Memorandum

To: Jeff Wiggins, *City of Cheyenne* and Sreyoshi Chakraborty *Cheyenne Metropolitan Planning Organization*

From: Rory Renfro and Kim Voros, *Alta Planning + Design*

Date: August 25, 2011

Re: Working Paper #10: Bicycle Support Facilities

The term 'bicycle support facilities' refers to bicycle parking and other end-of-trip facilities such as showers and clothing lockers for cyclists; signal loop detectors, an element of the street network, which aids cyclists crossing at intersections; wayfinding signing, which directs cyclists to popular destinations; and bike racks on buses, or other facilities that promote bicycle and transit integration. These types of support facilities can be a determining factor in a cyclist's decision make a bicycle trip. *Plan Cheyenne* and several other City and Metropolitan Planning Organization (MPO) documents endorse the development and provision of bicycle support facilities.

Bicycle Parking and End of Trip Facilities

Bicycle parking is an important component in encouraging people to use their bicycles for everyday transportation. Studies have shown that people are willing to bicycle more frequently if better bicycle facilities are provided[1].Cyclists' needs for bicycle parking range from short term parking near a destination such as a grocery store, to storage in a bicycle locker that affords weather, theft and vandalism protection, gear storage space, and 24-hour personal access. Most bicycles today cost 350 dollars to over 2,000 dollars and are one of the top stolen items in some communities, with components being stolen even when a bicycle is securely locked. Theft can be a serious deterrent to riding, especially for low-income riders or those with particularly expensive or rare bicycles.

This portion of the memorandum outlines best practices for bicycle parking facility types and the requirements of short- and long-term parking. This memorandum recommends policies that the City of Cheyenne could adopt to require or encourage developers to provide the most appropriate bicycle parking facilities possible, as well as identifying a City bike rack program.

Bicycle Parking Facility Types

Bicyclists need parking options that can provide security against theft, vandalism, and weather. Like automobile parking, bicycle parking is most effective when it is located close to trip destinations, is easy to access, and is easy to find. Where quality bicycle parking facilities are not provided, determined bicyclists

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[1] Pucher, J., Dill, J. and Handy, S. (2010). *Infrastructure, programs, and policies to increase bicycling: An international review.* Preventative Medicine 50:S106-S125.

lock their bicycles to street signs, parking meters, lampposts, benches, trees or other fixed objects. These alternatives are undesirable as they are usually not secure, may interfere with pedestrian movement, and can create liability or damage street furniture or trees.

Bicycle parking includes both long-term and short-term parking, which cater to different cycling groups depending largely on their trip duration and desired level of protection from weather and theft:

- Short-term parking: Bicycle parking meant to accommodate visitors, customers, messengers and others expected to depart within two hours; requires approved standard rack, appropriate location and placement, and weather protection.
- Long-term parking: Bicycle parking meant to accommodate employees, students, residents, commuters, and others expected to park more than two hours. This parking is to be provided in a secure, weather-protected manner and location.

Table 1 compares the typical characteristics of short- and long-term bicycle parking.

Table 1. Characteristics of Short and Long Term Parking

Criteria	Short-Term Bicycle Parking	Long-Term Bicycle Parking
Parking Duration	Less than two hours	More than two hours
Typical Fixture Types	Bicycle racks	Lockers, or racks provided in a secured area
Weather Protection	Unsheltered or sheltered	Sheltered or enclosed
Security	High reliance on personal locking devices and passive surveillance (i.e.., eyes on the street)	Restricted access and / or active surveillance / supervision Unsupervised: • "Individual-secure" (e.g., bicycle lockers) • "Shared-secure" (e.g., bicycle room or cage Supervised: • Valet bicycle parking • Video, CCTV or other surveillance
Typical Land Uses	Commercial or retail, medical/healthcare, parks and recreation areas, community centers	Residential, workplace, transit, schools

Source: Association of Pedestrian and Bicycle Professionals (2010)

Existing Conditions for End of Trip Facilities

Short-term bicycle parking facilities in Cheyenne are located at the Laramie County Library, retail locations near the downtown core, schools, and parks. All state government buildings provide long term bicycle parking, although it is not accessible to the public. A few bus stops and the Cheyenne Transit Program (CTP) Transfer Station have bike racks on the sidewalk but do not provide long-term parking.

The quality of existing short-term bike parking facilities varies by location, particularly due to the style of rack chosen and/or placement of the rack. Some existing racks near schools and shopping areas are substandard because they are not designed to support a bicycle at two points; the bicycle frame and at least one wheel cannot be locked to the rack without the use of a long bicycle cable or mounting the bicycle over the rack.

Informal bike parking (bikes being locked to hand rails, street signs, light poles and other objects) indicates a demand for additional bike parking supply. Some bikes have been informally parked throughout Cheyenne, including at multi-family residences, suggesting that insufficient formal bike parking is being provided or that it is not conveniently located in close proximity to a storefront or building entrance.

The location of showers and changing facilities is difficult to track as they may be supplied by a private entity, such as the owner of a public office building. Facilities exist in several state buildings but are not available for use by the general public.

Existing Bicycle Parking Code

Cheyenne's bicycle parking standards are located in Chapter 9 of the *Road Street & Site Planning Design Standards.* These standards discuss the need for both short-term and long-term bicycle parking as necessary to promote bicycle use throughout the system. The standards state the facilities should be designed in accordance with design guidelines set forth in Chapter 2 of the American Association of State Highway and Transportation Officials (AASHTO) 1999 *Guide for the Development of Bicycle Facilities.* Other factors that impact the usefulness of bicycle parking are discussed and include:

- Visibility
- Security
- Weather Protection
- Clearance
- Bicycle Parking Supply

The existing guidelines, shown in Table 2, provide bicycle parking supply recommendations that are based on land use and motor vehicle parking supply. Some land uses (e.g., public transit stations) do not have explicit standards set forth in the current design standards.

