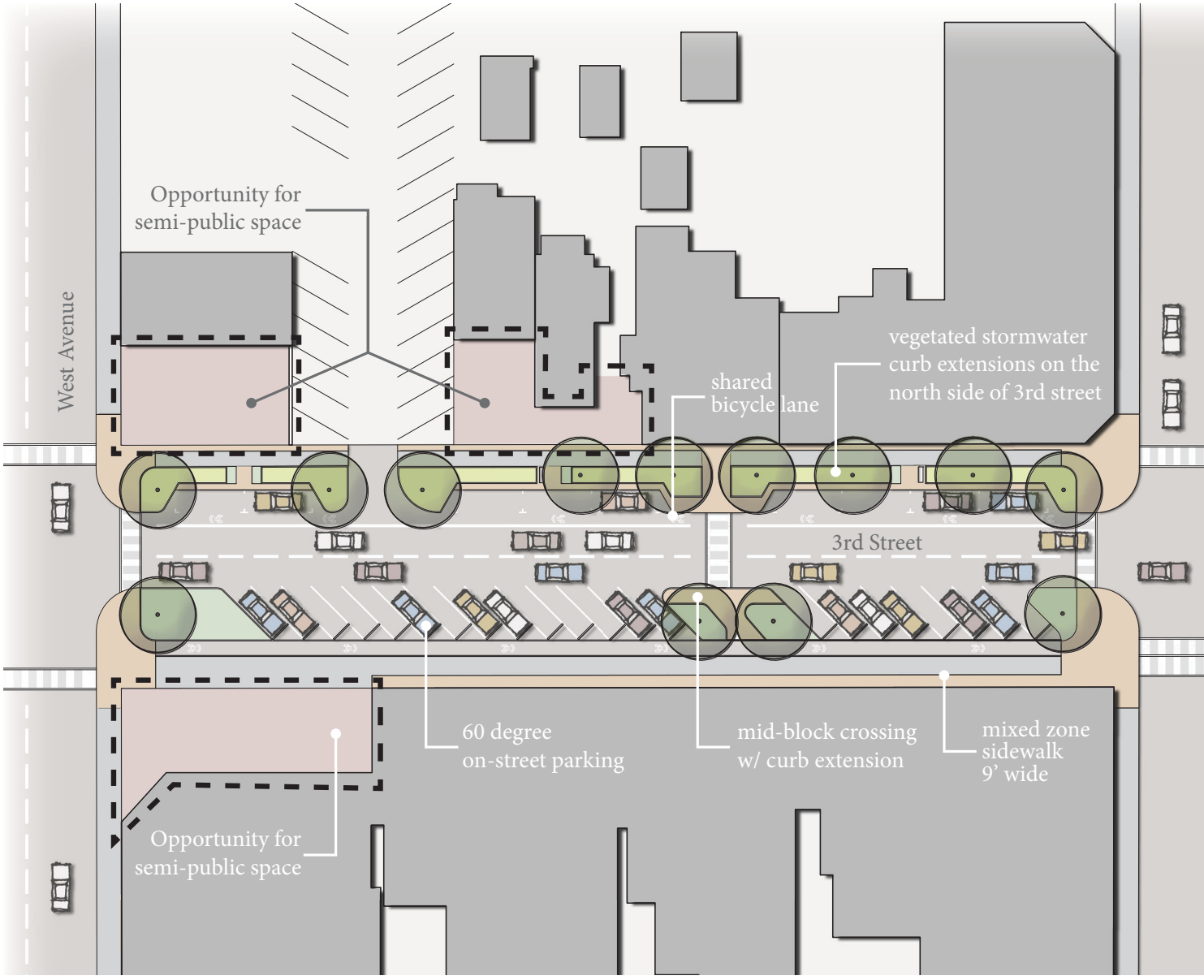


figure 5.94 evolved main street alternative cross-section (murner 2011)

figure 5.95 evolved main street alternative perspective(murner 2011)

application alternatives

Rifle, Colorado | *evolved main street alternative masterplan*



Design Scenario	Parking Spaces	Street Trees	Stormwater Management (sq ft)	Street Vegetation Area (sq ft)	Intersection Crossing Distance (ft)
Evolved	59	27	3,354	1,932	25

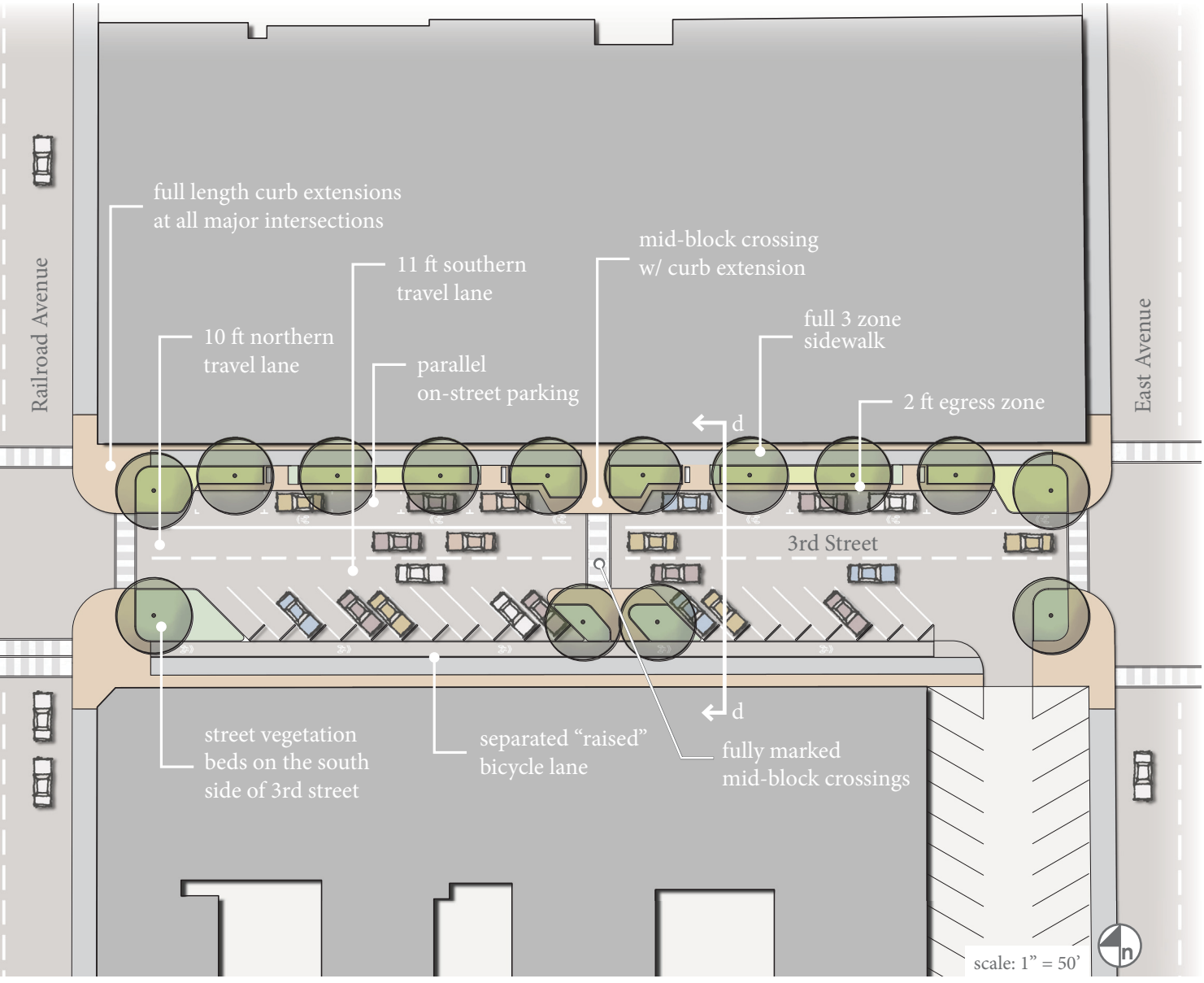


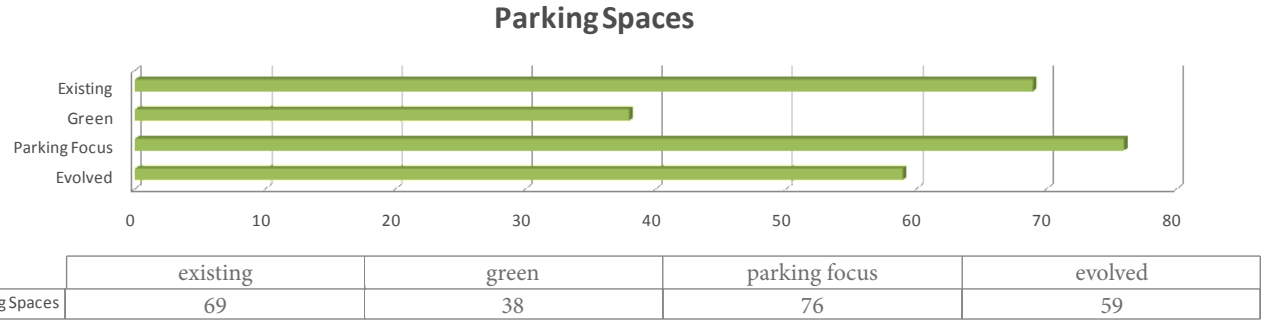
figure 5.96 evolved main street alternative masterplan (murner 2011)

understanding the alternatives

To evaluate and analyze the true effect each of the priority alternatives play on the outcome of a design, I completed a design alternative matrix. Showing some of the major concerns commonly associated with street development, the matrix and graphs show a side-by-side comparison of parking spaces, street trees, stormwater management areas, other vegetated areas, and pedestrian crossing distances. Understanding the trade-offs associated with each alternative is a key aspect in facilitating stakeholder dialogue and forming consensus on a design direction. Depending on what the true priorities of the community are, all alternatives are a viable solution. Yet when considered as a whole, the Evolved alternative best embodies the Main Street Evolved philosophy.

Design Scenario	Parking Spaces	Street Trees	Stormwater Management (sq ft)	Other Street Vegetation Area (sq ft)	Intersection Crossing Distance (ft)
Existing	69	8	0	2,951	40
Green	38	38	4,538	4,608	30
Parking	76	17	2,636	2,155	22
Evolved	59	27	3,354	1,932	25

table 5.4 design alternative matrix (murner 2011)

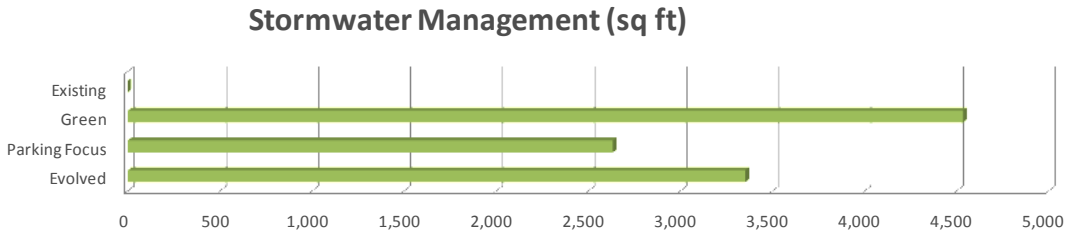


	existing	green	parking focus	evolved
Parking Spaces	69	38	76	59

figure 5.97 design alternative parking spaces comparison (murner 2011)

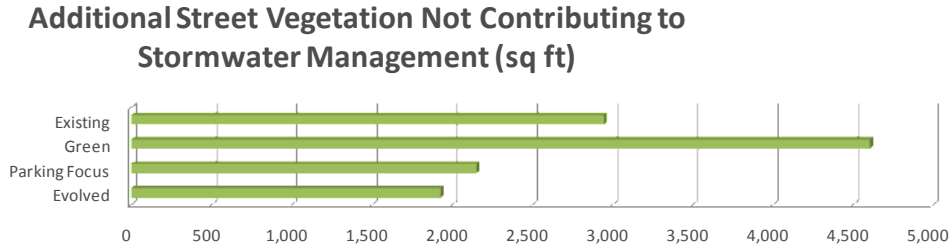
	existing	green	parking focus	evolved
Street Trees	8	38	17	27

figure 5.98 design alternative street trees comparison (murner 2011)



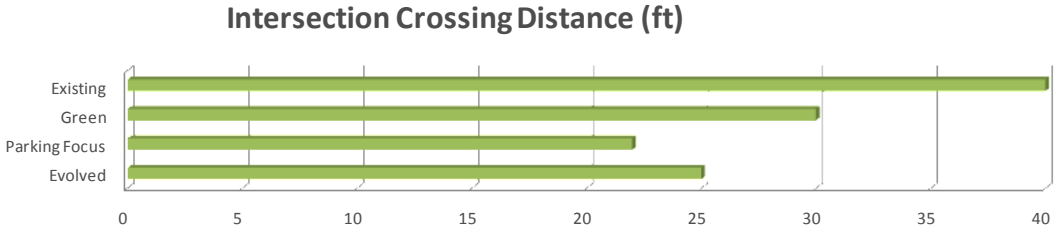
	existing	green	parking focus	evolved
Stormwater Management (sq ft)	0	4,538	2,636	3,354

figure 5.99 design alternative stormwater management area comparison (murner 2011)



	existing	green	parking focus	evolved
Additional Street Vegetation Not Contributing to Stormwater Management (sq ft)	2,951	4,608	2,155	1,932

figure 5.100 design alternative street vegetation area comparison (murner 2011)



	existing	green	parking focus	evolved
Intersection Crossing Distance (ft)	40	30	22	25

figure 5.101 design alternative intersection crossing distance comparison (murner 2011)

06 conclude

conclusions

Project Summary

Main Street Evolved presents a potential framework/process for creating a comprehensive main street in small rocky mountain communities. Although I cannot guarantee that by following the Main Street Evolved process every community will create a comprehensive Main Street, I can say that all communities possess the potential for implementing a more comprehensive street design. I have presented a holistic approach to street redevelopment that has the potential to provide the foundation for the redevelopment of Rocky Mountain Main Streets.

By investigating the ecological, multi-modal, and cultural ideals of modern street design initiatives, I was able to devise a framework/program and series of guidelines that illustrates the potential for creating a main street that not only considers future development needs, but also the cultural and ecological aspects of the region. Once devised, the application of the process and guidelines allowed me to understand how well the holistic program functioned and where it needed to be adapted.

The application of the process and guidelines, although rudimentary, begins to illustrate the importance community involvement and understanding play on the outcome of a design. The three design alternatives represent two common redesign philosophies and a hybrid philosophy. The application alternatives illustrate how a heavy focus on a singular priority, either ecological or economical, can lead to a somewhat comprehensive street design. Yet, by merging the two and understanding the trade-offs of each, an evolved solution can be created that can address both priorities.

This document is a comprehensive Main Street redevelopment program that has the potential to guide the revitalization efforts of Rocky Mountain communities in a way that is responsive to future development needs as well as the cultural and ecological aspects of the region. Main Street Evolved has the potential to enrich the connections between a community, its ecological surroundings, its cultural past, and its visions for the future. In turn, creating a truly Evolved Main Street.

Considerations

Through the course of this project, I have suggested critical considerations for the design of Main Streets that begin to define an Evolved approach. The first consideration is the importance of merging three major areas of interest; the built environment, the ecological environment, and the contextual environment. The merging of these areas of interest is at the heart of the entire project and is critical in creating a comprehensive street. If each of the three areas of interest are considered at a very early stage, it is likely that the redesign effort will be comprehensive in terms of merging the built, ecological, and contextual environments.

A second major consideration is to understand the limitations of each street. Some streets possess greater potential for successfully merging the built, ecological, and contextual environments simply based on available space, orientation, and topography. Although they can limit the degree a street can be modified, these established and unalterable aspects of each street should not be considered drawbacks. The individuality of every street is what makes them culturally significant. The goal of Main Street Evolved is not to create homogeny among small Rocky Mountain Main Streets, but to celebrate their uniqueness and propose methods of furthering individuality.

Finally, it is important to understand that the Main Street Evolved program and guidelines are only tools to be used. Although every community has the potential to transform their downtown into an ecologically responsible, culturally significant street with aspects of multi-modality, the success or failure lies within the priorities and choices established by each community. The choices made effect how the guidelines are used and the form the final solution takes. It is important for designers to demonstrate the benefits of merging the ecological, built, and contextual environments to their clients. If we as design experts can convince the community to accept a comprehensive approach from an early stage, the final design can become something truly evolved.

Limitations & Potential for Further research

There were numerous unexpected challenges and limitations in creating the Main Street Evolved project. The most critical challenge was the scale of the region. Although limiting the investigation to the Colorado Rockies was beneficial in attaining a general understanding of small mountain communities of the area, it neglected to take into consideration communities in the Rocky Mountains outside of Colorado. There is a chance that the Main Street Evolved process could be used by these non-Colorado mountain communities, but there may be issues and circumstances not addressed. On the other hand, generalizing all the mountain communities across the Colorado Rockies has its own drawbacks. Although I feel the generalization of these Colorado communities was done in a fair and informed way, unique features, surroundings, and circumstances that some communities have may have been overlooked in the process. Although the scope of the project could have been widened or narrowed, I feel the approach I have taken sets the foundation for future endeavors and research.

Furthermore, the sheer diversity within the representative communities combined with the limitless number of design alternatives made it extremely difficult to illustrate what an Evolved Main Street might look like in every context. Following the process on a number of communities across the region may have uncovered issues that were overlooked in the process. Further research to understand how well the process can be applied to the breadth of Rocky Mountain communities would be intriguing and beneficial to the process as a whole.

Finally, with so many differing opinions, standards, and dimensions for the various street features covered; this document is a culmination of research that suggests some approaches for what is best in a Rocky Mountain Context. The potential for the implementation of the Main Street Evolved process is limitless, but post occupancy evaluations of communities that have implemented some of the suggested standards would be invaluable to test the approach presented here and identify changes to a revised edition of the document.

If the Main Street Evolved framework/process can be established as a viable option for the redesign of Rocky Mountain communities, revisions to the guidelines and process could be made based on the experiences and outcomes of each redevelopment project. Much like the idea behind the Main Street Evolved project, this document should continually evolve and merge with other resources and ideals as they emerge.

