Memorandum

To: Jeff Wiggins and Sreyoshi Chakraborty

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

Date: February 1, 2011

Re: Working Paper #6: Cycle Zone Analysis Methodology

The purpose of this memorandum is to provide background and context for the Cycle Zone Analysis (CZA) process by:

- Describing the modeling purpose and proposed approach
- Listing existing data to be used in the model
- Providing instructions for the development of cycle zone boundaries
- Providing guidance for assignment of Bikeway Quality Index (BQI) scores to Cheyenne's existing on-street bikeways and greenways
- Proposing input factors and a weighting scheme to be used in CZA analysis

The CZA is a critical part of the *Cheyenne On-Street Bikeway and Greenway Plan Update* needs analysis, which will inform the development of the recommended bikeway network. City of Cheyenne and Cheyenne Metropolitan Planning Organization (MPO) staff will play a critical role in the development of data inputs used in this analysis, as described in the scope of work.

What is Cycle Zone Analysis?

Academic research has shown that density, land use mix, route connectivity and topography are the built environment factors that have the most significant impact on levels of transportation cycling. Cycle Zone Analysis is a spatial analysis methodology that considers the relationship between the built environment and cycling behavior to inform network planning decisions.

The process first requires division of the study area into geographically distinct cycle zones. Each cycle zone should consist of a more-or-less homogeneous cycling environment based on: employment and population density; land use mix; road network density and connectivity; and topography.

The cycle zones provide an organizing principle that allow for more nuanced discussion about cycling conditions in and around Cheyenne. Analysis of each zone offers a more fine-grained understanding of how cycling conditions differ across the study area and how investments can be tailored to respond to those different conditions. The following composite metrics can be extracted from a completed CZA:

- Existing Bicycle Network Conditions
- Overall Existing Conditions
- Cycling Potential

Proposed Approach

The CZA follows a standardized approach that includes the following steps:

- Developing cycle zone boundaries
- Assigning Bicycle Quality Index (BQI) scores to existing on-street bikeways and off-street facilities
- Computing zone scores for each input factor (e.g., bikeway network density)
- Combining zone scores for each input factor to create composite metric scores for each zone
- Analyzing preliminary outputs and developing opportunities and constraints analysis based on composite metric scores and individual factor scores

The remainder of the memorandum provides additional details for each CZA process step.

Development of Cycle Zone Boundaries

Cycle zone bondaries will be developed by City of Cheyenne and Cheyenne Metropolitan Planning Organization (MPO) staff with input and direction from Alta Planning + Design. The following instructions provide guidance for the development of zone boundaries.

Instructions for Zone Development:

Print out a copy of the attaced base map. Using a highlighter or marker, draw boundaries to form zones that have a relatively homogenous cycling environment from a cyclist's perspective. This exercise relies primarily on your professional judgment but should consider the following factors:

- Population density
- Employment density
- Land use mix and composition
- Topography (slope)
- Road network connectivity
- Road network density
- Bikeway quality and network density
- Barriers/obstacles (e.g., I-25 and Cheyenne Regional Airport)

A change in the size of city blocks, the beginning of a steep hill, and transitions between industrial, commercial, and residential areas are examples of changes in the cycling environment that could indicate a break between cycle zones. Try to use natural barriers as cycle zone boundaries, such as rivers or creeks, freeways, railroads, and arterial streets that are obstacles to bicycle movement from one cycle zone to another. It may be a useful exercise for individuals to draft their own cycle zone maps, and then gather to compare similarities and differences. Remember that the presence of bicycle facilities or the lack thereof can change, so whether an area has these facilities should not be the deciding factor in identifying cycle zone boundaries.

Cycle zones will vary in size according to conditions around the city. A cycle zone analysis of Portland, Oregon identified 32 different cycle zones. A city the size of Cheyenne may expect to identify about 15-30 cycle zones depending on the variation in cycling conditions across the study area.

After these zone boundaries have been agreed upon by staff, the results should be converted to a GIS shape file and submitted to Alta.