Table 2. Current Bicycle Parking Standards, Source: Road, Street and Site Planning Design Standards

Type of Establishment	Minimum Number of Bicycle Parking Spaces
Primary or Secondary School	10% of the number of students, plus 3% of the number of employees.
College or University	3% of the number of students, plus 1% of the number of employees.
Commercial—Retail or Office	One space per 10,000 sq. ft. of commercial space or 10% of the number of automobile spaces.
Sport and Recreation Center	5% of the number of automobile spaces.
Movie Theater or Restaurant	5% of the number of automobile spaces.
Industrial	2% of the number of automobile spaces.
Multi-unit Housing	1 space per 2 apartments.
Public Transit Stations	Varies, depending on usage.

Overview of Best Practices for Bicycle Parking and Changing Facilities

Short-Term Bicycle Parking

The majority of short-term bicycle parking facilities are racks placed on a sidewalk or in a private development near a building entrance. Key characteristics to consider when choosing a bicycle rack include the following:

- **Support:** The rack must support the bicycle upright by its frame at two points in a horizontal plane to prevent the bicycle from falling.
- **Security:** The rack must be able to be used with common bicycle locks, including cable locks or U-shaped locks, and should be designed so that the frame and one or both wheels can be secured.
- **Flexibility:** The rack must accommodate a wide range of bicycle sizes, wheel sizes, and types.
- **Materials:** The rack should be covered with a material that will not chip the paint of a bicycle that leans against it. The materials used should also resist rusting and corrosion.

U-racks, post and ring racks, and coat hanger racks meet these criteria, while comb or toaster racks (where bicycles are rolled into wheel slots) are not recommended. The Association of Pedestrian and Bicycle Professionals (APBP) *Bicycle Parking Guidelines* (2010) provides detailed information on the types of materials, maintenance requirements, and security considerations for bicycle parking racks.

On-sidewalk parking should be placed where it does not interfere with pedestrian use of the sidewalk. It is essential to provide sufficient space around the rack, otherwise riders will lock their bicycles perpendicular to the rack, which may block the sidewalk. Table 3 provides additional consideration for short-term bicycle rack placement.

Table 3. Short-Term Bicycle Rack Placement Guidelines

Design Issue	Recommended Guidance
Minimum Rack Height	To increase visibility to pedestrians, racks should have a minimum height of 33 inches or be indicated or cordoned off by visible markers.
Signing	Where bicycle parking areas are not clearly visible to approaching cyclists, signs at least 12 inches square should direct them to the facility. The sign should give the name, phone number, and location of the person in charge of the facility, where applicable.
Lighting	Lighting of not less than one foot-candle illumination at ground level should be provided in all bicycle parking areas.

Frequency of Racks on Streets	In popular retail areas, two or more racks should be installed on each side of each block. This does not eliminate the inclusion of requests from the public which do not fall in these areas. Areas officially designated or used as bicycle routes may warrant the consideration of more racks.
Location and Access	Access to facilities should be convenient; where access is by sidewalk or walkway, curb ramps should be provided where appropriate and ADA compliant. Parking facilities intended for employees should be located near the employee entrance, and those for customers or visitors near the main public entrances. (Convenience should be balanced against the need for security if the employee entrance is not in a well traveled area). Bicycle parking should be clustered in lots not to exceed 16 spaces each. Large expanses of bicycle parking make it easier for thieves to operate undetected.
Locations within Buildings	Provide bike racks within 50 feet of the entrance. Where a security guard is present, provide racks behind or within view of a security guard. The location should be outside the normal flow of pedestrian traffic.
Locations near Transit Stops	To prevent bicyclists from locking bikes to bus stop poles - which can create access problems for transit users, particularly those who are disabled - racks should be placed in close proximity to transit stops where there is a demand for short-term bike parking, away from the loading zone.
Retrofit Program	In established locations, such as schools, employment centers, and shopping centers, the City should conduct bicycle parking audits to assess the bicycle parking availability, suitability, and access, and add in additional bicycle racks where necessary.

Bike Racks

Design Summary

- Bicycle racks should be easy to use.
- Bicycle racks should be securely anchored to a surface or structure.
- The rack element (part of the rack that supports the bicycle) should keep the bicycle upright by supporting the frame in two places. The rack should allow one or both wheels to be secured.
- Avoid use of multiple-capacity "wave" style racks. Users commonly misunderstand how to correctly park at wave racks, placing their bikes parallel to the rack and limiting capacity to 1 or 2 bikes.
- Position racks so there is enough room between parked bicycles. Racks should be situated on 36" minimum centers.
- A five-foot aisle for bicycle maneuvering should be provided and maintained beside or between each row of bicycle racks.
- Empty racks should not pose a tripping hazard for visually impaired pedestrians. Position racks out of the walkway's clear zone.
- For sidewalks with heavy pedestrian traffic, at least seven feet of unobstructed right-of-way is desirable.
- Racks should be located close to a main building entrance, in a lighted, high-visibility area protected from the elements.

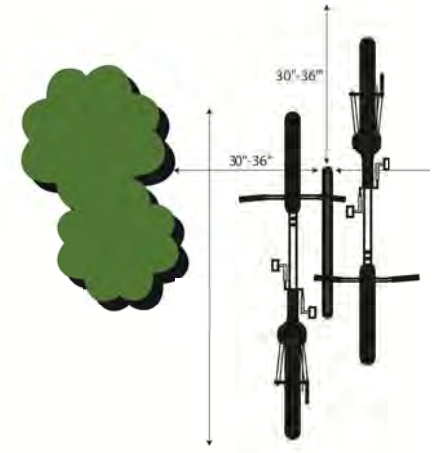
Discussion

Bicycle Parking Manufacturers:

- Palmer: www.bikeparking.com
- Park-a-Bike: www.parkabike.com
- Dero: www.dero.com
- Creative Pipe: www.creativepipe.com
- Cycle Safe: www.cyclesafe.com

Standard bicycle 'staple' rack.

Art racks can be an attractive way of marketing the bicycle parking.



Racks should be situated on 30" - 36" minimum centers.

Long-Term Bicycle Parking

Long-term bicycle parking facilities protect the entire bicycle, its components and accessories against theft and against inclement weather, including snow and wind-driven rain. Examples include lockers, check-in facilities, monitored parking, restricted access parking, and personal storage.