Main Streets are an evolving form, adapting to the needs of the people who inhabit them, as needs change, so will the function and design of the streets. Thus, the Main Street Evolved framework/process should adapt and transform to meet the needs of the unique Rocky Mountain communities it is intended to aid.

Personal Reflections

The Main Street Evolved report represents the culmination of my educational experience. Beyond the knowledge and comprehension of the principles behind modern street development and design, the development and execution of the total process will be extremely valuable in my future endeavors. The Main Street Evolved process allowed me the opportunity to explore and understand my interests, design process, and above all my personal aspirations within the field of landscape architecture. Yet, as the project began to take shape, I found myself looking beyond what I would gain from its completion. I found myself driven to create a document that communities across the Colorado Rockies could understand and use. My ultimate hope is that Main Street Evolved becomes an established framework for the redesign of Main Streets across the Rocky Mountains or, at the very least, a springboard for designers and planners to suggest a comprehensive approach to redevelopment.

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glossary

Biodiversity
The variety and essential interdependence of all living things; it includes organisms, the genetic differences among them, the communities and ecosystems in which they occur, and the ecological and evolutionary processes that keep them functioning. (Farr 2008)

Biofiltration
The use of vegetation (usually grasses or wetland plants) to filter and treat stormwater runoff as it is conveyed through an open channel or swale. (Lehner and Natural Resources Defense Council 1999)

Bioretention
The use of vegetation in retention areas designed to allow infiltration of runoff into the ground. The plants provide additional pollutant removal and filtering functions. (Metropolitan Service District 2002b)

BMP's Pest Management Practices
The practice considered most effective to achieve a specific result for protection of water, air, and land and to control the release of toxins. (Farr 2008)

Built Environment
The urban environment consisting of buildings, roads, fixtures, parks, and all other improvements that form the physical character of a city. (Farr 2008)

Character
The image and perception of a community as defined by its built environment, landscaping, natural features and open space, types and styles of housing, and number and size of roads and sidewalks.(Farr 2008)

Complete Street
Are streets that "serve everyone—pedestrians, bicyclists, transit riders, and drivers—and they take into account the needs of people with disabilities, older people, and children." (McCann 2010)

Context Sensitive Design (CSD)
A collaborative, interdisciplinary approach that involves all stakeholders to develop a facility that fits its physical setting and preserve scenic, aesthetic, historic, and environmental resources. CSD is an approach that considers the total context within which a project will exist. (Farr 2008)

Ecosystem
The species and natural communities of a specific location interacting with one another and with the physical environment. (Farr 2008)

Green Infrastructure
An adaptable term used to describe an array of products, technologies, and practices that use natural systems – or engineered systems that mimic natural processes – to enhance overall environmental quality and provide utility services. As a general principal, Green Infrastructure techniques use soils and vegetation to infiltrate, evapotranspirate, and/or recycle stormwater runoff. (US EPA 2009)

Green Street (Portland Metro)
A street that uses vegetated facilities to manage stormwater runoff at its source through a strategy that meets regulatory compliance and resource protection goals by using a natural systems appro¬¬ach to manage stormwater, reduce flows, improve water quality and enhance watershed health. (PBES 2010)

Green streets are streets that are designed to protect, and attempt to mimic, the natural hydrology of an area and to protect streams and other natural resources from the impacts of stormwater run-off. (Metropolitan Service District 2002)

Impervious Surface
A surface that cannot be penetrated by water such as pavement, rock, or a rooftop and thereby prevents infiltration and generates runoff. (Lehner and Natural Resources Defense Council 1999)

Infiltration
The process or rate at which water percolates from the land surface into the ground. (Lehner and Natural Resources Defense Council 1999)

Interception
The precipitation that falls on the surface of trees, including foliage surfaces, bark and branches. (Metropolitan Service District 2002)

Livable Streets
A livable street is one " that provides those environmental conditions that support independence and freedom of choice; provide orientation, safety and comfort; encourage a sense of community yet provide sufficient privacy; foster a sense of neighborly ownership and responsibility; avoid disturbing nuisances; and enhance the economic value of adjacent property." (Metropolitan Service District 2002)

Main Street
The principal street of a small town that is synonymous with the downtown commercial area or district of the small town. Adapted from (Francaviglia 1996)

Marked Seasonality
Mountain areas, especially those at high altitudes, are characterized by short, temperate summers lasting from mid-June to late September, even shorter growing seasons, and long, often sever winters from November to April. (Dorward 1990)

Multi-Modal
A multi-modal street provides for and balances the needs of all travel modes: pedestrians, bicyclists, transit riders, commercial and personal motorists and others - - by providing more options for getting from place to place by car, bus, bicycle or on foot. Adapted from (City of Eugene Oregon 2008)

Nonpoint Source Pollution
Pollution discharged over a wide land area, not from one specific location. These are forms of diffuse pollution caused by sediment, nutrients, organic and toxic substances originating from land-use activities, which are carried to lakes and streams by surface runoff. Non-point source pollution is contamination that occurs when rainwater, snow melt, or irrigation washes off plowed fields, city streets, or suburban backyards. As this runoff moves across the land surface, it picks up soil particles and pollutants, such as nutrients and pesticides. (Perlman 2010)

Public right-of-way
Areas within public ownership or easement to serve the purpose of providing access to other private and public property for people and goods. (Metropolitan Service District 2002)

Redevelopment
The conversion of a building or project from an old use to a new one. (Farr 2008)

Regional Streets
Streets that accommodate both regional through traffic as well as local traffic.(Metropolitan Service District 2002)

Retrofit
The creation or modification of a stormwater management practice, usually in a developed area, that improved or combines treatment with existing stormwater infrastructure. (Lehner and Natural Resources Defense Council 1999)

Sidewalk Zone System
The sidewalk zone system provides a good way to create uncluttered but interesting sidewalks. Each zone has its own designated area, each with its own function.
Sidewalk Zones

+ The Curb Zone prevents water from splashing onto the sidewalk and prevents motor vehicle encroachment.
+ The Furniture Zone provides space for street furniture, trees and landscaping, utility poles, signs, and other elements that are found in the right-of-way.
+ The Pedestrian Zone is the area kept clear of obstructions for pedestrians
+ The Frontage Zone is next to the building, and provides an area for property owners to display items or locate a sidewalk café without interfering with the walking zone.

(McCann 2010)

Stormwater
Water derived from a storm even or conveyed through a storm sewer system. (Lehner and Natural Resources Defense Council 1999)

Stormwater Treatment Train
A series of BMP's or natural features, each designated to treat a different constituent, component, or aspect of runoff, implemented together to maximize pollutant removal effectiveness. (Lehner and Natural Resources Defense Council 1999)

Streetscape
The space between the buildings on either side of the street that defines its character. The elements of a streetscape include:

+ Building frontage/façade
+ Landscaping
+ Sidewalks
+ Street Paving
+ Street Furniture
+ Signs
+ Awnings
+ Street lighting

(Farr 2008)

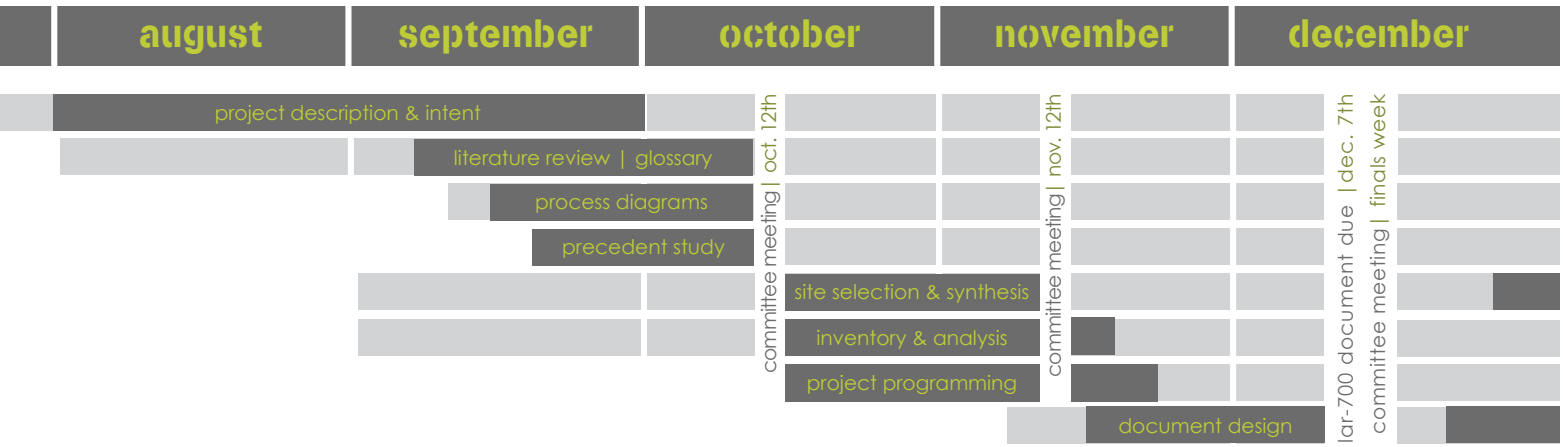
The Street Realm
The street realm is the overall setting in which people experience the character and use of the street. It is composed of the travelway, pedestrian and adjacent land-use realms. (Metropolitan Service District 2002)

Urban Runoff
Runoff derived from urban or suburban land-uses that is distinguished from agricultural or industrial runoff sources. (Lehner and Natural Resources Defense Council 1999)

Watershed
The geographic area from which water drains into a specific body. A watershed may contain several subwatersheds.(Farr 2008)

Xeriscaping
An alternative landscaping technique that focuses on water conservation through plant selection and site design. (Lehner and Natural Resources Defense Council 1999)

main street evolved timeline



project selection

tasks
+ research
+ preliminary investigation
+ question formulation

deliverables
+ two question
+ draft description & intent

preliminary study

tasks
+ literature collection
+ process development
+ precedent studies
+ revise description & intent

deliverables
+ final description & intent
+ draft process diagrams
+ draft timeline
+ draft literature map
+ draft literature review
+ draft precedent studies

inventory & analysis

tasks
+ community investigation
+ collect main street data
+ synthesize community data
+ identify existing strategies
+ formulate questions & goals

deliverables
+ draft inventory & analysis
+ draft inventory methodology
+ draft process diagrams
+ draft community attribute key

project programming

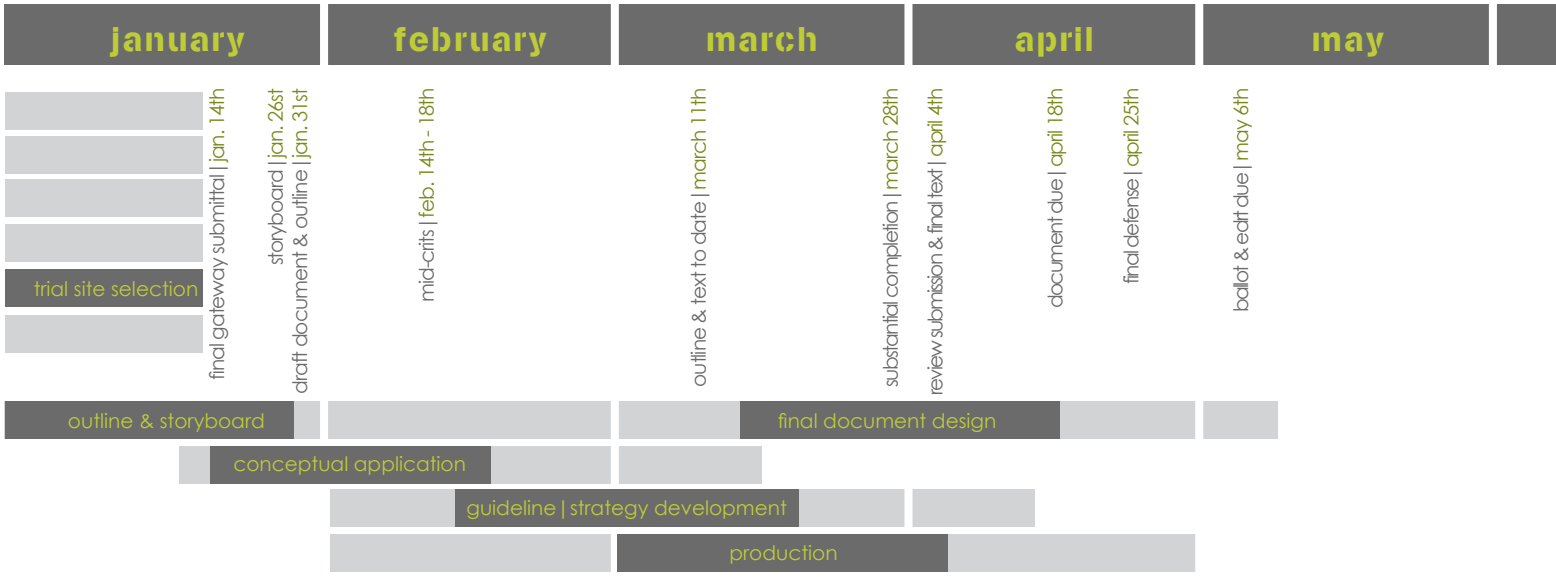
tasks
+ analysis of community data
+ develop program elements
+ categorize key features
+ diagram features
+ final literature review
+ final description & intent
+ final precedent study

deliverables
+ final community attribute key
+ draft program diagram
+ final lar-700 document

revisions

tasks
+ address suggested revisions
+ revise program
+ revise inventory & analysis

deliverables
+ final community attribute key (revised edition)



document design	conceptual application	concept finalization	production	final product & presentation
tasks + storyboard + InDesign template **deliverables** + final document outline	**tasks** + select trial site + strategy selection + strategy justification + guideline development **deliverables** + preliminary sketches + draft guideline outline	**tasks** + revise strategy selection + revise guideline outline + 3rd street mock-ups **deliverables** + draft conceptual graphics + draft guidelines + draft document + draft handbook	**tasks** + finalize graphics + finalize guidelines + finalize document text + presentation development **deliverables** + final defense documents + revised final document + revised handbook	**tasks** + address revisions + final edition + final presentation **deliverables** + final document + final presentation + final handbook

figure A.1 Main Street Evolved Timeline (Murner 2010)

supplemental plant lists

The following plant list was prepared for communities along the Front Range by the Colorado Department of Local Affairs, Office of Smart Growth. Due to the differences in elevation, climate and soil composition, the lists of drought-tolerant plants contained within the list may not be appropriate for all areas of the state. Please consult with a local landscape architect or master gardeners to ensure that plant materials are appropriate for your region. For more information, consult the Colorado Division of Local Government, Office of Smart Growth at **http://dola.colorado.gov**

table A.1 Colorado Water Wise Plant List (Knopf et. al., 2004)

Trees

(Deciduous Rocky Mountain Natives)

[Revised April '03]

WATER NEEDS OF PLANTS

The following chart shows how to group plants based on their water needs.
Reference Location: Denver. Numbers illustrate typical conditions.

* = Plants with potential, but requiring caution due to limited history in Rocky Mountain landscaping.

HIGH WATER	MODERATE WATER	LOW WATER	VERY LOW WATER
Reference plant: Bluegrass turf (Always wet at surface)	Reference plant: Turf-type Tall Fescue (Half of Bluegrass turf)	Reference plant: Buffalograss turf (Like Denver without irrigation)	Reference plant: Too dry for any turf (drier than Denver)
18-20 gals./ S.F./season July: 5"-- 3 times per week	10 gals./S.F./ season .75" -- once per week	0-3 gals./S.F./season .5" per 2 weeks, optional	No irrigation No irrigation

Celtis•occidentalis	Hackberry	(M-H)
Celtis•reticulata	Netleaf Hackberry	(M-H)
Fraxinus•cuspidata *	Fragrant Ash	(M+/-)
Fraxinus•pennsylvanica	Green Ash	(M-H)
Populus•angustifolia	Narrowleaf Cottonwood	(H)
Populus•deltoides	Plains Cottonwood	(H)
Populus•fremontii	Fremont's Cottonwood	(H)
Populus•tremuloides	Aspen	(H)
Populus•x•acuminata	Lanceleaf Cottonwood	(H)
Sapindus•drummondii *	Soapberry	(L-M)

Trees

(Deciduous, Introduced)

[Revised April '03]

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Acer•capillipes *	Snake-bark Maple (Japan)	(H)
Acer•cappadocicum *	Caucasican Maple (Cauc., A. Minor, n. India)	(M-H)
Acer•cissifolium *	Ivy-leafed Maple (c. China)	(M-H)
Acer•davidii *	Snake-bark Maple (n. China)	(M-H)
Acer•griseum *	Paperbark Maple (China)	(M-H)
Acer•heldreichii *	Greek Maple (Cauc., Balk., n. Turkey)	(M-H)
Acer•macrophyllum *	Oregon Maple (w. N. Am.)	(H)
Acer•mandschuricum *	Manchurian Maple (Korea, Manch.)	(M-H)
Acer•monspessulanum *	Montpelier Maple (Medit.- c. Asia)	(M+/-)
Acer•palmatum	Japanese Maple (Kor., Jap.)	(H)
Acer•pectinatum	----- (Tibet, w. & c. China)	(M-H)
Acer•platanoides	Norway Maple (Eur. to n. Persia)	M-H)
Acer•platanoides•ssp.•turkestanicum *	Turkestan Maple (c. Asia)	(M+/-)
Acer•pseudoplatanus *	Sycamore Maple (nw. c. Eur. to w. Asia)	(M-H)
Acer•pseudosieboldianum *	Korean Maple (Korea-Manch.)	(H)
Acer•rubrum	Red Maple (e. N. America)	(M-H)
Acer•saccharinum	Silver Maple (e. N. Am.)	(M-H)
Acer•saccharinum•'Laciniatum' +	Cutleaf Silver Maple (Hort. cultivar	(M-H)
Acer•saccharum	Sugar Maple (e. N. America)	(H)
Acer•triflorum *	Three-flowered Maple (Manch., Korea)	(M+/-)
Acer•truncatum *	Shantung Maple (n. China, Manch., Korea)	(H)
Acer•turkestanicum *	= A. platanoides ssp. turkestanicum	
Aesculus•flava	Sweet Buckeye (e. N. America)	(M-H)
Aesculus•glabra	Ohio Buckeye (e. N. America)	(M-H)
Aesculus•hippocastanum	Horse Chestnut (Eurasia)	(M-H)
Aesculus•octandra	= Aesculus•flava	
Aesculus•pavia *	Red Buckeye (se. USA)	(H)
Aesculus•turninata *	Japanese Horsechestnut (Japan)	(M-H)
Aesculus•x•carnea *	Red-flowered Horsechestnut (hort. hybrid)	(M+/-)
Ailanthus•altissima	Tree of Heaven (n. China)	(L-M-H)
Albizia•julibrissin*	Silk Tree (Iran-Japan)	(M+/-)
Amelanchier•asiatica *	Asiatic Serviceberry (China)	(M+/-)
Asimia•triloba *	Paw Paw (ec. USA)	(H?)
Betula•albosinensis *	Chinese Red Birch (c., w., nw. China)	(M-H)
Betula•ermanii *	Russian Rock Birch (ne. Asia)	(H)
Betula•mandshurica•var.•japonica *	Japanese White Birch (Jap., Sakhalin Is.)	(H)
Betula•maximowicziana *	Monarch Birch (Jap.)	(H)
Betula•nigra	River Birch (e. USA)	(H)