Bikeway Quality Analysis Development

The purpose of the Bikeway Quality Index (BQI) is to capture a snapshot of the current condition of existing on-street bikeways and greenways in relation to each other based on the local knowledge and evaluation criteria outlined below. This analysis will allow interested parties to assess and understand the quality of existing facilities, identify deficiencies in the existing network, and identify improvement opportunities. The factors identified below have been used previously in several communities in consideration of BQI score assignment. As described in the scope of work, City and Cheyenne MPO staff are responsible for the assignment of BQI scores for existing on-street bikeways and greenways.

Instructions for BQI Score Assignment

Please mark up the attached maps to indicate bikeway quality on Cheyenne's existing bikeways on a four-point scale (4 = best, 3 = good, 2 = average/moderate, 1 = needs significant improvement). Segments should be split when bikeway quality changes significantly.

Keep the following factors in mind while scoring, but personal experience will be the best measurement of a facility.

Shoulder bikeways (typical score = 1 - 2)

Factors to consider:

- Shoulder width
- Roadway speed
- Roadway volume
- Pavement conditions/sweeping

Signed bike Routes (typical score = 1 - 2)

Factors to consider:

- Roadway speed
- Roadway volume
- Pavement conditions
- Traffic calming
- Crossing treatments/difficult crossings
- Wayfinding/signs (how easy/intuitive is route to follow)
- Feeling of safety

Shared Use Pathways (typical score = 2 - 3)

Factors to consider:

- High pedestrian traffic
- Number of access points
- Proximity to destinations
- Number of constrained areas
- Difficult/frequent crossings
- Facility width
- Pavement condition

Bike lanes (typical score = 2 - 3)

Factors to consider:

- Adjacent parking
- Bike lane width
- Roadway speed
- Roadway volume
- Frequency of right turn movements
- Gutter pan/ presence of bicycle-friendly drainage grates

Greenway (typical score = 3 - 4)

Factors to consider:

- High pedestrian traffic
- Number of access points
- Proximity to destinations
- Number of constrained areas
- Difficult/frequent crossings
- Facility width
- Pavement condition

CZA Analysis Factors

The following factors are inputs to CZA; also included in this section are a definition of the factor, the data source and a description of the individual factor calculation methodology. Alta will use these factors to compute the cycle zone composite metrics.

Road Network Connectivity

Definition

A measure of network connectivity, this number ranging from zero to one represents the ratio of cul-de-sacs and three-way intersections to four- or more way intersections. The closer to one, the more grid-like the street pattern.

Reasoning

A zone with greater roadway connectivity will facilitate a better cycling experience by increasing route choice and potentially reducing out-of-direction travel.

Methodology

A Connected Node Ratio (CNR) will be calculated for each zone. This measure of network connectivity represents the ratio of four-or more way intersections to the total number of intersections within each zone. This measure produces a score ranging from zero to one, with a higher score representing a more grid-like street pattern (i.e. more connected network).

Data Source

Cheyenne Street Network and Cycle Zone Boundaries

Road Network Density

Definition

The density measured in linear feet per square acre of Cheyenne's existing roadways within each zone, excluding unpaved and limited access roadways.

Reasoning

A zone with a greater density of roads will facilitate a better cycling experience and increased route choice.

Methodology

GIS will be used to determine the overall length of roads falling within each zone, excluding unpaved or limited-access roads. This figure will be divided by each zone's total area in acres to obtain an average road network density.

Data Source

Cheyenne Street Network and Cycle Zone Boundaries

Topography

Definition

This factor assesses the proportion of the road network within each zone that has a slope considered suitable for cycling (e.g., less than five percent grade).

Reasoning

While some cyclists desire routes that are hilly for exercise and training purposes, many recreational cyclists and most utilitarian cyclists desire cycling routes that are flat.

Methodology

The roadway network is cut into segments of no more than 100 feet long. Using the elevation, the slope of each segment is calculated. The total length of the cut roadway segments is calculated, as is the total length of the cut roadway segments that have a slope of five percent. A percentage of road segments with a slope of less than five percent is calculated for the each zone as the topography score.

Data Source

Cheyenne Street Network, 10 Foot Contours and Cycle Zone Boundaries

Cycling Attraction/Generation

Definition

This factor combines the degree of concentration of cycling generating land uses in each zone with the residential and employment density in a zone.

Reasoning

Areas with a higher population and employment density have many potential cyclists and generally include many desirable destinations (e.g., greenway trailheads, schools and commercial destinations).