Bike Lockers

Design Summary

- Large metal or plastic stand-along boxes
- Place near building entrances or on the first level of a parking garage.
- Provide door locking mechanisms and systems.
- A flat, level site is needed; concrete surface is preferred.
- Enclosure must be rigid.
- Transparent panels are available on some models to allow surveillance of locker contents.
- Minimum dimensions: width (opening) 2.5′; height 6′; depth 4′.
- Stackable models can double bicycle parking capacity, but decrease ease of use.

Bike lockers at a transit station.

Discussion

Although bicycle lockers may be more expensive to install, they can make the difference for commuters who are deciding whether or not to cycle because they offer the highest level of personal bicycle parking security available.

Some lockers allow access to two users - a partition separating the two bicycles can help ensure users feel their bikes are secure.

Security requirements may require that locker contents be visible. Providing visibility into the locker also reduces unintended uses, such as use as homeless shelters, trash receptacles, or storage areas. Requiring that users procure a key or code to use the locker also reduces these unintended uses.

Traditionally, bicycle lockers have been available on a sign-up basis, whereby cyclists are given a key or a code to access a particular locker. Computerized on-demand systems allow users to check for available lockers or sign up online. Models from eLocker and CycleSafe allow keyless access to the locker with the use of a SmartCard or cell phone. With an internet connection, centralized computerized administration allows the parking provider to monitor and respond to demand for one-time use as well as reserved lockers.

Lockers available for one-time use have the advantage of serving multiple users a week. Monthly rentals, by contrast, ensure renters that their own personal locker will always be available. Bicycle lockers are most appropriate:

- Where demand is generally oriented toward long-term parking.
- At transit exchanges and park-and-rides to help encourage multi-modal travel.
- Medium-high density employment and commercial areas and universities.
- Where additional security is required and other forms of covered storage are not possible.

Bicycle Compounds/Cages

Design Summary

- See Bike Rack guidelines for placement and clear zone dimensions.
- A cage of 18′ by 18′ can accommodate up to 20 bicycles and uses the space of approximately two automobile parking spots.
- Improve surveillance provided through public lighting, video cameras, and visibility by other users of the facility.
- Bicycle compounds should have an exterior structure consisting of expanded metal mesh from floor to ceiling.
- In an attended parking facility, locate within 100′ of the responsible attendant or security guard.
- Entry doors should be steel and at least 2.5′ in width, with "tamper proof" hinges. A window may be provided in the door to provide permanent visual access.

Secure Parking Area (SPA) in Portland, OR uses both inverted 'U' and racks that stack bicycles.

Discussion

Bicycle compounds are fully enclosed, stand-alone bicycle parking structures. Compounds should not only have a locked gate but should also allow for the frame and both wheels to be locked to a bicycle rack, as other users also have access to the enclosure. Bicycle compounds are recommended for employment or residential bicycle parking areas, or for all-day parking at transit exchanges, workplaces and schools. They can be located at street level or in parking garages.

Bicycle Secure Parking Areas (SPAs) are a new concept implemented by transit agencies throughout the nation. They provide high capacity, secure parking areas for 80-100 bicycles at light rail and bus transit centers. The Bicycle SPAs are semi-enclosed covered areas that are accessed by key cards and monitored by security cameras. The increased security measures provide an additional transportation option for those who may not be comfortable leaving their bicycle in an outdoor transit station exposed to weather and the threats of vandalism. They may also include amenities that make the Bicycle SPA more attractive and inviting for users such as benches, bicycle repair stations, bicycle tube and maintenance item vending machines, as well as racks which allow people to leave their locks at the SPA.

Bicycle Rooms

Design Summary

- See Bike Rack guideline for placement and clear zone dimensions.
- Improve surveillance through public lighting video cameras, and visibility by other users of the facility.
- Walls should be solid and opaque from floor to ceiling.
- Install a panic button so as to provide a direct line of security in the event of an emergency.

Bike rooms can be provided in office or apartment buildings.

Discussion

Bicycle rooms are locked rooms or cages which are accessible only to cyclists, and which may contain bicycle racks to provide extra security against theft. Bicycle rooms are used where there is a moderate to high demand for parking, and where cyclists who would use the bicycle parking are from a defined group, such as a group of employees. Bicycle rooms are also popular for apartment buildings, particularly smaller ones in which residents are familiar with one another.

The bicycle parking facilities should be no further from the elevators or entrances than the closest motor vehicle parking space, and no more than 150′ from an elevator or building entrance. Buildings with more than one entrance should consider providing bicycle parking close to each entrance, and particularly near entrances that are accessible through the bicycle network. Whenever possible, bicycle parking facilities should allow 24-hour secure access.

Dedicated bicycle-only secure access points should be provided through the use of security cards, non-duplicable keys, or passcode access. The downside is that bicyclists must have a key or know a code prior to using the parking facilities, which is a barrier to incidental use.

Bike Depots

Design Summary

- While each depot unique, they often provide:
  - Attended or restricted-access parking spots
  - Bicycle rentals
  - Repair areas
  - Access to public transportation
  - Commute trip-planning information
  - End of trip support such as showering and changing rooms
  - Community space

Discussion

Bike depots generally refer to full-service parking facilities typically located at major transit locations that offer secure bicycle parking and other amenities. There is no universally accepted terminology to describe different types of full-service bicycle parking facilities.

The company BikeStation™, which runs several parking facilities in California, Oregon, and Washington, DC, offers a variety of free and for pay secure parking opportunities during business hours and after-hours . Paying members enjoy a number of services. Services, which differ by location, may include bicycle repairs, bicycle rentals, sales and accessories, restrooms, changing rooms and showers, and access to vehicle-sharing. They can also incorporate restaurants or other services.

Bike depot in Washington.

The downtown Berkeley BikeStation allows 24-hour access.

Recommended Bicycle Parking Code

Cheyenne can encourage developers to provide bicycle parking by including type and quantity requirements in the Code of Ordinances and by updating design guidelines included in the *Road, Street and Site Planning Design Standards*. Table 4 shows suggested bicycle parking requirements recommended by the Association of Pedestrian and Bicycle Professionals (APBP) in the 2010 *Bicycle Parking Guidelines*. These bicycle parking requirements can be phased in over a period of months or years; short-term bicycle parking requirements should be implemented first, followed by long-term bicycle parking requirements.