Betula•papyrifera	Paper Birch (e. N. America)	(H)
Betula•pendula•'Lacinata'	Cutleaf Weeping Eur.. Birch (hort. hybrid)	(H)
Betula•pendula	European Birch (Eur.-w. Asia)	(H)
Betula•utilis•var.•jacquemantii *	Whitebarked Himal. Birch (Kash., c. Nepal)	(M-H)
Carpinus•betulus *	European Hornbeam (Eur.-w. Asia)	(H)
Carpinus•carolinana *	American Hornbeam (e. N. America)	(H)
Carpinus•cordata *	Heartleaf Hornbeam (China)	(M-H)
Carpinus•henryana *	----- (c. China)	(M-H)
Carpinus•japonica *	Japanese Hornbeam (Japan)	(H)
Carpinus•laxiflora *	----- (Jap., Kor., n. & w. China)	(M-H)
Carpinus•orientalis *	Oriental Hornbeam (se. Eur., A. Minor)	(M-H)
Carpinus•tschonoskii *	Yeddo Hornbeam (ne. & sw. China)	(M-H)
Carpinus•turczaninovii *	----- (w. China)	(M+/-)
Carya•illinoinensis *	Pecan (Iowa s. to Mexico)	(M+/-)
Carya•laciniosa *	Shellbark Hickory (e. N. America)	(M-H)
Carya•ovata *	Shagbark Hickory (e. N. America)	(H)
Castanea•crenata *	Japanese Chestnut (Jap.)	(H)
Castanea•dentata	American Chestnut (e. N. America)	(H)
Castanea•mollissima *	Chinese Chestnut (China, Korea)	(M-H)
Catalpa•bignonioides *	Southern Catalpa (se. USA)	(H)
Catalpa•bungei *	----- (n. China)	(M+/-)
Catalpa•fargesii *	----- (w. China)	(M+/-)
Catalpa•ovata *	Chinese Catalpa (China)	(H)
Catalpa•speciosa	Catalpa (e. N. America)	(M-H)
Celtis•australis *	Mediterranean Hackberry (Medit., Mid East)	(M+/-)
Celtis•caucasica *	Caucasican Hackberry (Asia Minor-Afghan.)	(M+/-)
Celtis•laevigata	Sugarberry (se. USA)	(M-H)
Cercidiphyllum•japonicum *	Katsura Tree (Japan, w. China)	(H-M)
Cercis•canadensis	Eastern Redbud (e. N. America)	(M-H)
Cercis•reniformis *	Texas Redbud (N. Mex., Tex., Okla.)	(M+/-)
Chitalpa	= x•Chitalpa•tashkentensis	
Cladrastis•lutea *	Yellowwood (se. USA)	(H)
Cladrastis•platycarpa *	Japanese Yellowwood (Jap., China)	(H)
Cladrastis•sinensis *	Chinese Yellowwood (China)	(H)
Corlyus•colurna	Turkish Hazel (se. Europe, w. Asia)	(M+/-)
Cornus•walteri *	Walter Dogwood (c. China)	(M-H)
Corylus•americana *	American Hazel (e. N. America)	(H)
Crataegus•altaica•'Hissarica' *	Hissar Hawthorn (Tajikistan)	(M+/-)
Crataegus•ambigua +	Russian Hawthorn (se. Russia)	(M+/-)
Crataegus•arnoldiana *	----- (New England)	(M+/-)
Crataegus•azarolus *	Red Azarole (s. Eur., n. Afr., w. Asia)	(M+/-)
Crataegus•crus-galli	Cockspur Hawthorn (se. N. America)	(M+/-)
Crataegus•laevigata *	English Hawthorn (Eur., n. Afr., India)	(M-H)
Crataegus•maximowiczii *	----- (ne. Asia)	(M+)
Crataegus•mollis	Downy Hawthorn (e. N. America)	(M+/-)
Crataegus•monogyna *	Singleseed Hawthorn (Eur., n. Afr., w. Asia)	(M+/-)
Crataegus•pedicellata *	----- (ne. USA)	(M+/)
Crataegus•phaenopyrum	Washington Hawthorn (se. N. America)	(M+/-)
Crataegus•pinnatifida *	Chinese Hawberry (c. Asia, Korea)	(M+/-)
Crataegus•rivularis *	----- (Rocky Mtn. States)	(M+/-)
Crataegus•tianshanica *	Tien Shan Hawthorn (c. Asia)	(M+/-)
Crataegus•turkestanica *	Turkestan Hawthorn (Turkestan)	(M+/-)
Crataegus•viridis•'Winter•King' *	Winter King Hawthorn (e. USA)	(M+/-)
Crataegus•x•nitida *	Shining Hawthorn (s. USA)	(M+/-)
Cyrilla•racemiflora *	Leatherwood (e. N. Am. & e. S. Am.)	(H)
x•Chitalpa•tashkentensis *	Chiltalpa (Catalpa•bignonioides X Chilopsis•linearis)	(M+/-)
Diospyros•virginiana *	American Persimmon (e. USA)	(M-H)

Eucommia•ulmoides *	Hardy Rubber Tree (c. China)	(M+/-)
Evodia•daniellii *	= Tetradium•danielii *	
Evodia•hupehensis *	= Tetradium•hupehensis *	
Fagus•grandifolia *	American Beech (e. N. America)	(H)
Fagus•orientalis *	Oriental Beech (se. Eur.-Iran)	(M+/-)
Fagus•sylvatica	European Beech (Europe)	(H)
Fraxinus•americana	White Ash (e. N. America)	(M-H)
Fraxinus•americana•'Autumn•Purple'	Autumn Purple Ash (hort. cultivar)	(M-H)
Fraxinus•angustifolia•'Raywood' *	Raywood Ash (s. Europe-c. Asia, n. Afr.)	(M+/-)
Fraxinus•angustifolia•ssp.•syriaca *	Turkestan Ash (c. Asia, A. Minor)	(M+/-)
Fraxinus•chinensis *	Chinese Ash (China)	(M+/-)
Fraxinus•cuspidata *	Flowering Ash (N. Mex. to Mex.)	(L-M)
Fraxinus•excelsior *	European Ash (Europe, w. Asia)	(M+/-)
Fraxinus•latifolia *	Oregon Ash (w. US)	(M+/-)
Fraxinus•mandshurica *	Manchurian Ash (n. Asia)	(M+/-)
Fraxinus•nigra *	Black Ash (N. Am.)	(M+/-)
Fraxinus•ornus *	Flowering Ash (s. Europe-w. Asia)	(M+/-)
Fraxinus•oxycarpa•'Raywood' *	= F. angustifolia 'Raywood'	
Fraxinus•quandrangulata *	Blue Ash (Mich., to Ark.)	(M-H)
Fraxinus•sieboldiana *	----- (Japan, China)	(M-H)
Fraxinus•sogdiana *	= Fraxinus•angustifolia•ssp.•syriaca	
Fraxinus•velutina *	Velvet Ash (Ariz., N. Mex.)	(M+/-)
Ginkgo•biloba *	Ginkgo, Maidenhair Tree (se. China)	(M-H)
Gleditsia•caspica *	Caspian Honeylocust (Azerbaijan-n. Iran)	(M+/-)
Gleditsia•triacanthos•var.	Honeylocust varieties (c. & e. N. America)	(M-H)
Gymnocladus•dioica	Kentucky Coffeetree (c. & e. N. America)	(M-H)
Halesia•diptera *	Two-winged Silverbell (s. USA)	(H)
Halesia•tetraptera *	Silverbell Tree (se. USA)	(H)
Hemiptelea•davidii *	David Hemiptelea (n. China to Korea)	(M-H)
Hovenia•dulcis *		
Idesia•polycarpa *	----- (Sichuan)	M-H)
Juglans•ailanthifolia *	Japanese Walnut (Jap.)	(M+/-)
Juglans•ailantifolia *	Heartnut (Japan)	(H)
Juglans•cinerea *	White Butternut (N. America)	(M+/-)
Juglans•mandshurica *	Manchurian Walnut (Manchuria, ne. China)	(M+/-)
Juglans•microcarpa *	Little Walnut (OK., N. Mex., Tex., Kan., Mex.)	(M+/-)
Juglans•nigra	Black Walnut (e. USA)	(M-H)
Juglans•regia•varieties *	Carpathian Walnut varieties (se. Eur. - China)	(M+/-)
Kalopanax•pictus *	= Kalopanax•septemlobus	
Kalopanax•septemlobus *	Castor-aralia (China, Korea, Japan)	(M-H)
Koelreuteria•paniculata	Golden Raintree (n.China, Korea)	(M+/-)
Laburnum•alpinum *	Alpine Golden Chaintree (sc. Europe)	(M-H)
Laburnum•anagyroides *	Common Laburnum (c. & s. Eur.)	(M+/-)
Laburnum•X•'Waterer' *	Waterer Laburnum (hort. hybrid)	(H)
Larix•decidua	European Larch (Alps, Carpathian Mts.)	(H)
Larix•gmelinii *	Dahurian Larch (e. Asia)	(H)

Larix•kaempferi *	Japanese Larch (Japan)	(H)
Larix•laricina	Tamarack (n. N. America)	(H)
Larix•leptolepis *	= Larix•kaempferi	
Larix•occidentalis *	Rocky Mtn. Larch (B.C. to Montana)	(M-H)
Liquidambar•styraciflua *	Sweetgum (e. N. America to c. America)	(H)
Liriodendron•tulipifera *	Tulip Tree (e. N. America)	(H)
Maackia•amurensis *	Amur Maackia (Manchuria, Korea)	(M+/-)
Maackia•chinensis *	----- (c. China)	(M+/-)
Maclura•pomifera *	Osage Orange (Ark., Tex.)	(M+/-)
Magnolia•acuminata *	Cucmber Tree (e. N. AM)	(H)
Magnolia•kobus *	Tree Star Magnolia (Japan)	(M-H)
Magnolia•x•soulangiana	Saucer Magnolia (hort. hybrid)	(H)
Malus•'Hopa'	Hopa Crabapple (hort. cultivar)	(M+/-)
Malus•'Radiant'	Radiant Crabapple (hort. cultivar)	(M+/-)
Malus•'Snowdrift'	Snowdrift Crabapple (hort. cultivar)	(M+/-)
Malus•baccata	Siberian Crabapple (Manchuria, China)	(M+/-)
Malus•dolgo	Dolgo Crabapple (Siberia ?)	(M+/-)
Malus•ioensis	Prairie Crabapple (c. USA)	(M+/-)
Malus•ioensis•'Plena'	Bechtel Crabapple (hort. cultivar)	(M+/-)
Malus•sp.•'Golden•Delicious'	Golden Delicious Apple (hort. cultivar)	(M+/-)
Malus•sp.•'Red•Delicious'	Red Delicious Apple (hort. cultivar)	(M+/-)
Malus•sp.•'Winesap'	Winesap Apple (hort. cultivar)	(M+/-)
Malus•spp.	Common Apple (se. Europe, c. Asia)	(M+/-)
Mespilus•germanica *	Medlar (Europe-Asia Minor)	(M+/-)
Metasequoia•glyptostroboides *	Dawn Redwood (w. China)	(M-H)
Morus•alba	White Mulberry (Asia)	(M+/-)
Morus•australis *	----- (e. Asia)	(M+/-)
Morus•nigra *	Black Mulberry (sw. Asia)	(M+/-)
Morus•rubra *	Red Mulberry (e. N. America)	(M+/-)
Nothofagus•antarctica *	Southern Beech (Chile, Argentina)	(H)
Nyssa•sylvatica *	Blackgum (Ontario, Texas)	(H)
Ostrya•carpinifolia *	European Hop Hornbeam (s. Eur., se. Asia)	(M)
Ostrya•virginiana *	American Hop Hornbeam (e. N. America)	(H)
Paulownia•fortunei*	----- (China, Japan)	(H)
Paulownia•kawakamii*	----- (s. China, Taiwan)	(H)
Paulownia•tomentosa *	Empress Tree (c. & w. China)	(M-H)
Phellodendron•amurense *	Amur Cork Tree (n. China, Jap., Manch.)	(M-H)
Phellodendron•chinese *	Chinese Cork Tree (c. China)	(M-H)
Phellodendron•Japonicum *	Japanese Cork Tree (c. Japan)	(H)
Phellodendron•sachalinense *	Sakhalin Cork Tree (w. China, n. Jap., Kor.)	(H)
Pistacia•chinensis *	Chinese Pistachio (China, Taiwan)	(L-M)
Pistacia•vera *	Edible Pistachio (Persia, c. Asia)	(L-M)
Platanus•occidentalis *	Eastern Plane Tree (Ia., to Tex. to Mex.)	(H)
Platanus•orientalis *	Oriental Plane Tree (se. Eur., sw. Asia)	(M+/-)
Platanus•x•acerifolia *	London Plane Tree (hort. hybrid)	(H)
Prunus•armeniaca	Apricot (c. & e. Asia)	(M+/-)
Prunus•armeniaca•var.•mandshurica *	= Prunus•mandshurica	
Prunus•avium *	Bird Cherry (Eur.-A. Minor-e. Sib.)	(H-M)
Prunus•cerasus *	Pie Cherry (se. Eur., Iran, n. India)	(M+/-)
Prunus•cerasus•'Meteor'	Meteor Pie Cherry (hort. cultivar)	(M+/-)
Prunus•cerasus•'Morello'	Morello Pie Cherry (hort. cult.)	(M+/-)
Prunus•cerasus•x•'Montmorency'	Montmorency Pie Cherry (hort. cultivar)	(M+/-)
Prunus•cerasus•x•'North•Star'	North Star Pie Cherry (hort. cultivar)	(M+/-)
Prunus•maackii	Manchurian Cherry (Kor. Manch.)	(M-H)

Prunus•mahleb *	St. Lucie Cherry (Eur.-Asia Minor)	(M+/-)
Prunus•mandshurica *	Manchurian Apricot (Manchuria, Korea)	(M+/-)
Prunus•persica	Peach (c. & e. Asia)	(M+/-)
Prunus•salicina *	Japanese Plum (China, Jap.)	(H-M)
Prunus•sp.•'Green•Gage'	Green Gage Plum (hort. cultivar)	(M+/-)
Prunus•sp.•'Stanely'	Stanley Plum (hort. cultivar)	(M+/-)
Prunus•spp.	Domestic Plums	(M+/-)
Prunus•x•dasycarpa * (P. •armenica x P.•cerasifera)	Black Apricot (c. Asia-Asia Minor)	(M-L)
Pseudolarix•kaempferi *	Golden Larch (e. China)	(H?)
Ptelea•polyadenia*	----- (sw. USA)	(M+/-)
Pterocarya•fraxinifolia *	Caucasian Walnut (Caucasus, Persia)	(M+/-)
Pterocelti•tartarianovii *	Tartar Wingceltis (n., c. China)	(M+/-)
Pterostyrax•hispida *	Fragrant Epaulette Tree (Japan, China)	(H?)
Pyrus•bucharica *	= Pyrus•korshinsky	
Pyrus•calleryana•'Bradford'	Bradford Pear (China)	(M+/-)
Pyrus•communis +	Common Garden Pear (Europe, w. Asia)	(M+/-)
Pyrus•communis•'Maxine'	Maxine Pear (hort. cultivar)	(M+/-)
Pyrus•communis•'Moonglow'	Moonglow Pear (hort. cultivar)	(M+/-)
Pyrus•korshinsky *	Buchara Pear (Turkestan)	(L-M)
Pyrus•salicifolia *	Willow-leafed Pear (se. Europe, w. Asia)	(M+/-)
Quercus•acutissima *	Sawtooth Oak (Japan, China, Korea)	(M-H)
Quercus•alba	White Oak (e. USA)	(M+/-)
Quercus•bicolor	Swamp White Oak (ne. N. Am.)	(M+/-)
Quercus•douglasii *	California Blue Oak (w. US)	(M+/-)
Quercus•frainetto *	Hungarian Oak (s. Italy, Balk., Turkey)	(M+/-)
Quercus•glandulifera *	----- (Jap., Korea, China)	(M+/-)
Quercus•imbricaria *	Shingle Oak (e. & c. USA)	(M-H)
Quercus•kelloggii *	California Black Oak (w. US)	(M+/-)
Quercus•macrocarpa	Bur Oak (c., ne. N. America)	(M+/-)
Quercus•mongolica *	Mongolian Oak (ne. Asia)	(M+/-)
Quercus•muehlenbergii *	Chinquapin Oak (e. USA)	(M-H)
Quercus•palustris	Pin Oak (ne. N. America)	(M-H)
Quercus•phellos *	Willow Oak (se. USA)	(M-H)
Quercus•prinus *	Chestnut Oak (e. USA)	(M-H)
Quercus•robur	English Oak (Europe, n. Afr., w. Asia)	(M-H)
Quercus•rubra	Northern Red Oak (ne. USA)	(M-H)
Quercus•sadleriana *	Deer Oak (w. USA)	(M+/-)
Quercus•shumardii *	Shumard's Oak (c. USA)	(M-H)
Quercus•vacciniifolia *	Huckleberry Oak (w. US)	(M+/-)
Salix•pentandra *	Laurel-leaf Willow (Eur.)	(H)
Sassafras•albidum *	Sassafras (e. N. Am.)	(H)
Sophora•davidii *	David's Sophora (China)	(L-M)
Sophora•japonica (aka Styphnolobium•japonicum)	Japanese Pagoda Tree (China, Korea)	(M+/-)
Sorbus*torminalis *	Chequer Tree (A. Minor, n. Africa, Eur. Asia)	(H)
Sorbus•alnifolia *	----- (Jap., Korea)	(H)
Sorbus•americana	American Mtn. Ash (ne. N. America)	(M-H)
Sorbus•aria*	Whitebeam Mtn. Ash (Eur.)	(H)
Sorbus•aucuparia	European Mtn. Ash (Eurasia)	(M-H)
Sorbus•cashmeriana *	Kashmir Mountain Ash (Himalaya)	(H)
Sorbus•commixta *	----- (Korea, Japan)	(M-H)
Sorbus•decora	Showy Mountain Ash (ne. N. America)	(M-H)
Sorbus•forrestii *	Forest's Mountain Ash (China)	(M-H)
Sorbus•hupehensis *	Hupeh Mtn. Ash (c., w. China)	(M-H)
Sorbus•intermedia *	Scandinavian Mtn. Ash (Scand.)	(H)
Sorbus•latifolia *	----- (Europe)	(M-H)
Sorbus•pohuashanensis *	----- (n. China)	(H)
Sorbus•prattii *	Pratt's Mountain Ash (w. China)	(M+/-)
Sorbus•tianschanica *	Tien Shan Mtn. Ash (c. Asian mtns.)	(H)