Methodology

The methodology involves calculating both the land use mix of cycling generating land uses and combined residential/employment density per acre in each zone. Employment and residential population density per acre are calculated based on 2010 Census data. Each zone is assigned a score of one to five based on the residential/employment quintile it is falls within.

Percent of land use mix is defined as percentage of each zone that classified as mixed-use, commercial, open space, parks, or other public/quasi-public land use. Each zone is assigned a score of one to five based on the land use quintile to which it is assigned. These factors are combined as shown in Table 1.

Table 1. Land Use Mix and Density Relationship

Land use Mix Quintile Score					
5 (Highest)	3	4	4	5	5
4	3	3	4	4	5
3	2	2	3	4	4
2	1	2	2	3	4
1 (Lowest)	1	1	2	3	3
Population/ Employment Density Quintile Score	1 (Lowest)				5 (Highest)

Data Source

Cheyenne Existing/Future Land Use and 2010 Census Data and Cycle Zone Boundaries

Permeability

Definition

This factor assesses the permeability or ease of passage from one zone to the next based on the number of roadway or greenway connections between zones.

Reasoning

While CZA primarily examines conditions within a zone, ease of passage between zones will affect the amount of cycling activity seen within each zone.

Methodology

This factor is developed by assessing the number of access points per mile of the perimeter of the zone. Only those access points that lead from one zone to another are included in this analysis.

Data Source
Cheyenne Existing and Funded On-Street Bikeway Network, Existing and Funded Greenway Network and Cycle Zone Boundaries

Bicycle Network Density (Existing and Funded Network)

Definition
The density measured as linear feet per square acre of on-street bikeways and greenways in each zone.

Reasoning
A zone with a greater density of on-street bikeways and greenways will facilitate a better cycling experience by providing better network connectivity and increased route choice.

Methodology
The linear feet of designated on-street bikeway and greenway facilities within each zone will be divided by the overall acreage of each zone to determine the linear feet of designated bikeway facilities per zone.

Data Source
Cheyenne Existing and Funded On-Street Bikeway Network, Existing and Funded Greenway Network and Cycle Zone Boundaries

Bicycle Network Connectivity (Existing and Funded Network)

Definition
This measurement, ranging from zero to one, describes the overall connectivity of the on-street bikeway and greenway network. The closer to one, the more grid-like the street pattern.

Reasoning
A zone with greater bikeway network connectivity will facilitate a better cycling experience by increasing the route choice and potentially reducing out-of-direction travel.

Methodology
A Connected Node Ratio (CNR) will be calculated for each zone. This measure of network connectivity represents the ratio of four-or more way intersections to the total number of intersections within each zone. This measure produces a score ranging from zero to one, with a higher score representing a more grid-like street pattern (i.e. more connected network).

Data Source
Cheyenne Existing and Funded On-Street Bikeway Network, Existing and Funded Greenway Network and Cycle Zone Boundaries

Bikeway Quality Index

Definition

Designated bicycle facilities do not always provide the same user experience. For example, a shared roadway feels different than cycling along a greenway that is completely separated from motor vehicle traffic.

Reasoning

Generally, a higher measure of bikeway quality is correlated with increased cycling activity.

Methodology

Using BQI scores assigned to on-street facilities and greenways as part of this project, the average score per mile of designated bikeway will be calculated for each zone.

Data Source

Cycle Zone Boundaries and BQI Segment Scores

Development of Composite Zone Scores

The individual factors that are part of CZA can be integrated in several ways to provide different information about existing and future cycling conditions. Table 2 shows the CZA factors and potential weight that each factor will contribute to the composite metrics. Prior to computation of the metrics shown in Table 2, scores for each factor are normalized to a scale of zero to one.

Table 2. Cycle Zone Composite Metrics and Weightings

Factor	Weight (%)		
	Cycling Potential	Existing Bicycle Network Conditions	Overall Existing Conditions
Road Network Connectivity	20		10
Road Network Density	20		10
Topography	20		10
Land Use	40		20
Permeability			10
Bicycle Network Density (existing)		35	14
Bicycle Network Connectivity (existing)		35	14
Bikeway Quality		30	12
TOTAL	100	100	100