Table 4. Recommended Bicycle Parking Requirements

Type of Activity	Long-Term Bicycle Parking Requirement	Short-Term Bicycle Parking Requirement
Residential Land Uses		
Single-family dwelling	No spaces required	No spaces required
Multi-family dwelling		
a) With private garage for each unit*	No spaces required	0.5 spaces for each bedroom
b) Without private garage for each unit	0.5 spaces for each bedroom, minimum 2 spaces	0.5 spaces for each bedroom, min 2 spaces
c) Senior housing	Minimum 2 spaces	Minimum 2 spaces
Civic/Cultural Land Uses		
Non-assembly cultural (library, government buildings, etc.)	1 space for each 10 employees, minimum2 spaces	1 space for each 10,000 s.f. of floor area, minimum2 spaces
Assembly (church, theater, stadium, park, beach, etc.)	1 space for each 20 employees, minimum2 spaces	Spaces for 2% of minimum expected daily attendance
Health care/hospital	1 space for each 20 employees or 1 space for each 70,000 s.f. of floor area, whichever is greater, minimum 2 spaces	1 space for each 20,000 s.f. of floor area, minimum 2 spaces
Education		
a) Public, parochial, and private day-care centers for 15 or more children	1 space for each 20 employees, minimum 2 spaces	1 space for each 20 students of planned capacity, minimum 2 spaces
b) Public, parochial, and private nursery schools, kindergartens, and elementary schools (1-3)	1 space for each 10 employees, minimum 2 spaces	1 space for each 20 students of planned capacity, minimum 2 spaces
c) Public, parochial, and elementary (4-6) public and high schools	1 space for each 10 employees, plus 1 space for each 20 students or planned capacity, minimum 2 spaces	1 space for each 20 students of planned capacity, minimum 2 spaces

Type of Activity	Long-Term Bicycle Parking Requirement	Short-Term Bicycle Parking Requirement
d) Colleges and universities	1 space for each 10 employees, plus 1 space for each 10 students or planned capacity; or 1 space for each 20,000 s.f. of floor area, whichever is greater	1 space for each 20 students of planned capacity, minimum 2 spaces
Rail/bus terminals and stations/airports	Spaces for 5% projected a.m. peak period daily ridership	Spaces for 1.5% a.m. peak period daily ridership
Commercial Land Uses		
Retail		
General food sales or grocery	1 space for each 12,000 s.f. of floor area, minimum 2 spaces	1 space for each 2,000 s.f. of floor area, minimum 2 spaces
General retail	1 space for each 12,000 s.f. of floor area, minimum 2 spaces	1 space for each 5,000 s.f. of floor area, minimum 2 spaces
Office	1 space for each 1,000 s.f. of floor area, minimum 2 spaces	1 space for each 20,000 s.f. of floor area, minimum 2 spaces
Auto Related		
Automotive sales, rental & delivery, automotive servicing/repair, cleaning	1 space for each 12,000 s.f. of floor area, minimum 2 spaces	1 space for each 20,000 s.f. of floor area, minimum 2 spaces
Off-street public parking lots/garages without charge or on a fee basis	1 space for each 20 automobile spaces, minimum 2 spaces – unattended surface parking lots excepted	Min 6 spaces or 1 per 20 auto spaces – unattended surface parking lots excepted
Industrial Land Uses		
Manufacturing and production	1 space for each 15,000 s.f. of floor area, minimum 2 spaces	Number of spaces to be prescribed by the Director of City Planning. Consider min 2 spaces at each public building entrance

* A private locked storage unit may be considered as a private garage if a bicycle can fit into it.

Recommended City Programs

The City of Cheyenne can significantly improve availability and quality of bicycle parking with the following action items:

- Require bicycle parking with new development and redevelopment projects.
- Provide incentives to encourage bicycle parking facilities beyond the minimum requirements.

- Provide guidance on the design and placement of bicycle parking facilities, including staple racks, lockers, bike rooms, and bike cages.
- Encourage partnerships between private business that may not have shower facilities and health clubs (e.g., Curves and Smart Sports).
- Establish a bike rack program that assists in locating, designing, and funding bicycle racks in the public right of way.
- Work with the Cheyenne Transit Program to install short- and long-term bicycle parking at the Transfer Station and other transit stops.

Incentive Programs

A number of incentives can be used to encourage developers to provide adequate and high-quality bicycle parking. Strategies that the City of Cheyenne could employ include:

- Reducing the required number of motor vehicle parking spaces on new development or redevelopment where bicycle parking is provided beyond the minimum requirements.
- In space constrained applications, such as redevelopment of an existing building, allow for the conversion of motor vehicle parking spaces into long-term bicycle parking to meet the automobile parking requirements (typically five bicycle parking spaces can be achieved per motor vehicle parking space).
- Extending or introducing payment-in-lieu of parking programs to allow funds to be collected in-lieu of vehicle parking and placed in a sustainable transportation infrastructure fund to fund active transportation projects, which may include a centralized bicycle parking and end-of-trip facility (e.g., a bike depot). Note: this should not replace bicycle parking and end-of-trip facility requirements.

Bike Rack Program

Several cities have bike parking programs to install and maintain bicycle parking in the City's right-of-way. These programs can work with business owners who desire bicycle parking either by installing racks on request or by cost-sharing. The program can make the location of parking available online. Portland, Oregon's bicycle parking program includes helpful information:
http://www.portlandonline.com/transportation/index.cfm?c=34813

The City of Cheyenne should establish a Bicycle Rack Program to work with interested land owners to supplement the existing supply of bicycle parking. Cheyenne can provide information on possible vendors as well as rack design and placement as part of these guidelines.

Signalized Intersections

Accommodating bicyclists at traffic signals can be challenging for traffic engineers as the needs and characteristics of bicycles and motor vehicles vary. This section contains guidance on how bicycles can be better accommodated within Cheyenne's existing traffic signal system. The difference in acceleration and speed between motorists and bicyclists provides some challenges that can be addressed with signal timing.