Sorbus•x•hybrida *	Oakleaf Mtn. Ash (hort. hybrid)	(H)
Stranvaesia•davidiana *	Chinese Stranvaesia (w. China)	(H)
Styphnolobium•japonicum	see Sophora•japonica	
Styrax•japonicum *	Japanese Snowball (Japan, China)	(H)
Styrax•obassia *	Fragrant Snowbell (Japan)	(H)
Syringa•pekinensis	Peking Tree Lilac (n. China)	(M+/-)
Syringa•reticulata	Japanese Tree Lilac (n. Japan)	(M-H)
Syringa•reticulata•var.•mandschurica	Manchurian Tree Lilac (Japan)	(M+/-)
Taxodium•ascendens *	Pond Cypress (se. USA)	(H)
Taxodium•distichum	Bald Cypress (se. N. America)	(H)
Tetradium•danielii *	Korean Evodia (China, Korea)	(H)
Tetradium•hupehensis *	Hupeh Bee Bee Tree (sw. China, Korea)	(M+/-)
Tilia•americana	Basswood (c., e. N. America)	(H)
Tilia•amurensis *	Amur Linden (Manch., Korea)	(M-H)
Tilia•cordata	Littleleaf Linden (Eur. to Caucasus)	(H)
Tilia•mongolica *	Mongolian Linden (Mon., e. Russia, n. China)	(M-H)
Tilia•platyphyllos *	Bigleaf Linden (se., Europe)	(M-H)
Tilia•tomentosa *	Silver Linden (se. Europe, w. Asia)	(M+/-)
Tilia•x•euchlora *	Crimean Linden (hort. hybrid)	(M-H)
Toona•sinensis	----- (China)	(M-H)
Ulmus•parvifolia *	Chinese Elm (China, Japan, Korea)	(M-H)
Ulmus•americana•cvs.	American Elm (DED resistant cultivars)	(L-M-H)
Zelkova•carpinifolia *	Caucasian Zelkova (Cauc.)	(M-H)
Zelkova•serrata *	Japanese Zelkova (Jap., Taiwan, e. China)	(H)
Zelkova•sinica *	Chinese Zelkova (e. China)	(H)
Ziziphus•jujuba *	Chinese Jujuba (temp. Asia)	(H-M)

EVERGREENS

(Coniferous Trees)
[Revised April '03]

WATER NEEDS OF PLANTS

The following chart shows how to group plants based on their water needs.
Reference Location: Denver. Numbers illustrate typical conditions.

* = Plants with potential, but requiring caution due to limited history in Rocky Mountain landscaping.

HIGH WATER	MODERATE WATER	LOW WATER	VERY LOW WATER
Reference plant: Bluegrass turf (Always wet at surface)	Reference plant: Turf-type Tall Fescue (Half of Bluegrass turf)	Reference plant: Buffalograss turf (Like Denver without irrigation)	Reference plant: Too dry for any turf (drier than Denver)
18-20 gals./ S.F./season July: 5"-- 3 times per week	10_ gals./S.F./ season .75" -- once per week	0-3 gals./S.F./season .5" per 2 weeks, optional	No irrigation No irrigation

Abies•cilicica *	Cilician Fir (s. Turkey, nw. Syria, Lebanon)	(M-H)
Abies•concolor	White Fir (Colo. to Mex.)	(M-H)
Abies•holophylla *	Manchurian Fir (Manch., Korea)	(M-H)
Abies•homolepis *	Nikko Fir (Japan)	(H)
Abies•koreana *	Korean Fir (s. Korea)	(H)
Abies•lasiocarpa	Subalpine Fir (Rocky Mtns.)	(H)
Abies•nordmanniana *	Caucasian Fir (Greece, Cauc., Turkey)	(M)
Calocedrus•decurrens *	Incense Cedar (w. Ore.-Baja Calif.)	(M-H)
Cedrus•atlantica *	= Cedrus•libani•ssp.•atlantica	
Cedrus•deodara *	Deodara Cedar (Himilaya Mts. Afghan.-w. Nepal)	(M-H)
Cedrus•libani *	Lebanon Cedar (nw. Syria, se Turkey)	(M-H)
Cedrus•libani•ssp.•atlantica *	Atlas Cedar (Atlas Mts.)	(M-H)
Cedrus•libani•ssp.•stenocoma *	Hardy Turkish Cedar (s. Turkey)	(M-H)
Cupressus•arizonica *	Arizona cypress (Ariz., N. Mex., Tex., Mex.)	(L-M)
Cupressus•bakeri *	Modoc Cypress (Calif., Oregon)	(M+/-)
Picea•abies	Norway Spruce (n. & c. Europe)	(H)
Picea•engelmannii	Engelmann Spruce (B.C. to N. Mex.)	(H)
Picea•glauca	White Spruce (n. N. Am.)	(M-H)
Picea•glauca•'Black•Hills'	Black Hills Spruce (Black Hills S.Dak.)	(M-/-)
Picea•glauca•'Conica'	Dwarf Alberta Spruce (hort. cultivar)	(H)
Picea•omorika *	Serbian Spruce (Balk.)	(M-H)
Picea•pungens	Colorado Spruce (Wyo., Colo., N. Mex., Utah)	(M-H)
Picea•schrenkiana•ssp.•tianshanica *	----- (c. Asia)	(M+/-)
Pinus.•heldreichii (was P.•leucodermis) *	Bosnian Pine (w. Balkans - se. Italy - Greece)	(M+/-)
Pinus•aristata	Bristlecone Pine (Mts. Cal. to Colo.)	(M, H)
Pinus•bungeana *	Lacebark Pine (nw. China)	(M+/-)
Pinus•cembra *	Swiss Stone Pine (c. Eur. mtns.)	(M-H)
Pinus•contorta•ssp.•latifolia	Lodgepole Pine (Alaska, Cal., to Colo.)	(M-H)
Pinus•densiflora *	Japanese Red Pine (Jap., Korea)	(M-H)
Pinus•flexilis	Limber Pine (Albt. to Cal. to Tex.)	(M-H)
Pinus•nigra	Austrian Pine (se. Eur., w. Asia, n. Afr.)	(M-H)
Pinus•peuce *	Macedonian Pine (Balk.)	(M-H)
Pinus•ponderosa	Ponderosa Pine (w. North America)	(M+/-)
Pinus•pumila *	Dwarf Siberian Pine (ne. Asia)	(H)
Pinus•strobiformis	Southwestern White Pine (Colo., Ariz., n. Mex.	(M-H)

Pinus•strobus	Eastern White Pine (e. N. America)	(H)
Pinus•sylvestris	Scotch Pine (n. Eurasia)	(M-H)
Pinus•wallichiana *	Himalayan White Pine (Himalaya Mtns.)	(M-H)
Pseudotsuga•menziesii	Douglas Fir (B.C. to Mex. to Tex.)	(M-H)
Sequoiadendron•giganteum *	Giant Sequoia (Sierra Nevada Mts.)	(H)
Tsuga•canadensis	Canada Hemlock (ne. N. America)	(H)

EVERGREENS

(Coniferous Shrubs)

[Revised April '03]

WATER NEEDS OF PLANTS

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HIGH WATER	MODERATE WATER	LOW WATER	VERY LOW WATER
Reference plant: Bluegrass turf (Always wet at surface)	Reference plant: Turf-type Tall Fescue (Half of Bluegrass turf)	Reference plant: Buffalograss turf (Like Denver without irrigation)	Reference plant: Too dry for any turf (drier than Denver)
18-20 gals./ S.F./season July: 5"-- 3 times per week	10 gals./S.F./ season .75" -- once per week	0-3 gals./S.F./season .5" per 2 weeks, optional	No irrigation No irrigation

Chamaecyparis•pisifera *	----- (Japan)	(H)
Juniperus•chinensis	Chinese Juniper (e. Asia)	(L-M)
Juniperus•chinensis•'Hetzii•Glauca'	Hetzi Juniper (hort. cultivar)	(L-M)
Juniperus•chinensis•'Pfitzeriana'	Pfitzer Juniper (hort. cultivar)	(L-M)
Juniperus•chinensis•'Pfitzeriana•Compacta'	Compact Pfitzer Juniper (hort. cultivar)	(L-M)
Juniperus•chinensis•'Tortulosa' *	Hollywood Juniper (hort. cultivar)	(L-M)
Juniperus•chinensis•var.•sargentii	Sargent's Juniper (e. Asia)	(L-M)
Juniperus•communis•saxatilis	Mountain Common Juniper (circumboreal)	(L-M)
Juniperus•horizontalis	Horizontal Juniper (Nov. Sc. to Alaska, N J., to Mon.,)	(L-M)
Juniperus•horizontalis•'Bar•Harbor'	Bar Harbor Juniper (hort. cultivar)	(L-M)
Juniperus•horizontalis•'Blue•Chip'	Blue Chip Juniper (e. Asia)	(L-M)
Juniperus•horizontalis•'Plumosa'	Andorra Juniper (hort. cultivar)	(L-M)
Juniperus•horizontalis•'Prince•of•Wales'	Prince of Wales Juniper (hort. cultivar)	(L-M)
Juniperus•horizontalis•'Wiltonii'	Wilton Carpet Juniper (hort. cultivar)	(L-M)
Juniperus•monosperma	Oneseed Juniper (Colo., Utah, Tex., Mex.)	(VL-L)
Juniperus•osteosperma	Utah Juniper (sw. USA)	(VL-L)
Juniperus•procumbens var. & cv.	Japgarden Juniper varieties and cultivars	(M-H)
Juniperus•sabina	Savin Juniper (w. Asia)	(L-M)
Juniperus•sabina•'Buffalo'	Buffalo Juniper (hort. cultivar)	(L-M)
Juniperus•sabina•'Skandia'	Skandia Juniper (hort. cultivar)	(L-M)
Juniperus•sabina•var.•tamariscifolia	Tam Juniper (hort. cultivar)	(L-M)
Juniperus•scopulorum	Rocky Mtn. Juniper (B.C. to s. Ariz., to Tex.)	(L)
Juniperus•squamata	----- (India, Tibet, Taiwan)	(M+/-)
Juniperus•squamata•'Meyeri'	----- (hort. cultivar)	(M+/-)
Juniperus•virginiana	Eastern Redcedar (e. N. Am.)	(M-H)
Microbiota•decussata *	Siberian Cypress (Siberia)	(M+/-)
Pinus•edulis	Piñon Pine (Wyo., Cal., Mex.)	(VL-M)
Pinus•mugo	Mugo Pine (c. Eur. Balk.)	(M-H)
Platycladus•orientalis *	Oriental Arborvitae (China, Korea)	(M+/-)
Taxus•baccata *	English Yew (Eur., n. Afr., w. Asia)	(H)

Taxus•brevifolia *	Anticancer Yew (pnw. USA)	(H)
Taxus•cuspidata *	Japanese Yew (Jap., Kor., Manchuria)	(H)
Taxus•x•media *	----- (hort. hybrid)	(H)
Thuja•occidentalis•var.	Western Arborvitae varieties (e. N. Am.)	(H)
Thuja•orientalis (now Platycladus•orientalis)		
Thuyopsis•dolabrata *	False Arborvitae (Japan)	(H)

7. EVERGREENS

(Non-coniferous)
[Revised April '03]

WATER NEEDS OF PLANTS

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HIGH WATER	MODERATE WATER	LOW WATER	VERY LOW WATER
Reference plant: Bluegrass turf (Always wet at surface)	Reference plant: Turf-type Tall Fescue (Half of Bluegrass turf)	Reference plant: Buffalograss turf (Like Denver without irrigation)	Reference plant: Too dry for any turf (drier than Denver)
18-20 gals./ S.F./season July: 5"-- 3 times per week	10 gals./S.F./ season .75" -- once per week	0-3 gals./S.F./season .5" per 2 weeks, optional	No irrigation No irrigation

Agave•parryi *	Parry's Agave (Cal., N.Mex., Mex.)	(VL-L)
Agave•utahensis *	Utah Agave (Cal., Nev. Utah, Ariz.)	(VL-L)
Allenrolfea•occidentalis *	Iodine Bush (sw. USA, deserts)	(L-VL)
Arctostaphylos•patula *	Greenleaf Manzanita (sw. USA)	(M+/-)
Artemisia•cana •(a.k.a. Seriphidium•canum)	Black Sage (w. USA)	(VL-M)
Artemisia•tridentata (a.k.a. S. tridentata)	Big Western Sage (intermtn. w. N. America)	(VL-M)
Aucuba•japonica *	Spotted Laurel (China, Taiwan, s. Japan)	(H)
Berberis•candidula *	Paleleaf Barberry (China)	(M+/-)
Berberis•julianae	Wintergreen Barberry (w. China)	(M+/-)
Berberis•triacanthophora *	= Berberis•X•wisleyensis	
Berberis•verruculosa *	Warty Barberry (w. China)	(M+/-)
Berberis•x•wisleyensis *	Threespike Barberry (hort. hybrid)	(M+/-)
Bruckenthalia•spiculifolia *	Spike Heath (se. Europe, Asia Minor)	(M+/-)
Buxus•microphylla•v.•koreana *	Korean Boxwood (Jap., Korea)	(M-H)
Buxus•sempervirens *	Common Boxwood (s. Eur., w. Asia , n. Afr.)	(M-H)
Ceanothus•fendleri	Fendler Ceanothus (Rocky Mtn. West)	(M+/-)
Ceanothus•integerrimus *	Deerbrush (sw. N. America)	(M+/-)
Ceanothus•sanguineus *	Oregon Tea (B.C. to Mont. to Calif.)	(M+/-)
Ceanothus•velutinus *	Snowbrush Ceanothus (Western Mtns., USA)	(M-H)
Cercocarpus•breviflorus	= Cercocarpus•ledifolius•v.•paucidentatus	
Cercocarpus•intricatus	= Cercocarpus•ledifolius•v.•intracatus	
Cercocarpus•ledifolius	Curlleaf Mtn. Mahogany (Intermtn. USA)	(VL-L)
Cercocarpus•ledifolius•v.•intracatus	Littleleaf Mtn. Mahogany (Intermtn. sw. USA)	(VL-L)
Cercocarpus•ledifolius•v.•paucidentatus	Hairy Mtn. Mahogany (Ariz., N. Mex., Mex.)	(VL-L)
Chamaebatiaria•millefolium	Fernbush (Ore., e. Cal., Wyo., Ariz.)	(VL-L)
Cistus•laurifolius *	Laurel Rock Rose (sw. Europe)	(M+/-)
Coronilla•emerus *	Scorpion senna (c. & s. Europe)	(L-M)
Cotoneaster•congestus *	Pyrenees Cotoneaster (Himilaya Mts.)	(M+/-)
Cotoneaster•conspicuus *	Wintergreen Cotoneaster (c. China, se. Tibet)	(M+/-)
Cotoneaster•dammeri *	Bearberry cotoneaster (c. China)	(M-/-)
Cotoneaster•glaucophyllus *	Brightbead Cotoneaster (w. China)	(L-M)
Cotoneaster•microphyllus *	Littleleaf Cotoneaster (mtns. Afghan. to China)	(L-M)
Cowania•mexicana (syn. Purshia•mexicana)	Cliff Rose (intermtn. sw. USA & Mex.)	(VL-L)
Cytisus•scoparius *	Scotch Broom (Europe)	(M+/-)

Cytisus•x•praecox *	Warminster Broom (hort. hybrid)	(M+/)
Daphne•cneorum	Daphne (mtns. c. & s. Europe)	(M+/-)
Daphne•retusa *	= Daphne•tangutica	
Daphne•tangutica *	----- (nw. & w. China)	(M+/-)
Daphne•x•burkwoodii	-----	(M+/-)
Daphne•x•burkwoodii•'Carol•Mackie'	Carol Mackie Daphne (hort. cultivar)	(M+/-)
Daphne•pontica *	----- (A. Minor, se. Eur., Cauc.)	(M+/-)
Elaeagnus•pungens *	----- (Jap., China)	(VL, M)
Ephedra•americana•v.•andina *+	----- (Andes, Ecuador. to Patagonia)	(VL-M)
Ephedra•equisetina +	----- (c. Asia, w. china)	(VL)
Ephedra•gerardiana *+	----- (China, Himalaya)	(VL-L)
Ephedra•glauca *	----- (c. Asia-Seravshan Mts.)	(VL-L)
Ephedra•minima *+	----- (China)	(VL-L)
Ephedra•minuta *	----- (c. Asia-Seravshan Mts.)	(VL-L)
Ephedra•nevadensis *+	Nevada Ephedra (Great Basin)	(VL-L)
Ephedra•regaliana *	----- (c. Asia-Pamir Mts.)	(VL-L)
Ephedra•torreyana +	Torrey Ephedra (intermtn. sw. USA)	(VL-L)
Ephedra•viridis +	Green Ephedra, Mormon Tea (Intermtn. sw. USA)	(VL-L)
Euonymus•fortunei•'Vegetus'	Euonymus (c. & w. China)	(M-H)
Euonymus•kiautschovicus•'Manhattan'	Manhattan Euonymus (hort. cultivar)	(M-H)
Fargesia•murielae, A. m., Sinarundinaria m. (see Thamnocalamus•spathaceus) *		
Fargesia•nitida., Arundinaria n., Sinarundinaria n., Thamnocalamus•nitida (see Sinarundinaria•nitida) *		
Fargesia•spathacea, Arundinaria s. (see Thamnocalamus•spathaceus) *		
Fuchsia•magellanica *	Fuchsia (Peru, Chile, Argentina)	(H)
Garrya•flavescens *	Yellow Silktassel (e. Cal., w. Az., s. Utah, s. Nev.)	(L)
Garrya•fremontii *	Fremont's Silktassel (w. Wa., Ore., Cal.)	(M+/-)
Garrya•wrightii *	Wright's Silktassel (sw. AZ., s. N. Mex., w. Tex.)	(L)
Gelsemium•sempervirens *	Carolina Yellow Jasmine (s. USA to c. Am.)	(H)
Hesperaloe•parviflora +	Hesperaloe (sw. Texas)	(VL-M)
Iberis•sempervirens	Evergreen Candytuft (Eurasia)	(M-H)
Ilex•aquifolium *	English Holly (Eur., n. Afr., w. Asia)	(H)
Ilex•cornuta *	Chinese Holly (China, Korea)	(H)
Ilex•crenata *	Japanese Holly (Sakhalin Is., Jap., Korea)	(H)
Ilex•opaca *	American Holly (e. USA)	(H)
Ilex•wilsonii *	Wilson's Holly (c., w., e. China, Taiwan)	(M-H)
Ilex•x•meserveae var.	Blue Prince & Blue Princess Hollies etc. (hort. hybrids)	(H)
Jasminum•fruticans *	----- (Medit. Asia Minor)	(L-M)
Kalmia•angustifolia *	Lambkill Kalmia (Hudson Bay to Georgia)	(H)
Kalmia•latifolia *	Mountain Laurel (e. N. Am.)	(H)
Lavandula•angustifolia var.	English Lavender varieties (Medit.)	(VL-M)
Lavandula•stoechas *	Spanish Lavender (c. Spain, ne. Portugal)	(VL-M)
Leucophyllum•minus *	Cenzia, Texas Ranger (Texas, New Mexico)	(L)
Lonicera•nitida *	Boxleaf Honeysuckle (China)	(H)
Lonicera•pileata *	Privet Honeysuckle (China)	(H)

Mahonia•aquifolium +	Oregon Hollygrape (Cascade mtns.)	(M-H)
Mahonia•fremontii +	Fremont Mahonia (sw. USA)	(VL-L)
Mahonia•haematocarpa +	Redberry Mahonia (sw. USA)	(VL-L)
Mahonia•repens +	Creeping Mahonia (Rocky Mtn. West)	(L-H)
Mahonia•trifoliata *+	Three-leaf Mahonia, Algerita (Ariz., N. Mex., Tex., Mex.)	(L)
x•Mahoberberis•miethkeana *	----- (Berberis•julianae•X•Mahonia•aquifolium)	(M+/-)
Nandina•domestica *	Heavenly Bamboo (India to e. China)	(M-H)
Nolina•microcarpa *	Bear Grass (sw. USA)	(L)
Opuntia•imbricata	Cholla (Colo., Kan., Tex., & Mex., to Ariz.)	(VL-L)
Opuntia•polycantha ,etc.	Prickly Pear Cactus species (w. USA, Can., Mex.)	(VL-L)
Osmanthus•americanus *	Devilwood (se. USA)	(H)
Osmanthus•decorus•'Baki•Kasapligil' *	----- (Caucasus)	(H)
Osmanthus•heterophyllus *	Holly Osmanthus (Japan, Taiwan)	(H)
Osmanthus•x•burkwoodii *	----- (garden origin)	(H)
Paxistima•canbyi	Eastern Mtn. Lover (e. N. America)	(M+/-)
Paxistima•myrsinites	= Paxistima•myrtifolia	
Paxistima•myrtifolia *	Western Mtn. Lover (B.C. Cal., Mont., Colo., N. Mex.)	(M-H)
Phillyrea•vilmoriniana *	= Osmanthus•decorus	
Photina•villosa *	Oriental Photina (Japan, Korea, China)	(H)
Photinia•serrulata *	Chinese Photinia (China)	(H)
Photinia•x•fraseri *	Photina (hort. hybrid)	(H)
Phyllostachys•aureosulcata *	Yellow-groove Bamboo (ne. China)	(H)
Phyllostachys•nigra *	Black Bamboo (e., c. China)	(H)
Phyllostachys•nuda *	Bamboo (China)	(H)
Pieris•japonica *	Japanese Pieris (Jap., Taiwan, e. China)	(H)
Prunus•laurocerasus•'Schipkaensis' *	Schipkanensis Cherry Laurel (Bulgaria)	(M-H)
Prunus•laurocerasus•'Zabeliana'*	Zabeliana Cherry Laurel (garden origin)	(M-H)
Purshia•mexicana	= Cowania•mexicana	
Purshia•tridentata	Antelope Bitterbrush (Rocky Mtn. West)	(L-M)
Pyracantha•coccinea	Pyracantha (Eurasia)	(M+/-)
Quercus•grisea *	Gray Oak (Tex., N. Mex., Mex., s. Colo.)	(M+/-)
Quercus•turbinella *	Turban Oak (Cal., & n. Baja. Ca.. to w. Tex. & se. Colo.)	(M+/-)
Quercus•vacciniifolia *	Huckleberry Oak (w. US)	(M+/-)
Quercus•virginiana•v.•fusiformis *	Texas Shrub Live Oak (Ok., Tex., Mex.)	(L-M)
Rosmarinus•officinalis•'Arp' *	Rosemary 'Arp' (a hardy cultivar from Arp, Texas)	(L-M)
Santolina•chamaecyparissus	Santolina (w. & c. Medit.)	(VL-M)
Santolina•rosmarinifolia	Green Santolina (Portugal to France)	(L-M)
Santolina•viridis	= Santolina•rosmarinifolia	
Sasa•kurilensis *	Kurile Islands Bamboo (Jap. Kor.)	(H)
Sasa•palmata *	Palmate Bamboo (n. Japan)	(H)
Shepherdia•rotundifolia *+	Roundleaf Buffaloberry (Az., Utah)	(L-M)
Sinarundinaria•nitida *	Fountain Bamboo (c. China)	(H)
Thamnocalamus•spathaceus *	Umbrella Bamboo (c. China)	(H)
Viburnum•davidii *	David's Viburnum (w. China)	(M-H)

Viburnum•farreri *	Fragrant Viburnum (China)	(M-H)
Viburnum•rhytidophyllum *	Leatherleaf Viburnum (c. & w. China)	(M-H)
Viburnum•x•burkwoodii	Burkwood Viburnum (hort. hybrid)	(M-H)
Viburnum•x•rhytidophylloides•'Mohican'	Mohican Lantanaphyllum Viburnum (garden origin)	(M-H)

Yucca•baccata +	Banana Yucca (Colo. Plateau)	(VL-L)
Yucca•elata +	Soaptree Yucca (Az., N. Mex., Mex.)	(VL-L)
Yucca•glauca +	Front Range Yucca (w. Great Plains)	(VL-L)
Yucca•harrimaniae +	Harriman Yucca (Colo. Plateau)	(VL-L)

SHRUBS

(Deciduous Rocky Mountain Natives)

[Revised April '03]

WATER NEEDS OF PLANTS

The following chart shows how to group plants based on their water needs.
Reference Location: Denver. Numbers illustrate typical conditions.

* = Plants with potential, but requiring caution due to limited history in Rocky Mountain landscaping.

HIGH WATER	MODERATE WATER	LOW WATER	VERY LOW WATER
Reference plant: Bluegrass turf (Always wet at surface)	Reference plant: Turf-type Tall Fescue (Half of Bluegrass turf)	Reference plant: Buffalograss turf (Like Denver without irrigation)	Reference plant: Too dry for any turf (drier than Denver)
18-20 gals./ S.F./season July: 5"-- 3 times per week	10 gals./S.F./ season .75" -- once per week	0-3 gals./S.F./season .5" per 2 weeks, optional	No irrigation No irrigation

Acer•glabrum	Rocky Mountain Maple	(M-H)
Acer•grandidentatum	Bigtooth Maple, Wasatch Maple	(M)
Alnus•tenuifolia	Rocky Mountain Alder	(H)
Amelanchier•alnifolia	Rocky Mtn. Serviceberry	(M+/-)
Amelanchier•utahensis *	Utah Serviceberry	(VL- M)
Amorpha•canescens	Lead Plant	(L- M)
Amorpha•fruticosa	False Indigo	(M +/-)
Amorpha•nana	Dwarf Lead Plant	(L- M)
Atriplex•canescens	Four-wing Saltbush	(VL-L)
Atriplex•confertifolia	Shadscale	(VL-L)
Betula•fontinalis	Rocky Mtn. River Birch	(H)
Betula•glandulosa	Bog Birch	(H)
Ceratoides•lanata *	Winterfat	(L)
Cercocarpus•montanus	Deciduous Mountain Mahogany	(L- M)
Chamaebatiaria•millefolium	Fernbush	(VL-L)
Chrysothamnus•spp.	Rabbitbrush species	(VL-L)
Cornus•sericea (now C. stolonifera)		
Cornus•stolonifera	Redtwig Dogwood	(H)
Corylus•cornuta	Beaked Hazelnut	(H- M)
Crataegus.•var.•occidentalis *	Native Hawthorn	(M+/-)
Crataegus•erythropoda *	(syn.? C. s. var. occidentalis)	(M+/-)
Crataegus•succulenta•var.•macrantha *	Native Hawthorn	(M+/-)
Fallugia•paradoxa	Apache Plume	(VL-L)
Fendlera•rupicola	Cliff Fendlerbush	(L- M)
Forestiera•neomexicana	New Mexico Privet	(M+/-)
Fraxinus•anomala	Singleleaf Ash	(L)
Holodiscus•dumosus	Rock Spray	(L- M)
Jamesia•americana	Jamesia	(M - H)
Lonicera•involucrata	Twinberry	(H)
Lycium•pallidum *	Pale Wolfberry	(L)
Ostrya•knowltonii *	Western Hop Hornbeam	(M+/-)

Parryella•filifolia *	Dunebloom	(M+/-)
Pentaphylloides•floribunda	= Potentilla•fruticosa	
Peraphyllum•ramosissimum *	Squaw Apple	(L- M)
Philadelphus•lewisii	Lewis's Mockorange	(M+/-)
Philadelphus•microphyllus	Littleleaf Mockorange	(M+/-)
Physocarpus•monogynus	Mountain Ninebark	(M+/-)
Poliomintha•incana *	Purple Sage	(VL-L)
Potentilla•fruticosa	Shrubby Potentilla	(M - H)
Prunus•americana	Wild Plum	(M+/-)
Prunus•besseyi	Sand Cherry	(L-M)
Prunus•pensylvanica *	Pin Cherry	(M+/-)
Prunus•pensylvanica•saximontana *	Dwarf Pin Cherry	(M+/-)
Prunus•virginiana	Chokecherry	(M - H)
Ptelea•trifoliata	Hoptree	(M+/-)
Purshia•tridentata	Bitterbrush	(L - H)
Quercus•gambelii	Gambel's Oak	(M+/-)
Quercus•turbinella *	Turbinella Oak	(L - M)
Quercus•undulata *	Wavyleaf Oak	(L - M)
Rhamnus•smithii *	-----	(M+/-)
Rhus•glabra	Smooth Sumac	(L- M)
Rhus•glabra•var.•cismontana	Rocky Mountain Smooth Sumac	(L-M)
Rhus•glabra•'Laciniata'	Cutleaf Smooth Sumac	(L-M)
Rhus•microphylla *	Littleleaf Sumac	(L-M)
Rhus•trilobata	Three-leaf Sumac	(L - M)
Ribes•aureum	Golden Currant	(M+/-)
Ribes•cereum *	Squaw Currant	(M+/-)
Ribes•inerme	Whitestem Gooseberry	(M+/-)
Rosa•woodsii	Wood's Rose	(M+/-)
Rubus•deliciosus	Boulder Raspberry	(M+/-)
Rubus•idaeus•var.•strigosus	Wild Raspberry	(M - H)
Rubus•parviflorus *	Thimbleberry	(M - H)
Salix•irrorata	Bluestem Willow	(H)
Sambucus•caerulea *	Blue Elderberry	(H)
Sambucus•melanocarpa *	Blackbead Elderberry	(H)
Sambucus•racemosa *	Red Elderberry	(H)
Sarcobatus•vermiculatus *	Greasewood	(VL-L)
Shepherdia•argentea	Silver Buffaloberry	(M+/-)
Shepherdia•canadensis *	Buffaloberry	(M+/-)
Sorbus•scopulina *	Rocky Mtn. Mountain Ash	(M - H)
Symphoricarpos•albus	Snowberry	(M+/-)
Symphoricarpos•orbiculatus *	Coralberry	(M+/-)
Tetradymia•canescens *	Gray Horsebrush	(L)

SHRUBS

(Deciduous, Introduced)

[Revised April '03]

WATER NEEDS OF PLANTS

The following chart shows how to group plants based their water needs.
Reference Location: Denver. Numbers illustrate typical conditions.

* = Plants with potential, but requiring caution due to limited history in Rocky Mountain landscaping.

HIGH WATER	MODERATE WATER	LOW WATER	VERY LOW WATER
Reference plant: Bluegrass turf (Always wet at surface)	Reference plant: Turf-type Tall Fescue (Half of Bluegrass turf)	Reference plant: Buffalograss turf (Like Denver without irrigation)	Reference plant: Too dry for any turf (drier than Denver)
18-20 gals./ S.F./season July: 5"-- 3 times per week	10 gals./S.F./ season .75" -- once per week	0-3 gals./S.F./season .5" per 2 weeks, optional	No irrigation No irrigation

Abelia•chinensis *	Chinese Abelia (China)	(M-H)
Abelia•x•grandiflora *	Abelia (origin unknown)	(M-H)
Abeliophyllum•distichum *	----- (Korea)	(M+/-)
Acanthopanax•senticosus *	Syn. Elentherococcus s.	
Acanthopanax•sieboldianus *	= Elentherococcus•sieboldianus	
Acer•azimovii * (= A.•ovczimmikovii?)	Azimov Maple	(M+/-)
Acer•campestre *	Hedge Maple (e. Europe & w. Asia)	(M-H)
Acer•ginnala	= Acer•tataricum•ssp.•ginnala	
Acer•maximowiczianum *	----- (China-Mongolia-Korea)	(M-H)
Acer•semenovii *	= Acer•tataricum•ssp.•semenovii	
Acer•tataricum	Tatarian Maple (A. Minor, se. Asia)	(L-M)
Acer•tataricum•ssp.•ginnala	Ginnala Maple (c. Asia)	(L-M)
Acer•tataricum•ssp.•semenovii *	Turkestan Maple (c. Asia)	(L-M)
Aesculus•parviflora *	Bottlebrush Buckeye (Ga., Ala.)	(H)
Aesculus•sylvatica *	----- (se. USA)	(H)
Alnus•cordata *	Italian Alder (Corsica, s. Italy)	(H)
Alnus•glutinosa *	European Alder (Eur., n. Africa, Turkey)	(H)
Alnus•rubra (was A.•oregona) *	Oregon Alder (w. N. Am.)	(H)
Amelanchier•stolonifera *	Running Serviceberry (ne. N. Am.)	(H)
Aralia•elata *	Angelica Tree (Jap., Kor., Manch.)	(M-H)
Aralia•spinosa *	Devil's Walkingstick (e. USA)	(M-H)
Aronia•melanocarpa	Chokeberry (e. N. America)	(M+/-)
Artemisia•abrotanum	Southernwood (s. Europe)	(M+/-)
Atraphaxis•caucasica *	----- (Transcaucasica)	(M+/-)
Atraphaxis•pyrifolia *	----- (c. Asia)	(L)
Berberis•koreana *	Korean Barberry (Korea)	(M+/-)
Berberis•oblonga *	----- (Turkestan)	(M-L)
Berberis•thunbergii	Japanese Barberry (Jap.)	(M-H)
Buddleja•alternifolia *	Butterflybush (nw. China)	(M+/-)
Buddleja•davidii	Butterflybush (China)	(M+/-)
Buddleja•globosa *	----- (Chile, Argentina, Peru)	(M+/-)
Buddleja•x•'Lochinch' *	----- (hort. hybrid)	(M+/-)
Callicarpa•bodinieri *	Beauty Berry (c. & w. China)	(M+/-)
Callicarpa•dichotoma *	Korean Beautyberry (e. USA)	(H)
Calycanthus•occidentalis *	California Allspice (sw. USA)	(H)