Additionally, the difference in bicycle and motor vehicle size and material composition can pose detection challenges, which lend themselves to other solutions.

Bicycles and traffic signal timing

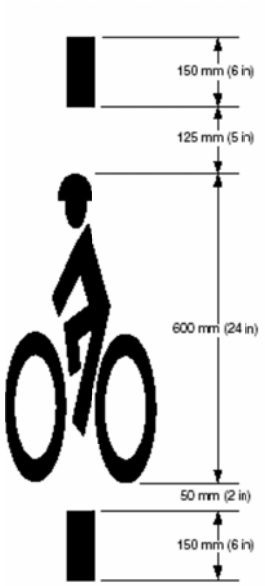
Bicycles typically travel more slowly than motor vehicles and can find themselves with inadequate time to clear an intersection before the conflicting green phase begins. The time allowed for reacting to the change in signal, starting up and accelerating to free flow speed, plus the time to clear the width of the intersection must be accommodated within the combined time of the green plus amber change intervals. The duration of both the green and amber intervals of signals is typically determined by the expected motor vehicle startup, acceleration, and speed through an intersection, which is faster than the average cyclist speed. Methods for better accommodating bicyclists once they have been detected at an intersection include:

- Increase the minimum green interval to effect a minimum bicycle timing sufficient to allow bicycles to clear the last conflicting lane. Bicyclists have slower speeds and accelerations than motor vehicles and even if they are at the head of the vehicle queue when a green light is given, the bicyclist may still lack sufficient time to clear the intersection during the green. (An example of this strategy can be seen in Caltrans Policy Directive 09-06)
- Lengthening the amber change interval of the intersection slightly to allow for the slower acceleration and speed of bicyclists. This should be only part of the solution as longer amber intervals can also encourage motor vehicles to enter intersections under this phase.
- Lengthen the 'all red' clearance interval of the intersection. This allows any vehicles or bicyclists still in the intersection to clear it before a green interval is given to opposing traffic. The maximum length of the 'all red' phase should not generally be greater than three seconds. Under no circumstances should this time be extended beyond six seconds.
- Shorten cycle lengths to reduce wait times and increase red light compliance
- If demand warrants, rest the signal in green on the street that serves the high priority bicycle network
- Time coordinated signals in the urban core to keep travel speeds relatively low, such as 20 miles per hour, which will also accommodate bicyclists traveling 10 miles per hour. This strategy makes it possible to alter signal timing to provide 'green waves' for bicyclists without significantly impeding motor vehicle flow[2].
- Install "bicycle only" traffic signals in areas of high conflict or unique geometry to trigger a bicycle only phase.
- Use signal detection to detect moving bicyclists. Video detection technology can be programmed to detect the presence of bicyclists and trigger a bike phase or extend the green phase based on their presence in a bike lane. This technique is not recommended when bicycles and motor vehicles share a travel lane as video technology cannot always make the distinction between a cyclist and a motor vehicle.

[2] 'Green wave' refers to the practice of intentionally coordinating signal timing at multiple intersections along a travel corridor to facilitate continuous travel at a specific travel speed (e.g., 10 – 15 miles per hour). A vehicle traveling at this speed will see a cascade or wave of green lights, allowing them to avoid stopping.

- Add a bike phase to the traffic signal timing plan, such that the presence of a bicyclist in the bike lane has the effect of extending the green time. This strategy would not be necessary if minimum bicycle timing were provided at all traffic signals.

Bicycle Detection



While some traffic signals are pretimed and the changes in signal phase are dependent on the passing of time rather than the presence of vehicle traffic, demand actuated signals are dependent on the presence of a vehicle or pedestrian to trigger a phase change. Although most detection technologies can detect bicycles, when appropriately calibrated, their sensitivity varies and they can seem unreliable to bicyclists. Bicycle detection at these signalized intersections is a critical aspect of a bicycle network; if cyclists cannot trigger a signal along a bikeway they may not be able to use a route at certain times of the day because a motor vehicle may not come along to demand the phase change. In this situation, a bicyclist is left to run the red light or activate the pedestrian phase, which typically requires dismounting or sophisticated bicycle handing skills which leave the bicyclist in the crosswalk or facing the wrong direction when the light changes.

The City of Cheyenne is currently running demand actuated signals on 60% of the 75 signals in the traffic signal network. The primary detection mechanism is video (80%), with 19% running on loop detection, and the remainder on the Sensys[3] system. The City discontinued the practice of installing loop detectors in 2006. WYDOT, on the other hand utilizes video detection for 20% of its network within the City, 40% loops, 5% microwave or radar, and 35% Sensys. Some traffic signals are running different technologies on different legs, with a mix of semi- and fully- actuated signals throughout the networks (personal communication from Traffic Engineer, dated July 21, 2011.)

Loop Detectors

Inductive loop detectors are installed within the roadway to allow the presence of a motor vehicle or bicycle to trigger a call to the traffic signal controller that demands a change in the traffic signal, through its sensing of the presence of a conductive metal object. This allows the bicyclist to stay within the lane of travel and avoid maneuvering to the side of the road to trigger a push button. The type, placement, and sensitivity of detector loops influences the reliability of the loop in responding to a bicyclist's presence. Unfortunately, inductive loop detection technology may not always detect a bicyclist's presence. If bicyclists fail to position themselves correctly over the loop, they may fail to trigger the signal or a bicycle may not have enough material to be detectable to the loop.

Although most types of inductive loop detectors, can be tuned to adjusted to detect cyclists, the practice requires ongoing maintenance by skilled technicians, who must adjust the loops to be sensitive enough that

[3] http://www.sensysnetworks.com/home

they detect bicyclists, but not so sensitive that they respond to nearby parked cars or other atmospheric influences. The loops used for presence detection within the City are typically the 6' x 20' quadrapole type, which are difficult to keep tuned for bicycles. The smaller 6' x 6' square loops are used in some places for advance detection, however, these smaller loop detectors are typically positioned in the motor vehicle lane in advance of the intersection, where the loop does not discriminate between a bicycle and motor vehicle in the signal sent to the controller. The loops that best accommodate bicycle detection are typically 3' in diameter. Some states utilize the practice of installing loops specifically wound to increase the probability of detection by bicyclists, for example, the D-Loop in California. The City of Cheyenne currently calibrates in-pavement loop detectors for motor vehicles. In several locations, signals with loop detection have been tuned in the past to detect cyclists. Currently, the City does not track whether these locations detect cyclists; it is possible that these signals they have drifted out of calibration and no longer detect cyclists.

Even in well-adjusted loops, some bicycles may lack enough detectable material to be picked up. However, loops that are sensitive enough to detect bicycles should include pavement markings to instruct cyclists how place their bicycle to successfully trigger a signal phase change (see Figure 2).

Video Detection

Video detection technology can detect a bicyclist's presence over a larger area by using pixel analysis of an image to detect the change from absence to presence of vehicles or bicycles. With video detection, disturbance to the pavement can be avoided, and the relative placement of bicyclists and their ability to create a disturbance to the electromagnetic field compared to vehicles become inconsequential. Changes to the detection can be made quickly with a few modifications to the software to adjust to a change in lane configuration or the addition of a bike lane. The detection zones can also be hand drawn to the appropriate size relatively easily, should it be found that bicyclists tend to position themselves outside of the expected vehicle detection zone. However, video detection cannot differentiate between a motor vehicle and a bicycle in a shared travel lane and therefore cannot be used to extend or create a signal phase unique for bicyclists. This may be possible when a bicycle lane is provided, but would still require evaluation at each intersection.

Shortcomings to video can include poor detection in darkness (a lighted intersection and bicycles well equipped with lights solve this), and the shadows of adjacent vehicles triggering the bicycle area during certain times of day. Video camera system costs range from $20,000 to $25,000 per intersection.

Remote Traffic Microwave Sensor Detection (RTMS)

RTMS is a system developed in China, which uses frequency modulated continuous wave radio signals to detect objects in the roadway. This method is marked with a time code which gives information on how far away the object is. The RTMS system is unaffected by temperature and lighting, which can affect standard video detection cameras.

Push Button Activation

Similar to pedestrian push button activation, a button positioned on the side of the roadway will allow a cyclist to trigger a signal change without dismounting from his or her bicycle or riding up on the sidewalk to push the button. This design takes advantage of existing infrastructure, diminishes the potential for bicycle/pedestrian conflicts, and increases the convenience of the route for cyclists. Well-designed push

button activation will be curbside and mounted at a height easily reached by cyclists. On-street parking near the push button area should be prohibited.

Recommendations

The City of Cheyenne can improve detection of bicycles and use of signals by bicyclists through the following actions:

- Work with cyclists to develop a list of intersections along frequently used routes where the existing infrastructure can be modified to detect cyclists better at a relatively low cost. Prioritize these locations for signal improvements.
- Ensure that all new signals provide a means of cyclist activation.
- Consider adjusting signal timing plans to provide a minimum bicycle timing at appropriate intersections
- Use pavement markings to identify the most sensitive spots of in-pavement loop detectors

Wayfinding Signing

Wayfinding uses landmarks, signs, and environmental cues to assist in navigation. It creates a sense of empowerment and security by providing directional cues to inform a cyclist how to reach a destination without confusion. Road signs direct motor vehicle traffic to destinations and provide information about major streets and key turns, reinforcing drivers' confidence as they travel to a destination. However, automobile wayfinding is usually located along major streets and most bicycle routes do not provide this information. This same level of guidance is equally important to helping cyclists navigate through their environment.

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Designing wayfinding systems for cyclists should reflect specific attributes of riding. Traditional elements of a wayfinding system include signs, pavement markings, and maps. Interactive web mapping and hand held digital devices are also becoming popular tools. This section provides an overview of how to develop a wayfinding system, the elements of wayfinding and best practices from national and international cities with successful bicycle wayfinding systems.

Signage can serve both wayfinding and safety purposes including:

- Helping to familiarize users with the bicycle network
- Helping users identify the best routes to destinations.
- Helping to address misperceptions about time and distance.

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Bicycle wayfinding signs also visually cue motorists that they are driving along a bicycle route and should use caution.

Sign Information

Uniformity, legibility, and adherence to existing standards are among the elements to consider when determining the appropriate wayfinding sign design for Cheyenne. National, state, and local standards, along with local input, should guide the development of signage design. Uniformity considerations include size, font, abbreviations or stacking for long labels,[4] number of labels, and arrow placement. National guidance on wayfinding signage is found in the *Manual on Uniform Traffic Control Devices* (MUTCD) and the American Association of State Highway and Transportation Officials (AASHTO) *Guide for the Development of Bicycle Facilities*.

[4] For example, a common practice is to abbreviate destination names when it will fit on a single line. Unabbreviated destination names can be stacked on two lines if sufficient space exists on the sign. Abbreviations can be used on stacked text if necessary to accommodate long destination names.

Destinations to include on wayfinding signs can include:

- On-street bikeways
- Commercial centers (e.g., Frontier Mall)
- Greenways (e.g., Crow Creek and Dry Creek)
- Civic/community destinations (e.g., Cheyenne Depot Plaza and the Laramie County Library)
- Local parks and paths (e.g., Cahill Park, Lions Park and Holliday Park)
- Hospitals (e.g., Cheyenne Regional Medical Center)
- Schools (e.g., elementary schools, junior high schools, high schools and Laramie County Community College)
- Public transit sites (e.g., Cheyenne Transit Program Transfer Station)

At greater distances, area destinations (e.g., downtown and neighborhoods) should be signed as a general location. As the distance to these areas decreases, specific destinations within the area can be named. The closest destination to each sign should be placed in the top slot. Destinations that are further away should be placed in the subsequent slots. This allows the nearest destination to 'fall off' the sign and subsequent destinations to move up the sign as the bicyclist approaches.

Some signs may be temporary or contain future destinations. Signs in some locations can reserve space for destinations that do not yet exist.

Distance and Time

Signs should include mileage and travel time estimates to help minimize the tendency to overestimate the amount of time it takes to travel by bicycle (Figure 5. Example decision sign. Most jurisdictions use a 10 mph average speed be used to estimate travel time based on an average urban bicycling speed.