Calycanthus•chinensis *	----- (e. China)	(H)
Calycanthus•floridus *	Carolina Allspice (se. USA)	(H)
Caragana•arborescens	Siberian Peashrub (c. Asia - Mongolia)	(L-M)
Caragana•aurantiaca *	Dwarf Peashrub (Sib., Afghan., Turkestan)	(L-M)
Caragana•frutex *	Russian Peashrub (c. Asia, Siberia)	(L-M)
Caragana•maximowicziana *	----- (Tibet, n. China)	(L-M)
Caragana•microphylla	----- (nw. China, Sib.)	(L-M)
Caragana•pygmaea *	----- (nw. China)	(L-M)
Caragana•sinica *	Chinese Peashrub (n. China)	(L-M)
Caryopteris•incana *	----- (China, Jap.)	(L-M)
Caryopteris•mongolica *	----- (n. China, Mong.)	(L-M)
Caryotperis•x•clandonensis	Bluemist Spirea (hort. hybrid)	(L-M)
Ceanothus•sanguineus *	Oregon Tea (Cal. to BC)	(H)
Cerasus•verrucosa *	----- (Tajikistan)	(L-M)
Cercis•griffithii *	Griffith's Redbud (c. Asia)	(L-M)
Chaenomeles•japonica *	Dwarf Quince (Japan)	(M+/-)
Chaenomeles•lagenaria	= C. speciosa	
Chaenomeles•speciosa *	Flowering Quince (China, Japan)	(M+/-)
Chamaecytisus•hirsutus *	----- (Sib.-n. China)	(M+/-)
Chilopsis•linearis*	Desert Willow (desert southwest)	(L-M)
Chimonanthus•praecox *	Fragrant Wintersweet (China)	(H)
Chionanthus•retusus	Chinese Fringe Tree (China, Kor. Taiwan)	(H)
Chionanthus•virginicus	Fringe Tree (e. N. America))	(M-H)
Clematis•heracleifolia•var.•davidiana *	----- (e. China)	(M-H)
Clerodendrum•trichotomum *	Glory Bower (Japan)	(H)
Clethra•alnifolia *	Summer-sweet (e. N. America)	(H)
Clethra•delavayi *	Summer-sweet (w. China)	(M+/-)
Cornus•alba•'Elegantissima'	Variegated R'twig Dog'd (Sib., n. Chi., Kor.)	(H)
Cornus•alternifolia	Pagoda Dogwood (e. N. America)	(H)
Cornus•amomum *	Silky Dogwood (e. N. America)	(M-H)
Cornus•controversa *	Giant Dogwood (Japan, China, Him.)	(H)
Cornus•kousa *	----- (Japan, Korea, China)	(M-H)
Cornus•kousa•var.•chinensis *	----- (China)	(H)
Cornus•mas *	Cornelian Cherry (c. Europe-w. Asia)	(M-H)
Cornus•racemosa *	Gray Dogwood (ne. N Am)	(M-H)
Cornus•sericea (now C.•stolonifera)	(See: Native Rocky Mtn. deciduous shrubs)	
Cornus•stolonifera•'Flaviramea'	Yellowtwig Dogwood (N. Am.)	(H)
Coronilla•emerus *	Scorpion Senna (s. Norway, Spain, Greece)	(M-H)
Corylopsis•pauciflora *	Winter Hazel (Japan, Taiwan)	(H)
Corylopsis•sinensis *	Chinese Winter Hazel (c. China)	(M+/-)
Corylopsis•spicata *	Japanese Winter Hazel (Japan)	(H)
Corylus•avellana *	European Hazel (Europe)	(M-H)
Corylus•chinensis *	Chinese Hazel (sw. China)	(H)
Corylus•maxima *	Filbert (se. Eur., A. Minor)	(H)
Cotinus•coggygria	Smoke Tree (s. Europe-Asia)	(M+/-)
Cotinus•obovatus *	American Smoketree (s. USA)	(M-H)
Cotoneaster•actuifolius	Peking Cotoneaster (n. China)	(M+/-)
Cotoneaster•apiculatus	Cranberry Cotoneaster (China)	(M+/-)
Cotoneaster•bullatus *	----- (w. China)	(M+/-)
Cotoneaster•divaricatus	Spreading Cotoneaster (China)	(M+/-)
Cotoneaster•franchetii *	----- (sw. China, Tibet)	(M-H)
Cotoneaster•horizontalis	Rock Cotoneaster (w. China)	(M+/-)
Cotoneaster•ignavus*	----- (e. Turkestan)	(M+/-)
Cotoneaster•multiflorus•	Many-flowered Cotoneaster (nw. China)	(M+/-)
Cotoneaster•racemiflorus•songaricus *	----- (c. Asia)	(M+/-)
Cotoneaster•simonsii *	----- (Himal., Sikkim, Nepal)	(M-H)
Crataegus•x•mordanensis•'Toba'	Toba Hawthorn (hort. hybrid)	(M+/-)
Cudrania•tricuspidata *	Chinese Silkworm Thorn (China)	(H)
Cydonia•oblonga *	Quince (n. Persia)	(M+/-)
Cydonia•sinensis *	= Pseudocydonia•sinensis	
Cyrilla•racemiflora *	Leatherwood (e. N. America)	(H)
Cytisus•albus *	= Cytisus•multiflorus	

Cytisus•decumbens *	Prostrate Broom (s. Europe)	(L-M)
Cytisus•hirsutus	= Chamaecytisus•hirsutus	
Cytisus•multiflorus *	Portuguese Broom (se. Europe)	(L-M)
Cytisus•purgans *	----- (s. Eur. - n. Afr.)	(L-M)
Cytisus•scoparius *	Scotch Broom (c. & s. Europe)	(L-M)
Cytisus•x•praecox *	Warminster Broom (hort. hybrid)	(L-M)
Dalea•formosa *	Feather Plume (w. Tex., Okl., Colo.)	(L
Dalea•frutescens *	Black Dalea (w. Tex., Okla.)	(L)
Dalea•scoparia *	Broom Dalea (w. Tex., N. Mex., Az.)	(L)
Daphne•caucasica *	Caucasian Daphne (Caucusus)	(M+/-)
Daphne•genkwa *	----- (China)	(M+/-)
Daphne•giraldii *	Daphne (nw. China)	(M+/-)
Daphne•mezereum *	February Daphne (Europe, w. Asia)	(M+/-)
Decaisnea•fargesii *	----- Bluebean Shrub (w. China)	(M-H)
Deutzia•gracilis *	Slender Deutzia (Japan)	(M-H)
Deutzia•scabra *	Fuzzy Deutzia	(M-H)
Deutzia•x•lemoinei *	Lemoine Deutzia (Hort. hybrid)	(M-H)
Diervilla•lonicera *	----- (e. N. America)	(H)
Diervilla•sessilifolia *	Southern Bush-honeysuckle (se. USA)	(H)
Dipelta•floribunda *	----- (c. & w. China)	(M+/-)
Dipteronia•sinensis *	----- (China)	(M+/-)
Disanthus•cercidifolius *	----- (China, Jap.)	(H)
Elaeagnus•multiflora *	Cherry Elaeagnus (Jap., China)	(M-H)
Elentherococcus•sieboldianus *	----- (Jap., China)	(M+/-)
Eleutherococcus•senticosus *	Siberian Ginseng (ne. Asia)	(M-H)
Elsholtzia•stauntonii *	Mint Shrub (n. China)	(M+/-)
Euonymus•atropurpureus *	Wahoo (NY to Fla, Minn. to Tex.)	(M-H)
Euonymus•alatus	Burning Bush Euonymus (China, Jap., Kor.)	(M+/-)
Euonymus•bungeanus *	Winterberry (China, Korea, Manch., Jap.)	(M+/-)
Euonymus•europaeus *	Spindletree (Europe)	(M-H)
Euonymus•nanus•v.•turkestanicus *	Turkestan Euonymus (Caucasus - w. China)	(M+/-)
Euonymus•phellomanus *	----- (n. & w. China)	(M+/-)
Euonymus•sachalinensis *	Sakhalin Euonymus (ne. Asia)	(M+/-)
Exochorda•albertii (now E. korolkowii)		
Exochorda•giraldii *	Pearlbush (c. China)	(M+/-)
Exochorda•korolkowii *	Pearlbush (Uzbekistan, Tajikistan)	(M+/-)
Exochorda•racemosa *	Common Pearlbush (n. China)	(M-H)
Exochorda•serratifolia *	Pearlbush (Korea, Manchuria)	(M+/-)
Exochorda•x•macrantha *	Pearlbush (hort. hybrid)	(M+/-)
Fontanesia•phillyreoides•ssp.•fortunei *	----- (China)	(M+/-)
Forsythia•mandschurica *	Manchurian Forsythia (Manch.)	(M+/-)
Forsythia•ovata *	Early Forsythia (Korea)	(M+/-)
Forsythia•suspensa *	Forsythia (China)	(M+/-)
Forsythia•x•intermedia	Forsythia (hort. hybrid)	(M+/-)
Fothergilla•gardenii *	Fothergilla (Va. - Ga.)	(H)
Fothergilla•major *	----- (Allegheny Mts.)	(H)
Genista•tinctoria *	----- (Europe, w. Asia)	(L-M)
Halimodendron•halodendron *	Salt Tree (se. Russia-c. & w. Asia)	(VL-L)
Hamamelis•japonica *	Japanese Witch Hazel (Japan)	(H)
Hamamelis•mollis *	Chinese Witch Hazel (w. China)	(H)
Hamamelis•vernalis *	Witch Hazel (s.e. N. America)	(H)
Hamamelis•virginiana *	Common Witch Hazel (Canada to Georgia)	(H)

Heptacodium•miconioides *	----- (China)	(M+/-)
Hibiscus•syriacus	Rose-of-Sharon Hibiscus (China, India)	(M+/-)
Hippophaë•rhamnoides	Sea Buckthorn (Eurasia)	(M-H)
Holodiscus•discolor *	Rock Spirea (s. Ore.-s. Calif.)	(M+/-)
Hydrangea•arborescens	Hills-of-snow Hydrangea (e. USA)	(H)
Hydrangea•involucrata *	----- (Japan)	(H)
Hydrangea•paniculata	Peegee Hydrangea (China, Japan)	(H)
Hydrangea•quercifolia *	Oakleaf Hydrangea (se. USA)	(H)
Hydrangea•serrata *	----- (Jap., Korea)	(M-H)
Indigofera•amblyantha *	Pink Indigo (China)	(M+/-)
Indigofera•decora *	White Chinese Indigo (China)	(M+/-)
Indigofera•gerardiana *	= Indigofera•heterantha	
Indigofera•heterantha *	----- (Afghan.-w. China)	(M+/-)
Indigofera•incarnata *	= Indigofera•decora	
Indigofera•kirilowii *	----- (n. China, Korea)	(M+/-)
Indigofera•potaninii *	Potanin Indigo (nw. China)	(M+/-)
Itea•virginica *	Sweetspire (e. USA)	(H)
Jasminum•nudiflorum *	Winter Jasmine (China)	(M+/-)
Kerria•japonica	Kerria (Japan)	(M-H)
Kolkwitzia•amabilis	Beautybush (China)	(M+/-)
Leptodermis•oblonga *	----- (n. China)	(M+/-)
Lespedeza•bicolor *	----- (Japan)	(M+/-)
Lespedeza•thunbergii *	----- (Japan, China)	(M+/-)
Ligustrum•vulgare	Common Privet (Medit. region)	(M+/-)
Lindera•benzoin *	Spicebush (e. USA)	(M)
Lindera•obtusiloba*	----- (KOr., Jap., China)	(M-H)
Lonicera.•spinosa *	----- (nw Him., Tibet, e. Turkestan)	(M+/-)
Lonicera•alberti *	----- (Turkestan, Tibet)	(M+/-)
Lonicera•caerulea *	----- (Tibet, e. Siberia)	(M+/-)
Lonicera•chrysantha *	----- (ne. Asia, c. Japan)	(M-H)
Lonicera•etrusca *	----- (Medit. to s. Switzerland)	(M+/-)
Lonicera•fragrantissima *	Winter Honeysuckle (China)	(M-H)
Lonicera•hispida *	----- (Turkestan)	(M+/-)
Lonicera•korolkowii	----- (Mts. c. Asia, Afghan. Pak.)	(M+/-)
Lonicera•maackia*	Amur Honeysuckle (e. Asia)	(M-H)
Lonicera•maximowiczii•v.•sachalinensis *	Sakhalin Honeysuckle (Manch, China, Kor.)	(M-H)
Lonicera•microphylla *	----- (nw. Him., Tibet, Sib.)	(M+/)
Lonicera•morrowii *	Morrow Honeysuckle (Jap.)	(M-H)
Lonicera•pileata *	----- (China)	(M+/-)
Lonicera•quinquelocularis *	----- (Afghan. to Yunnan)	(M+/-)
Lonicera•spinosa•var.•alberti *	Fragrant Turkestan Honeysuckle (c. Asia)	(M+/-)
Lonicera•standishii *	Fragrant Winter Honeysuckle (China)	(M+/-)
Lonicera•syringantha	Lilac-scented Honeysuckle (China, Tibet)	(M-H)
Lonicera•tatarica•'Zabelii'	Zabel's Honeysuckle (c. Asia, Afghan.)	(M+/-)
Lonicera•thibetica *	Tibetan Honeysuckle (Tibet., w. China)	(M+/-)
Lonicera•xylosteum *	European Fly Honeysuckle (Eurasia)	(M+/-)
Lonicera•x•Xylosteoides *	----- (garden orgin)	(M+/-)
Lycium•chinense *	Chinese Wolfberry (e. Asia)	(M-H)
Magnolia•sieboldii *	Oyama Magnolia (Jap., Korea, w. China)	(H)
Magnolia•stellata	Star Magnolia (c. Japan)	(H)
Myrica•pensylvanica *	Bayberry (e. N. America)	(H)

Neillia•thibetica *	----- (Himalaya Mts.)	(M+/-)
Nevieusii•alambamensis *	----- (se. USA)	(H)
Orixa•japonica *	----- (Japan, China, Korea)	(M+/-)
Paeonia•lutea *	Tree Peony (China, Tibet)	(M+/-)
Paeonia•suffruticosa *	Tree Peony (China, Tibet)	(M+/-)
Parrotia•persica *	----- (Persia)	(M+/-)
Parrotiopsis•jacquemontiana *	----- (Himalaya)	(M-H)
Philadelphus•coronarius +	Sweet Mockorange (Europe, sw. Asia)	(M+/-)
Philadelphus•x•virginalis +	----- (Hort. Hybrid)	(M+/-)
Photinia•villosa *	Oriental Photinia (China, Korea, Jap.)	(M-H)
Physocarpus•opulifolius	Dwarf Ninebark (e. N. America)	(M+/-)
Poncirus•trifoliata *	Trifoliate Orange (c. & n. China)	(M-H)
Prinsepia•sinensis *	----- (Manchuria)	(M+/-)
Prinsepia•uniflora *	----- (nw. China)	(M+/-)
Prunus•andersonii *	Desert Peach (sw. U.S.A.)	(L-M)
Prunus•cerasifera	Cherry Plum (A. Minor, Cauc.)	(M+/-)
Prunus•cerasifera•'Newport'	Newport Plum (garden origin)	(M+/-)
Prunus•fruticosa *	European Dwarf Cherry (Eur.., Siberia)	(M+/-)
Prunus•nigra *	Canada Plum (ne. N. Am.)	(M-H)
Prunus•padus *	Bird Cherry (Eurasia)	(M+/-)
Prunus•tomentosa	Nanking Cherry (n. w. China, Tib. Kashmir)	(M-H)
Prunus•x•cistena	Cistena Plum (hort. hybrid)	(M+/-)
Pseudocydonia•sinensis *	Quince (China)	(M+/-)
Purnus•fasciculata *	Desert Almond (sw. USA)	(VL-L)
x•Pyracomeles•vilmorinii *	(Pyracanthus•crenatoserrataXOsteomeles•subrotunda)	(M+/-)
Rhamnus•dahuricus *	Common Buckthorn (e. Russia to Japan)	(M+/-)
Rhamnus•frangula	Glossy Buckthorn (Eur., Turk., n. Afr.)	(M+/-)
Rhamnus•frangula•'Asplenifolia' *	----- (Hort. Cultivar)	(M+/-)
Rhodotypos•scandens *	Jetbead (Japan, China)	(H)
Rhus•punjabensis *	----- (c., w. China)	(M+/-)
Rhus•typhina	Staghorn Sumac (e. N. America)	(M+/-)
Rhus•typhina•'Laciniata'	Cutleaf Staghorn Sumac (?)	(M+/-)
Ribes•alpinum	Alpine Currant (w. Europe)	(M-H)
Ribes•nevadense *	Sierra Currant (Ore., Cal., Nev.)	(M+/-)
Rosa•banksiae *	Banksia Rose (w. & c. China)	(M+/-)
Rosa•davidii *	David's Rose (w. & c. China)	(M+/-)
Rosa•ecae *	----- (c. Asia)	(M+/-)
Rosa•filipes *	----- (w. China)	(M+/-)
Rosa•foetida•'Bicolor'	Austrian Copper Rose (c. Asia)	(M-L)
Rosa•foetida•'Persiana'	Persian Yellow Rose (s.w. Asia)	(M-L)
Rosa•glauca	Redleaf Rose (c. & s. Europe)	(M+/-)
Rosa•helenae *	Helen Wilson's Rose (c. China)	(M+/-)
Rosa•hugonis	= R.•xanthira•f.•hugonis	
Rosa•kokanica *	----- (c. Asia, China)	(M+/-)
Rosa•laxa *	----- (c. Asia, nw. China)	(M+/-)
Rosa•moyesii *	Moyes Rose (w. China)	(M+/-)
Rosa•moyesii *	Moyes Rose (w. China)	(M+/-)
Rosa•persica *	Persian Rose (Persia, Afghan., c. Asia)	(M+/-)
Rosa•pulverulenta *	----- (s. Eur. to Afghanistan)	(M+/-)
Rosa•rubrifolia (now R.•glauca)		
Rosa•rugosa	Rugosa Rose (e. Russia)	(M+/-)
Rosa•sericea *	----- (c. Asia, w. China)	(M+/-)
Rosa•setigera *	Prairie Rose (e. & c. USA)	(M+/-)
Rosa•webbiana	----- (c. Asia, Afghan, Kashmir.)	(M+/-)
Rosa•wichuriana *	----- (e. Asia)	(M+/-)

Rosa•xanthina•f.•hugonis	Father's Rose (c. China)	(M+/-)
Rosa•x•harisonii *	Harison's Yellow Rose (Hort. hybrid)	(M+/-)
Salix•discolor	Pussy Willow (e. N. America)	(H)
Salix•matsudana•'Tortuosa'	Corkscrew Willow (China, Japan)	(H)
Sambucus•canadensis	Elderberry (e. N. America)	(H)
Sibiraea•altaiensis *	----- (w. China to Balkans)	(L-M)
Sibireae•laevigata	= Siberaea•altaiensis	
Sophora•davidii *	Father David's Sophora (China)	(L-M)
Sorbaria•sorbifolia	Ural False Spirea (Sib., Manch., Korea, Jap.)	(M+/-)
Sorbaria•tomentosa•v.•angustifolia *	----- (Afghan., Pak., Kashmir)	(L-M)
Spiraea•betulifolia•var.•lucida *	----- (B.C., Ore., Wyo., Mon.)	(M+/-)
Spiraea•cantoniensis *	----- (China)	(M+/-)
Spiraea•douglasii *	----- (B.C. to n. Cal.)	(M+/-)
Spiraea•japonica *	----- (Japan, China)	(M+/-)
Spiraea•japonica•'Albiflora' *	----- (Japan)	(M+/-)
Spiraea•japonica•'Anthony•Waterer'	Anthony Waterer Spirea (garden origin)	(M+/-)
Spiraea•japonica•'Bumalda'	----- (Hort. cultivar)	(M+/-)
Spiraea•japonica•'Froebelii'	Froebel's Spirea (garden origin)	(M+/-)
Spiraea•nipponica *	----- (Japan)	(M+/-)
Spiraea•trilobata	----- (n. Sib., Turkestan, n. China)	(L-M)
Spiraea•wilsonii *	----- (c. & w. China)	(M+/-)
Spiraea•x•vanhouttei	Vanhoutte Spirea (hort. hybrid)	(M+/-)
Spirea•x•arguta*	Garland Spirea (garden origin)	(M+/-)
Staphleya•trifolia*	Bladdernut (e. USA)	(M-H)
Staphylea•holocarpa *	Oriental Bladdernut (China)	(H)
Staphylea•pinnata *	European Bladdernut (c., se. Eur. A. Minor)	(H)
Stephanandra•incisa *	Lace Shrub (Jap., Korea, Taiwan)	(H)
Stephanandra•tanakae *	Lace Shrub (Japan)	(M-H)
Stephylea•bumalda *	Japanese Bladdernut (Japan)	(M-H)
Symphoricarpos•x•chenaultii•'Hancock' +	Hancock Coralberry (garden origin)	(M+/-)
Symplocos•paniculata *	Sapphireberry (Pakistan to Korea)	(M +/-)
Syringa•amurensis *	= Syringa•reticulata•v.•mandschurica	
Syringa•joskiaea *	Hungarian Lilac (Hungary)	(M+/-)
Syringa•meyeri *	----- (n. China)	(M+/-)
Syringa•microphylla *	Littleleaf Lilac (n. China)	(M+/-)
Syringa•oblata *	Early Lilac (n. China)	(M+/-)
Syringa•patula *	----- (Korea, China)	(M+/-)
Syringa•persica	Persian Lilac (Persia)	(M+/-)
Syringa•persica•'Laciniata' *	Cutleaf Persian Lilac (Persia ?)	(M+/-)
Syringa•reflexa *	Nodding Lilac (c. China)	(M+/-)
Syringa•reticulata•'Miss•Kim'	Miss Kim Lilac (hort. hybrid)	(M+/-)
Syringa•sweginzowii *	Chengtu Lilac (nw. China)	(M+/-)
Syringa•velutina *	Korean Lilac (Korea)	(M+/-)
Syringa•villosa	----- (China)	(M+/-)
Syringa•vulgaris	Common Lilac (s.e. Europe)	(M+/-)
Syringa•wolfii *	Wolf's Lilac (Korea, Manchuria)	(M+/-)
Syringa•x•chinensis	----- (hort. hybrid)	(M+/-)
Syringa•x•laciniata	Cutleaf Lilac (sw. Asia)	(M+/-)
Syringa•x•prestoniae *	----- (Canadian hort. origin)	(M+/-)
Viburnum•burejaeticum *	----- (n. China, Korea, Russia)	(M-H)
Viburnum•carlesii	Korean Spice Viburnum (Korea, Jap.)	(M-H)
Viburnum•cassinoides *	Witherod Viburnum (e. N. Am.)	(H)
Viburnum•dentatum	Arrowwood Viburnum (e. N. America)	(H-M)
Viburnum•dilatatum *	Linden Viburnum (China, Jap.)	(H)
Viburnum•farreri *	Fragrant Viburnum (n. China)	(H)
Viburnum•lantana	Wayfaring Vib. (Eur., n. Afr., Cauc. A. Minor)	(M+/-)
Viburnum•lentago	Nannyberry (e. N. America)	(M-H)
Viburnum•opulus	European Highbush Cranberry (Eurasia)	(H)

Viburnum•opulus•'Compactum'	----- (cultivar)	(H)
Viburnum•opulus•'Roseum'	European Snowball Viburnum	(H)
Viburnum•plicatum *	----- (Jap., China)	(H-M)
Viburnum•plicatum•'Sterile' *	Japanese Snowball Viburnum (Jap. China)	(H)
Viburnum•plicatum•form•'tomentosum' *	Doublefile Viburnum (Jap., China)	(H)
Viburnum•prunifolium	Black Haw (e. N. Am.)	(M-H)
Viburnum•sargentii *	Sargent's Vib. (e. Sib., n. & w. China, Jap.)	(M-H)
Viburnum•setigerum *	Tea Viburnum (c. & w. China)	(M+/-)
Viburnum•sieboldii *	----- (Japan)	(H)
Viburnum•trilobum	American Highbush Cranberry (N. America)	(H)
Viburnum•trilobum•'Compactum'	----- (cultivar)	(H)
Viburnum•x•bodnantense•'Pink•Dawn' *	----- (hort. hybrid)	(M-H)
Viburnum•x•carlcephalum	----- (hort. hybrid)	(M-H)
Vitex•agnus-castus•f.•latifolia *	Hardy Chaste Tree (s. Europe to c. Asia)	(L-M)
Vitex•negundo•var.•heterophylla *	Cutleaf Chaste Tree(n. China, Mongolia)	(M+/-)
Vitex•rotundifolia *	----- (Asia to Australia)	(M+/-)
Weigela•florida	Weigela (n. China, Korea, Jap.)	(H)
Weigela•middendorffiana *	Middendorff Weigela (n. China, Jap.)	(H)
Xanthocerus•sorbifolium	Yellowhorn (n. China)	(M+/-)
Zanthoxylum•piperitum *	Pepper Tree (China, Korea, Jap.)	(M+/-)
Zanthoxylum•schinifolium *	Pepper Tree (China, Korea, Jap.)	(M+/-)
Zanthoxylum•simulan *	----- (China, Taiwan)	(M-H)
Zenobia•pulverulenta *	Dusty Zenobia (N. Carolina-Florida	

VINES

[Revised April '03]

WATER NEEDS OF PLANTS

The following chart shows how to group plants based on their water needs.
Reference Location: Denver. Numbers illustrate typical conditions.

* = Plants with potential, but requiring caution due to limited history in Rocky Mountain landscaping.

HIGH WATER	MODERATE WATER	LOW WATER	VERY LOW WATER
Reference plant: Bluegrass turf (Always wet at surface)	Reference plant: Turf-type Tall Fescue (Half of Bluegrass turf)	Reference plant: Buffalograss turf (Like Denver without irrigation)	Reference plant: Too dry for any turf (drier than Denver)
18-20 gals./ S.F./season July: 5"-- 3 times per week	10 gals./S.F./ season .75" -- once per week	0-3 gals./S.F./season .5" per 2 weeks, optional	No irrigation No irrigation

Akebia•quinata *	Five-leaf Akebia (Japan, Korea, China)	(M-H)
Akebia•trifoliata *	Three-leaf Akebia (c. China, Jap.)	(M-H)
Akebia•x•pentaphylla *	(A. quinata x A. trifoliata) (Japan)	(M-H)
Ampelopsis•aconitifolia *	Monkshood Vine (n. China, Mong.)	(M+/-)
Ampelopsis•brevipedunculata *	Porcelain Vine (China, Jap., Korea)	(M+/-)
Ampelopsis•delavayana *	----- (w. China)	(M+/-)
Ampelopsis•humulifolia *	----- (n.China)	(M+/-)
Ampelopsis•megalophylla *	----- (w. China)	(M+/-)
Aristolochia•durior *	= Aristolochia•macrophylla	
Aristolochia•macrophylla *	Dutchman's Pipe (Appalachian Mts.)	(M-H)
Campsis•grandiflora *	Chinese Trumpet Creeper (Jap., China)	(M-H)
Campsis•radicans +	Trumpet Creeper (e. USA)	(M-H)
Celastrus•loeseneri *	Loeserner Bittersweet (c. China)	(M-H)
Celastrus•orbiculatus *	Oriental Bittersweet (ne. Asia)	(M-H)
Celastrus•scandens	Bittersweet (e. N. America)	(M-H)
Clematis (hort. varieties & hybrids)	----- (hort. hybrids & varieties)	(M-H)
Clematis•alpina *	----- (Eurasia)	(M-H)
Clematis•brevicaudata *	----- (Jap., China., w. Mong.)	(M+/-)
Clematis•chrysocoma *	----- (sw. China)	(M+/-)
Clematis•crispa *	Curly Clematis (se. USA)	(H)
Clematis•fargesii *	----- (China)	(M+/-)
Clematis•flammula	----- (s. Eur., to Turkestan)	(M+/-)
Clematis•grata *	----- (China, Himalaya)	(M+/-)
Clematis•ligusticifolia	Western Virgin's Bower (Man. to B.C., Mo., to Calif.)	(M+/-)
Clematis•macropetala *	----- (Siberia, n. China, Mongolia)	(M+/-)
Clematis•maximowicziana	= Clematis•terniflora	
Clematis•montana var. *	----- (Afghanistan. to sw. & c. China, Himalaya)	(M+/-)
Clematis•paniculata *	New Zealand Clematis (New Zealand)	(H)
Clematis•paniculata	= Clematis•terniflora	
Clematis•rehderiana *	Rehder's Clematis (w. China)	(M+/-)
Clematis•tangutica	Golden Lantern Clematis (Mongolia, nw. China)	(M+/-)
Clematis•terniflora	Sweet Autumn Clematis (Korea, China, Japan)	(M+/-)
Clematis•texensis *	Texas Clematis (sw. USA)	(M+/-)
Clematis•tibetana *	----- (Tibet, China, n. India)	(M+/-)
Clematis•vernayi (now C. tibetiana)		
Clematis•viorna *	Leather Flower (s. N. Am.)	(M-H)
Clematis•vitalba *	Traveller's Joy (Eur., Cauc., c. Asia, n. Afr.)	(M+/-)

Clematis•viticella *	----- (s. Europe, w. Asia)	(M+/-)
Dicentra•scandens *	----- (Nepal, to se. China)	(M+/-)
Euonymus•fortunei var.	Wintercreeper varieties (China)	(M-H)
Hedera•colchica *	Persian Ivy (Cauc., Turkey)	(M+/-)
Humulus•americanus	= Humulus•lupulus	
Humulus•lupulus	Hop Vine (n. Temperate regions worldwide)	(M+/-)
Hydrangea•anomala *	Climbing Hydrangea (Himalaya, China)	(H)
Hydrangea•anomala•ssp.•petiolaris*	= Hydrangea•petiolaris	
Hydrangea•petiolaris *	Climbing Hydrangea (Japan, China, Korea, Taiwan)	(H)
Jasminum•beesianum *	----- (China)	(M+/-)
Lathyrus•latifolius	Perennial Sweetpea (c. & e. Europe)	(M+/-)
Lonicera•alesuosmoides *	Evergreen Honeysuckle (w. China)	(M+/-)
Lonicera•caprifolium *	Italian Honeysuckle (Eur., s. Asia)	(M+/-)
Lonicera•flava *	Yellow Honeysuckle (se. USA)	(H)
Lonicera•henyri *	----- (w. China)	(M+/-)
Lonicera•japonica•'Halliana'	Hall's Honeysuckle (e. Asia)	(M-H)
Lonicera•periclymenum	Woodbine Honeysuckle (Eur., w. Asia)	(M+/-)
Lonicera•periclymenum•'Graham•Thomas'	Graham Thomas Honeysuckle (hort. cultivar)	(M+/-)
Lonicera•prolifera *	Grape Honeysuckle (c. USA)	(M+/-)
Lonicera•sempervirens	Scarlet Trumpet Honeysuckle (e. & s. USA)	(M-H)
Lonicera•sempervirens•'Alabama•Crimson'	-----	(M-H)
Lonicera•sempervirens•'Sulphurea	-----	(M-H)
Lonicera•tragophylla *	Chinese Woodbine (w. China)	(M+/-)
Lonicera•x•brownii•'Dropmore•Scarlet'	(L.s. x L. brownii)	(M+/-)
Lonicera•x•heckrottii	Heckrottii Honeysuckle (hort. hybrid)	(M-H)
Lycium•halimifolium *	Common Matrimony Vine (se. Europe, w. Asia)	(M+/-)
Mennispermum•canadense *	Moonseed Vine (e. N. America)	(M-H)
Parthenocissus•quinquefolia	Virginia Creeper (e. N. America to Rocky Mtns.)	(M-H)
Parthenocissus•tricuspidata	Boston Ivy (Japan, c. China)	(M-H)
Passiflora•incarnata *	Passion Flower (c. USA)	(H)
Polygonum•aubertii	Silver Lace Vine (w. China, Tibet, Tajikistan)	(M+/-)
Polygonum•baldschuanicum *	Buchara Fleeceflower (c. Asia, Tajikistan)	(M+/-)
Schisandra•chinensis *	Magnolia Vine (China)	(H)
Schizophragma•hydrangeoides *	Hydrangea Vine (Japan, Korea)	(M-H)
Smilax•rotundifolia *	Common Greenbriar (e. USA)	(H)
Tripterygium•regelii *	Regel's Tripterygium (Manchuria, Japan, Korea)	(M-H)
Vitis•amurensis *	Amur Grape (Manchuria)	(M+/-)
Vitis•arizonica	Arizona Grape (w. Tex.- Cal. & Mex.)	(M+/-)
Vitis•coignetiae *	Gloryvine (Japan, Korea)	(M+/-)
Vitis•riparia	Riverbank Grape (Nov. Sc. - Man., Tenn. & Tex. - Rocky Mts.)	(M-H)
Vitis•vinifera•varieties *	Eurasian Grape varieties (Eur., A. Minor, Cauc. Turkestan)	(M+/-)

Wisteria•floribunda *	Japanese Wisteria (Japan)	(M-H)
Wisteria•macrostachys *	Kentucky Wisteria (c. USA)	(H)
Wisteria•sinensis *	Chinese Wisteria (China)	(M-H)

GROUND COVERS

(Icluding turf & meadow grasses)

[Revised April '03]

WATER NEEDS OF PLANTS

The following chart shows how to group plants based on their water needs.
Reference Location: Denver. Numbers illustrate typical conditions.

* = Plants with potential, but requiring caution due to limited history in Rocky Mountain landscaping.

HIGH WATER	MODERATE WATER	LOW WATER	VERY LOW WATER
Reference plant: Bluegrass turf (Always wet at surface)	Reference plant: Turf-type Tall Fescue (Half of Bluegrass turf)	Reference plant: Buffalograss turf (Like Denver without irrigation)	Reference plant: Too dry for any turf (drier than Denver)
18-20 gals./ S.F./season July: 5"-- 3 times per week	10_ gals./S.F./ season .75" -- once per week	0-3 gals./S.F./season .5" per 2 weeks, optional	No irrigation No irrigation

Achillea•ageratifolia	Grecian Yarrow (Greece)	(L-M)
Achillea•serbica	Serbian Yarrow (Balkans)	(L-M)
Aegopodium•podagraria	Bishop's Weed (Europe)	(H)
Ajuga•reptans	Ajuga (Eur., Persia, Transcaucasia.)	(H)
Akebia•quinata *	Five-leaf Akebia (Jap., Korea, China)	(M-H
Andropogon•scoparius	Little Blue Stem (syn. Schizachyrium•scoparium)	(L-M+/-)
Anemopsis•californica *	Yerba Mansa (sw. USA, Mex.)	(M-H)
Antennaria•parvifolia	Pussytoes (G. Plains, w. to B.C., Wash., Ariz.)	(M+/-)
Antennaria•rosea	Pussytoes (Alaska to Cal. & N. Mex.)	(M+/-)
Arabis•alpina *	Alpine Rock-cress (Europe, Siberia)	(M+/-)
Arctostaphylos•uva-ursi	Kinnikinnick (circumpolar)	(M+/-)
Arenaria•balearica *	Corsican Sandwort (Balearic Is. & Corsica)	(M+/-)
Aronia•melanocarpa	Chokeberry (e. N. Am.)	(M-H)
Asperula•odorata	= Galium•odoratum	
Astroturfoides•ultradeceptiverous	Astro Turf (Houston, Texas)	(L+/M-)
Aurinia•saxatilis	Basket-of-gold (c. & se. Europe)	(L-M)
Bouteloua•gracilis	Blue grama (N. America)	(L+/-)
Buchloë•dactyloides	Buffalograss (Great Plains)	(L)
Campanula•poscharskyana	Poscharsky Bellflower (Dalmatia)	(M-H)
Cerastium•tomentosum	Snow-in-summer (Eur. to w. Asia)	(L-M)
Ceratostigma•plumbaginoides	Plumbago (w. China)	(M+/-)
Convallaria•majalis	Lily-of-the-valley (Eurasia, e. N. America)	(M-H)
Cotoneaster•apiculatus *	Cranberry Cotoneaster (China)	(M+/-)
Cotoneaster•dammeri *	Creeping Cotoneaster (China)	(M+/-)
Cotoneaster•microphyllus *	Littleleaf Cotoneaster (Mts. Afghan., China)	(L-M)
Delosperma•cooperi	Hardy Pink Ice Plant (s. Africa)	(M+/-)
Delosperma•nubigenum	Hardy Yellow Ice Plant (s. Africa)	(M+/-)
Duchesnea•indica	Mock Strawberry (Korea, Jap., to India)	(M-H)
Epimedium•alpinum *	Alpine Epimedium (s. & c. Europe)	(M-H)
Epimedium•grandiflorumum *	Longspur Epimedium (n. Japan, Korea, s. Manch.)	(M-H)
Euonymus•fortunei•'Coloratus'	Purpleleaf Wintercreeper (hort. cult.)	(M+/-)