Mileage and travel time for each destination should be listed when text is stacked, if possible. Time and distance may be listed as a single line of text to the right, left, or below the destination if necessary. Consistency in placement is desirable.

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Sign Placement

Signs are typically placed at key locations leading to and along bicycle routes, including the intersection of multiple routes. Turn signs (e.g., a bicycle route sign with a directional arrow) indicate where a bikeway turns from one street onto another street. Turn signs are located on the near-side of intersections. Decision signs mark the junction of two or more bikeways. Decision signs are located on the near-side of intersections. They can include destinations and their associated directional arrows, but not distances.

Additional placement recommendations include:

- Signs should be placed along all designated city bikeways. In cases where the bikeway does not yet exist, sign installation should occur simultaneously with, or immediately after, bikeway construction.
- Signs should be placed in locations where the direction of the bike route is not immediately obvious (e.g., changes in direction), at key intersections along developed bikeways, at key decision points, and as guidance through complex routing areas.
- Signs should be placed along the right-of-way in places where the cyclist can see an upcoming sign from approximately 100 feet away. On steep downhill segments, the sign should be placed further upstream from the intersection to provide a cyclist adequate time to make a directional decision. Signs should also be placed further from the intersection on busier streets with a center turn lane or left turn pocket to provide a cyclist with enough time to safely signal entry into the turn pocket.

Pavement markings may be used to reinforce routes and directional signage. Markings, such as shared lane markings, may be used in addition to or in place of turn signs along bike routes.

Recommended Wayfinding Signing Program

The City of Cheyenne should develop a signing program with the specific uniform standards as recommended above, or as determined by City staff. Members of the public can collaborate on sign design and layout, as well as which destinations should be included.

The signing program can be implemented in several phases to make use of available funding and construction opportunities. Signs should be integrated with Cheyenne's existing greenway signing.

Cheyenne should begin by signing bicycle facilities included in the finalized *On Street Bicycle Plan and Greenway Plan Update*. Installation of signage on bikeways outside the current city limits or bikeways managed by Laramie County or Wyoming Department of Transportation will require coordination with these agencies.

Bicycle Transit Integration

This section describes typical issues related to bicycle access to transit and accommodation on transit vehicles. Issues covered in this section include:

- Appropriately planning for expected levels of bicycling to transit and desire for bike-on-bus facilities.
- Providing connections between the bicycle and transit networks.
- Providing appropriate bicycle parking facilities at transit stops.
- Creating convenient access at, to, and from transit stops.
- Developing policies for carrying bicycles onto transit vehicles.
- Accommodating cyclists in the physical design of the transit stop.

Expected Demands

The Cheyenne Transit Program (CTP) provides transit service for the metropolitan area. Bicycle racks on all transit vehicles currently accommodate cyclists on buses. Interviews with the transit authority indicate that these racks are used, though they are not frequently filled to capacity. When both racks are full, cyclists can bring their bicycles inside the transit vehicle, though this occurs infrequently. Areas of the transit system that typically experience higher use are downtown, near the transfer station at W 17th Street and Carey Avenue,

and along the "South" route that serves Laramie County Community College. Recently, Cheyenne has experienced population growth to the east of the downtown core, slightly increasing transit ridership in the area. Interviews with the transit provider indicated that there was potential for population growth in west and southwest and the 2012 update to the CTP *Transit Development Plan and Coordination Study* will analyze these areas in more detail.

The transit system's largest user group are "transportation disadvantaged" users who do not have access to an automobile or cannot drive (e.g., for medical reasons). The transit system generally serves utilitarian (e.g., trips to work or school) rather than recreational trips (e.g., getting to the greenway for a recreational ride). CTP is interested in expanding the user base by targeting individuals that have access to a motor vehicle but could become interested in usinga bus instead of a car to extend the bicycle portion of their trip . Potential targets for pockets of commuter cyclist and transit use include the downtown area and Frontier Mall.

Rack capacity could become an issue as the population of the Cheyenne Metropolitan Area increases over time. Bicycle presence on transit vehicles should be tracked informally and a formal analysis of rack capacity should be undertaken if transit operators frequently report that racks are full. Cheyenne should also consider installing additional bicycle parking (discussed earlier in this memorandum) to accommodate future demand.

One method of estimating future bicycle parking needs and bicycle use is by developing a "Bicycle Access Growth Factor", such as the one shown in Table 5. This analysis is a tool that can be used to prioritize installation of short- or long-term bicycle parking throughout the system based on potential demand. This analysis can be modified to use available local data, or can use readily-available US Census and American Community Survey Data.

Table 5. Bicycle Transit Access Growth Factor Analysis

Variable	Rating
Home-Based Ridership	▪ Points given to stop based upon home-based weekday passenger entries.
Ridership Rate	▪ Points given to stop based upon total weekday passenger entries.
Bicycle Mode Share in AM Peak	▪ Points given to stop based upon percent bicycle mode share during AM peak period.
Population within 1 Mile of Station	▪ Points given to stop based upon population within 1 mile of station.
Households with No Car within 1 Mile of Station	▪ Points given to stop based upon number of households with no car available within 1 mile of station.
Topography/Traffic/ Barrier Factor	▪ Points given to stop based upon factors affecting bicycle travel such as surrounding topography, traffic on roadways leading to stop, and impediments to bicycle travel including railroad tracks and freeway ramps.