Euonymus•obovatus *	Running Euonymus (e. USA)	(H)
Festuca•elatior•cvs.	Turf-type Tall Fescue (Eur., Siberia)	(M+/-)
Galium•odoratum	Sweet Woodruff (Eurasia)	(M-H)
Genista•pilosa *	Dwarf Broom (Europe)	(M+/-)
Geranium•spp.	Hardy Geraniums	(M+/-)
Hosta•spp.	Host species (Jap., China, Korea)	(H)
Juniperus•spp. & cultivars +	Juniper species and cultivars	(L-M)
Lamium•maculatum	Spotted Deadnettle, Lamium (Eur., n. Afr., w. Asia)	(M-H)
Lathyrus•latifolius	Perennial Sweetpea (c. & e. Europe)	(M-H)
Lonicera•japonica•'Halliana'	Hall's Honeysuckle (e. Asia)	(M+/-)
Lonicera•sempervirens	Scarlet Trumpet Honeysuckle (e.& s. N. America)	(M-H)
Lonicera•x•heckrottii	Heckrottii Honeysuckle (hort. hybrid)	(M+/-)
Lysimachia•nummularia	Moneywort (Europe)	(H)
Mahonia•repens	Creeping Mahonia (Rocky Mtn. West)	(L-M-H)
Mazus•reptans *	----- (Himalayas)	(M-H)
Marrubium•rotundifolium	----- (Asia Minor)	(L-M)
Poa•pratensis	Kentucky Bluegrass (Eurasia, n. Africa)	(H)
Osteospermum•berberae	South African Daisy (S. Africa)	(M+/-)
Pachysandra•terminalis	Pachysandra (Japan, nc. China)	(M-H)
Parthenocissus•quinquefolia	Virginia Creeper (e. N. America to Rocky Mts.)	(M-H)
Phlox•stolonifera	Creeping Phlox (se. USA)	(M+/-)
Phlox•subulata	Moss Phlox (Penn. to Ga.)	(M+/-)
Polygonum•affine•'Border•Jewel'	Himalayan Border Jewel (Himalayas)	(M-H)
Polygonum•japonicum•var.•compactum	Fleece Flower (e. Asia)	(M-H)
Polygonum•reynoutria	= Polygonum•japonicum•var.•compactum	
Potentilla•nevadensis	----- (Spain)	(L-M)
Potentilla•verna•'Nana'	Creeping Potentilla (hort. cult.)	(M-H)
Rhus•trilobata	Three-leaf Sumac (w. N. Am.)	(L-M)
Saponaria•ocymoides	Saponaria (mtns. sw. & sc. Europe)	(M+/-)
Schizachyrium•scoparium	= Andropogon•scoparius	
Symphoricarpos•x•chenaultii•'Hancock'	Hancock Coralberry (hort. cult.)	(M+/-)
Teucrium•chamaedrys	Germander (c. & s. Europe, w. Asia)	(M+/-)
Thymus•spp.	Thyme species (Eurasia, N. Africa)	(L-M)
Waldsteinia•fragarioides	Barren Strawberry (e. USA)	(H)

Veronica•liwanensis	Turkish Veronica (ne. Anatolia, Cauc.)	(M-H)
Veronica•pectinata	Woolly Veronica (e. Balkans, A. Minor)	(L-M)
Vinca•major	----- (Italy, Balk.)	(M-H)
Vinca•minor	Vinca (Europe , w. Asia)	(H)

SELECTED PERENNIALS

[Revised April '03]

WATER NEEDS OF PLANTS

The following chart shows how to group plants based on their water needs.
Reference Location: Denver. Numbers illustrate typical conditions.

* = Plants with potential, but requiring caution due to limited history in Rocky Mountain landscaping.

HIGH WATER	MODERATE WATER	LOW WATER	VERY LOW WATER
Reference plant: Bluegrass turf (Always wet at surface)	Reference plant: Turf-type Tall Fescue (Half of Bluegrass turf)	Reference plant: Buffalograss turf (Like Denver without irrigation)	Reference plant: Too dry for any turf (drier than Denver)
18-20 gals./ S.F./season July: 5"-- 3 times per week	10 gals./S.F./ season .75" -- once per week	0-3 gals ./S.F./season .5" per 2 weeks, optional	No irrigation No irrigation

Achillea x 'Coronation Gold'	Coronation Gold Yarrow	(VL)
Achillea x 'Moonshine'	Moonshine Yarrow	(VL-L-M)
Aesclepias•tuberosa	Butterfly Weed	M-H
Agastache cana	Double Bubble Mint	(M+/-)
Alchemilla•vulgaris	Lady's Mantle	M-H
Anthemis•tinctoria	Golden Margurerite	M-H
Aquilegia•spp.	Columbines	H
Arum•italicum	Italian Arum	M-H
Aster porteri	Porter's Aster	(VL-L)
Aster•novae-angliae	New England Aster	M-H
Aster•x•frikartii	Frikart's Aster	M-H
Aurinia saxatilis	Basket-of-gold	(L-M)
Baptisia•australis	Baptisia	M-H
Berlandiera lyrata	Chocolate Flower	(VL-L)
Boltonia•asteroides	Boltonia	H
Borago•laxiflora	Borage	M-H
Callirhoë involucrata	Poppy Mallow	(L-M)
Centranthus ruber	Centranthus	(L-M-H)
Cerastium tomentosum	Snow-in-summer	(L-M)
Chrysanthemum•x•morifolium	Chrysanthemums	H
Chrysanthemum•x•superbum	Shasta Daisy	M-H
Convallaria•majalis	Lily-of-the-valley	H
Crocosmia•x•crocosmiiflora	Crocosmia	H
Crocus spp. *	Crocus species	(L-M)
Datura meteloides	Sacred Datura	L-M
Delosperma cooperi	Hardy Pink Ice Plant	(M+/-)
Delphinium•x•elatum	Hybrid Delphiniums	H
Dianthus•spp.	Various Dianthus	L-M
Dicentra•eximia	Bleeding Heart	H
Dictamnus•albus	Gas Plant	L-M
Digitalis•purpurea	Common Foxglove	H
Echinacea•purpurea	Echinacea	M+/-
Echinops•ritro	Globe Thistle	H
Eremurus•spp.	Foxtail Lily	L-M
Eryngium•spp.	Sea Holly	L-M
Gaillardia aristata	Native Gaillardia	(L-M)
Geranium•spp.	Hardy Geraniums	M-H
Helianthemum•spp.	Sun-roses	M+/-
Helianthus maximiliani	Maximilian Sunflower	(M+/-)
Helianthus•spp.	Sunflowers	M+/-

Helleborus•spp.	Hellebores	M-H
Hemerocallis•spp.	Daylilies	M-H
Hosta•spp.	Hostas	H
Iberis•sempervirens	Candytuft	M+/-
Incarvillea•delavayii	Hardy Gloxinia	M+/-
Iris bucharica	Buchara Iris	(M+/-)
Iris germanica cvs..	Bearded Iris varieties	(L-M)
Kniphofia•spp.	Poker Plants	M-H
Lavandula spp.	Various Lavenders	(VL-M)
Liatris punctata	Dotted Gay Feather	(VL-L)
Liatris•punctata	Dryland Gayfeather	VL-L
Liatris•spicata	Wetland Gayfeather	H
Limonium•spp.	Sea Lavenders	L-M
Linum•perenne	Blue Flax	L-H
Lobelia•cardinalis	Cardinal Flower	H
Lobelia•syphilitica	Great Blue Lobelia	H
Lychnis•coronaria	Rose Campion	L-H
Malva•alcea	Hollyhocks	M+/-
Mirabilis multiflora	Native Four O'clock	(VL-L-M)
Monarda•spp.	Monardas	M-H
Narcissus spp.	Daffodils	(L-M)
Nepeta x faassenii	Faassen's Catnip	(L-M)
Paeonia•spp.	Peonies	M+/-
Papaver•orientale	Oriental Poppies	M-H
Penstemon pinifolius	Pineleaf Penstemon	(L-M)
Penstemon strictus	Rocky Mountain Penstemon	(L-M)
Perovskia atriplicifolia	Russian Sage	(VL-L)
Phlomis russeliana	Russel Phlomis	(M+/-)
Phlox subulata	Moss Phlox	(M+/-)
Phlox•paniculata	Garden Phlox	H
Platycodon•grandiflorus	Platycodon	H
Primula•spp.	Primroses	H
Ruta•graveolens	Rue	M+/-
Salvia azurea var. grandifora	Pitcher Sage	(L-M)
Salvia officinalis	Cooking Sage	(L-M)
Salvia•spp.	Salvias	M+/-
Santolina chamaecyparissus	Santolina	(VL-M)
Saponaria ocymoides	Soapwort	(L-M-H)
Saponaria•ocymoides	Rock Soapwort	M+/-
Scabiosa ochroleuca	Yellow Pincushion Flower	(L-M)
Scabiosa•ochroleuca	Yellow Scabiosa	L-H
Secum•spp.	Sedums	M+/-
Silene laciniata	Mexican Campion	(M+/-)
Tanacetum niveum	Silver Tansy	(L-M)
Verbascum•chaxii	Nettle-leaf Mullein	M+/-
Zauschneria arizonica	Arizona Zauschneria	(L-M)
Zinnia grandiflora	Prairie Zinnia	(VL-L)

annotated bibliography

American Association of State Highway and Transportation Officials. 2002; 2001. A policy on geometric design of highways and streets, 2001. 4th , 2 print ed. Washington, D.C.: American Association of State Highway and Transportation Officials.

Produced by the American Association of State Highway and Transportation Officials, A policy on Geometric Design of Highways and streets contains the latest design practices for highway and street design. This text is an accepted authority on the design of streets and highways in the United States. Included, specifically in chapters 4 and 5, are standards for traffic lanes, curbs, medians, pedestrian facilities and on-street parking in local and urban situations. Although the guidelines within represent the traditional standards for street design, they do provide a solid and accepted minimum standard for street design and element widths. Although deviation from these standards may occur, they provided a starting point for adaptation of exiting Rocky Mountain Main Streets.

Bitting, Jennifer, Christopher Kloss, United States. Environmental Protection Agency, and Low Impact Development Center, Inc. 2008. Managing wet weather with green infrastructure municipal handbook. Washington, D.C.: U.S. Environmental Protection Agency.

Produced by the United States Environmental Protection Agency, the "Managing Wet Weather with Green Infrastructure Municipal handbook" series is intended to be used by municipalities to assist and support implementation of green infrastructure. Multiple portions of the handbook cover various topics from covering costs to green infrastructure retrofit policies. Specifically, the Green Streets section includes implantation strategies, techniques and case studies of existing Green Street projects. This text provides a foundation for the green infrastructure portion of "Main Street Evolved". With relevant strategies and implementation hurdles for Alternative Street Designs, Swales, Bioretention Curb Extensions and Sidewalk Planters, Permeable Pavement, and Sidewalk trees and tree boxes, the Green Streets handbook provides definition and basis for the development of implementation guidelines.

"By design and function, urban areas are covered with impervious surfaces: roofs, roads, sidewalks, and parking lots. Although all contribute to stormwater runoff, the effects and necessary mitigation of the various types of surfaces can vary significantly. Of these, roads and travel surfaces present perhaps the largest urban pollution sources and also one of the greatest opportunities for green infrastructure use."

"Effective road drainage, translated as moving stormwater into the conveyance system quickly, has been a design priority while opportunities for enhanced environmental management have been overlooked especially in the urban environment."

Burden, Dan. 1999. Street design guidelines for healthy neighborhoods. Sacramento, CA: Center for Livable Communities.

Written by Dan Burden, one of the leading experts in walkable communities, Street Design Guidelines for Healthy Neighborhoods is a collection of street design procedures that attempt to "identify better ways to design new neighborhoods or retrofit existing ones to be more interactive, walkable, enjoyable, and livable." Based on successful projects from around the United States, Street Design Guidelines for Healthy Neighborhoods provides definitions for typical elements that make up a street. The section on main streets is of particular interest, as Burden describes these streets as places of commerce and mixed-use development for their respective neighborhoods. Included is a typical section of a Health Main Street (Figure 2-2), which illustrates the minimum standards for travel lane width, sidewalks, vehicle speeds, and pedestrian amenities. As these guidelines represent the standards for a health "walkable" community, they should take precedent over any traditional standard whenever possible.

Crankshaw, Ned. 2009. Creating vibrant public spaces : Streetscape design in commercial and historic districts. Washington: Island Press.

In Creating Vibrant Public Spaces: Streetscape Design in Commercial and Historic Districts, Ned Crankshaw uses examples from communities across the United States to demonstrate the possibility of creating a balance between automobile access and walkability. With ideas to consider when designing urban centers, Crankshaw insists on first considering who uses a space, what they do there, and what the intended purpose of the district is. Although the text provided little in the way concrete guidelines on widths and placement, Crankshaw dose provide a series of strategies and recommendation that can be applied to a variety of situations in an effort to analyze existing conditions and evaluate design recommendations.

Colorado Department of Local Affairs: Division of Local Government. Downtown development programs. in Colorado Division of Local Government [database online]. Denver, Coloardo, [cited November 6th 2010]. Available from http://dola.colorado.gov/dlg/fa/ddp/index.html.

The "Community Revitalization Partnerships" is a downtown development program from the Colorado Department of Local Affairs that provides assistance to Colorado's downtowns. "The goal is to assist communities in breaking through roadblocks, questions or issues and identify best next steps to move toward implementation." The Partnership provides Advisory Services and Technical Assistance to communities looking to revitalize their respective downtowns. The key to the Community Restoration Partnership is that it is intended from communities of 20,000 or less, thus providing not only the definition of a "Small Community" but also provides an example of how "Main Street Evolved" can fit into an existing state mandated redevelopment program.

Duany, Andres, Jeff Speck, and Mike Lydon. 2010. The smart growth manual. New York: McGraw-Hill.

The Smart Growth Manual offers clear and concise strategies, guidelines, and advice for urban and street development.

Complete Streets
"For some 60 years now, most American streets have been designed with the sole objective of moving cars. As a result, pedestrian and bicycle use has declined, as has the viability of closely enfronting urban buildings. --Thoroughfares other than highways – should be designed as places of gathering. – The resulting thoroughfares will typically provide narrow (slower-speed) travel lanes, bicycle facilities, on-street parking, continuous tree cover, ample sidewalks, appropriate street furniture, and lighting, -- When streets become pleasant places, more people are likely to leave the car at home."

On-Street Parking
"On-Streets parking provides many benefits. It slows down drivers, who are instinctively watchful of other cars in the roadway; it protects pedestrians from traffic with a thick steel barrier of cars along the sidewalk; it reduces the demand for on-site parking, -- and increases sidewalk activity as drivers walk from car to destination."

Streetlights
"The light standard most pleasing to the eye is no greater than 150 watts and less than 15 feet tall. Lighting levels should be achieved by increasing the number of lights, not their wattage or height. – In urban centers and in retail areas, streetlights should be frequent – approximately 30 feet on center – in support of nighttime activity."

Sidewalk Obstruction
"To minimize pedestrian inconvenience, all sidewalks must provide minimum clear zones for walking"

Dorward, Sherry. 1990. Design for mountain communities : A landscape and architectural guide. New York: Van Nostrand Reinhold.

Although it was written from a holistic perspective and does not focus on street design, Design for Mountain Communities: A landscape and Architectural Guide dose provide numerous issues to consider when designing any aspect of a mountain community. Sherry Dorward offers 16 design guidelines or concepts to consider when design for mountain communities. These range from taking advantage of views to remembering the change of season. Although all of these concepts are important to design, in particular, remembering the change of seasons is vital to mount design. Subfreezing winters, marked seasonality, and most importantly snow are all critical elements of mountain climates that must be considered when designing cold weather communities. In terms of retrofitting existing main street conditions,

the text may be lacking in some respects. Yet, it does provide important factors to consider and suggestions for managing the unique climatic conditions of mounting areas.

"Given the right combination of climatic factors and slope gradient, snow can paralyze circulation, collapse structures, and bury anything in its path."

Gibbons, Johanna, Bernard Oberholzer, and Terry Milne. 1991. Urban Streetscapes: A Workbook for Designers. Cambridge, MA: B. Blackwell.

The Urban Streetscapes Workbook provides an illustrated source for the selection organization of various street furniture elements. Particularly important to Main Street Evolved are the general design principles related to seating, planters, litter bins, lighting, and tree guards. Although it does not provide specifics on materiality, size, or location; the streetscape Workbook dose offer some general principles to consider and illustrates a possible approach to writing guidelines that are informative yet open to interpretation.

Kershaw, Linda., MacKinnon, Andy., Pojar, Jim. 1998. Plants of the Rocky Mountains. Auburn, WA: Lone Pine Publishing.

The Plants of the Rocky Mountains field guide is a horticultural handbook that describes the major vegetative species found throughout the Rocky Mountains. This text is used as a starting point in determining a plant list for Main Street Evolved. Although using only natives would be ideal, some concessions will need to be made in order to minimize irrigation while still enhancing the streetscape.

Ogden, Kathleen M. , Seluga, Michael J. , and Eisenberg, Bethany E. 2010. Green Street Retrofits in the Northeast: Design and Acceptance Challenges for Stormwater Management Retrofits.

Through an in-depth review of two green infrastructure projects located in the Northeast, "Green Street Retrofits in the Northeast: Design and Acceptance Challenges for Stormwater Management Retrofits" describes how green infrastructure can be standardized in the Northeast. With a focus on the successful outcomes and the lessons learned, the report begins to unearth the issues related to implementing vegetative stormwater management in cold climates. Although the New England area and the Rocky Mountain area are vastly different, this report starts to look at cold weather performance of green infrastructure, thus providing a factual background for such.

Urban, James. 2008. Up by roots : Healthy soils and trees in the built environment. Champaign, Ill.: International Society of Arboriculture.

Up by Roots: Healthy Soils and Trees in the Built Environment is a summary of best pstratagies for selecting, preparing, planting, and supporting urban trees to ensure their long term health. Written by James Urban, one of the top experts in urban tree planting, the text suggests that the success of an urban tree is linked it the soils in which it is planted. The book is broken into two main parts, the 1st part addresses the "Science of Trees and Soils", while the 2nd part addresses the "Application of the Science of Trees and Soils." Although the science of what makes good trees and soils is important, for Main Street Evolved, the application section of the book is most beneficial. In an essence, the survival of any urban tree is dependent a two major variables; the volume of soil available and the quality of soil. The quality of the soil refers to compaction, nutrient levels, aeration, available water and drainage.

"What is the minimum size hole for planting a tree? -- the space for the tree and the paving should be developed together, with the paving design to provide the minimum width needed for the use of space, and the area for tree planting designed to be the largest size practical."