Adapted from the San Francisco Bay Area Rapid Transit (BART) *Station Access Evaluation System, (2002)*

Stop Planning

Determining the appropriate type of bicycling infrastructure for each transit stop is critical to attracting and maintaining transit riders. Recommended provisions at transit stops, which will vary depending on the type and use of stops, include:

- Seating: either benches or seats attached to the bus stop post. Seating should be placed so that waiting passengers are visible to the bus driver.
- Shelter: can be a dedicated bus shelter or make use of surrounding building elements such as awnings to provide rain and wind protection. A shelter should provide adequate room for cyclists to maneuver and avoid potential conflicts with other transit users.
- Trip information: essential information that should be provided at every stop includes the route number and the stop number. It is preferable to also provide a route map and timetable. Real-time arrival information may be appropriate where there are frequent bus arrivals and multiple lines at a stop and if the required technology is in place.
- Bicycle parking: In general, minor and local stops can make do with bike racks. As the stop's importance increases, more secure options should be provided. For example, the transfer station at W 17th Street and Carey Avenue is an ideal location for secure long-term bicycle parking. Additional guidance on bicycle rack placement and location is discussed previously in this memorandum.
- End-of-trip facilities: major transit hubs and stops may offer end-of-trip facilities beyond parking such as showers, washrooms, clothing lockers, etc.
- Pedestrian-scale lighting to increase security and visibility for riders and transit operators.
- A trash container.

Cheyenne's transit stops generally provide trip information and occasionally seating and trash receptacles. Recently the City upgraded a number of bus shelters with funding provided by the American Recovery and Reinvestment Act. Amenities were upgraded at approximately 41 stops within the system service area. Typical improvements included improved shelters, seating and wind screening. Bicycle parking was not installed at this time but CTP indicated interest in future rack or locker installation.

The Transit Cooperative Research Program report, *Bicycle and Transit Integration*, recommends that bicycle parking receive priority siting near the bus loading zone. Parking should also be located so that cyclists do not need to carry bicycles through large crowds of travelers. The parking facility should be located in the clear view of the general public, vendors or transit staff. Security is a particular concern if bicycle parking is provided within a garage. In these cases, bicycle parking should be located in a central, frequently traveled part of the garage, ideally near an attendant. Most guidelines recommend against providing bicycle racks in unattended garages. Garages may also require treatments to manage conflicts between bicycles, automobiles and pedestrians at entrances and within the garage.

Bicycles on Transit

Carrying bicycles onto transit enables cyclists to avoid potentially difficult situations, including large hills, busy streets, long distances and inclement weather. It also reduces the fear of being stranded in the case of equipment failure. Various mechanisms for allowing bicycles on transit vehicles are described below as well as other considerations for facilitating bike-on-bus programs.

Front–Mounted Bike Racks

Most bike racks on buses hold two bicycles, although some transit agencies have been testing racks with capacity for three to five bicycles. When not in use, the bike rack typically folds up on the front of the bus. When cyclists want to use the rack, they pull it down and lift their bicycle onto the unit. Some buses are capable of kneeling, to help with mounting of the bicycle.

The two-bike front racks add six to nine inches of length to the bus (folded), requiring additional storage space in the bus yard. For certain size buses, racks can interfere with windshield wiper, headlight, and turn signal operations.

The capital costs of a bike-on-bus program include primarily the purchase and installation of the rack units. In 2005, these cost between $500 and $1,000 each (including installation) for two-bicycle racks. Purchasing bike racks on new buses reduces the labor cost of retrofitting. It is recommended that at a minimum a visual inspection of the rack is performed each day along with a 30-day general maintenance inspection, which consists of tightening bolts and checking for wear and tear. Maintenance of the bike racks costs about $50 to $100 per rack per year. They need to be replaced after six to seven years, often due to rust or colliding with other objects.

Rear-Mounted Bike Racks

Some transit agencies have experimented with rear-mounted racks, but these designs are problematic because of user safety concerns. They also block access to the engine and reduce driver visibility, as drivers cannot see the rack and monitor the safety and security of bicyclists as they load and unload their bicycles. Bicycles can also get dirtied by exhaust at the rear of the bus.

Bikes-in-Buses

Another option is to allow the cyclist to carry his or her bicycle onboard. In some jurisdictions, the driver can allow cyclists to bring their bicycle into the bus when the rack is full. However, this is often a cumbersome maneuver, requiring bicyclists to lift the bike up stairs and can be problematic during busy periods. Where bicycles are allowed in buses, bus drivers usually have authority to decide when to allow bicycles on the bus. In a few cases, where buses have additional space for luggage, bicycles are allowed to be stored in this compartment, often underneath the bus.

Education and Marketing

First-time and novice users are often concerned about how to load their bicycle on to the bus or train and have fears about the system being time-consuming or otherwise difficult to use. There are numerous examples where advertising, events, and targeted audience participation have successfully introduced users to their use. Information should be made available on CTP's and/or the City's website(s). Videos are an effective means of instruction.

Tri-Met, in Portland, Oregon, has a model bike rack which they bring to fairs and employment centers. Users can experiment with the system before having to depend on it. Similarly, in Chicago representatives of a mayor's bicycling education program have staged demonstrations of bike-on-bus racks at events for hands-on training.

Bicycle/Transit Interface

In addition to providing safe routes to get to transit, it is important to minimize potential conflicts between cyclists and transit vehicles as well as people waiting or boarding transit. Where bicycles and transit share lane space, buses frequently stop to pick up or drop off passengers. This can delay cyclists or require them to pass the transit vehicle.

Recommendations for improving bicyclists' safety around buses include:

- Designate dedicated space for bicyclists through use of bike lanes or greenways (although this introduces new conflicts between bicycles and pedestrians boarding the bus that can be addressed with proper design).
- Provide advance crossbars, a bike box, or a dedicated signal cycle to increase cyclists' visibility at intersections.

Bicycle/Transit Integration Recommendations

- The City and MPO should work with CTP to provide bicycle lockers near the Transfer Station and other locations where cyclists may desire long-term parking (e.g., Laramie County Community College).
- Consider partnering with CTP to obtain grant money for bicycle rack installation near transit stops that experience high use.
- Explore a partnership with CTP and other agencies or organizations (e.g., Laramie County Community College and Warren Air Force Base) that may have a high potential for transit use to promote the potential benefits of transit to cyclists (e.g., by taking transit to work and bicycling home).
- Continue to support CTP's bikes-on-bus policy.
- Work with CTP to develop questions about bicycle and bus integration that can be included on the 2012 passenger survey that will support the *CTP Transit Development Plan and Coordination Study* update. Include these questions on subsequent passenger surveys to track changes in user behavior and attitudes over time.
- Work with CTP to pursue expanded transit service that may be desirable to commuters and other choice users.