RESEARCH

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DEVELOPING A RUBRIC AND BEST PRACTICES FOR CONDUCTING COUNTS OF NON-MOTORIZED TRANSPORTATION USERS

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Submitted By:

ACTIVE PLANNING

Authored By:

Shaunna K. Burbidge, PhD

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DISCLAIMER

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16. Abstract

Over the past five years non-motorized modes of transportation have become ever more prevalent on Utah's roadways. Historically, these modes have not been included in traffic counts nor are they accurately represented in the long range planning models used by UDOT and the MPOs. This exclusion creates an incomplete picture of both state and local transportation systems, making it difficult to evaluate facility usage. This research created a structured approach for conducting non-motorized user counts, including which methods are most appropriate for conducting bicycle and pedestrian counts across Utah's diverse urban and rural environments. First, existing methods and technologies for counting non-motorized transportation users were identified; Second, methods were evaluated based on their appropriateness and effectiveness in different environments/conditions, and for different purposes (e.g. recreation, transportation, transit access); Third, Radar Signal and Micro Radar technologies were tested locally to identify their feasibility for use in counting non-motorized system users. After evaluating all existing count methodologies and testing new potential methods, findings were summarized and compiled into a practical guidebook. The Utah Bicycle and Pedestrian Counts Guidebook systematically walks users through a counts process by outlining necessary steps for creating a counts program, preparing to conduct counts, selecting methods and technologies for any given site, collecting count data, and synthesizing the data in a meaningful way. Recommendations from this work promote local technical innovation including the creation of a statewide online repository and storage site for non-motorized count data, which would serve as a data clearinghouse for planning and analysis.

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LIST OF ACRONYMS

AADT	Average Annual Daily Traffic
ADT	Average Daily Traffic
ALR	Active Living Research
BYU	Brigham Young University
COG	Council of Governments
FHWA	Federal Highway Administration
IBPI	Initiative for Bicycle and Pedestrian Innovation
ILD	Inductive Loop Detector
MAG	Mountainland Association of Governments
MPO	Metropolitan Planning Organization
MUTCD	Manual on Uniform Traffic Control Devices
NBPDP	National Bicycle and Pedestrian Documentation Project
NCHRP	National Cooperative Highway Research Program
SCAG	Southern California Association of Governments
SLC	Salt Lake City
TAC	Technical Advisory Committee
TEM	Traffic Engineering Manual
TMG	Traffic Monitoring Guide
TRB	Transportation Research Board
UCATS	Utah Collaborative Active Transportation Study
UDOT	Utah Department of Transportation

EXECUTIVE SUMMARY

Over the past five years Utah has experienced a significant increase in both the use of bicycles and walking for transportation as well as demand for bicycle and pedestrian friendly infrastructure. Historically, these modes have not been included in traffic counts nor are they accurately represented in the long range planning models used by UDOT and the MPOs. This exclusion creates an incomplete picture of both state and local transportation systems, and limits the ability to comprehensively plan for and accommodate all roadway users.

This research sought to create a structured approach for conducting non-motorized user counts, including which methods are most appropriate for conducting bicycle and pedestrian counts across Utah's diverse urban and rural environments. First, existing methods and technologies for counting non-motorized transportation users were identified. They were then evaluated to determine their appropriateness and effectiveness in different environments and conditions, as well as usefulness for measuring different trip purposes (e.g. transit access). A comprehensive literature review was conducted covering published, peer reviewed research, as well as examining work that had been completed by agencies, large municipalities, or advocacy groups. Interviews were conducted with both local agencies who have experience conducting counts (Salt Lake City and MAG) as well as subject matter experts from around the country. Additional efforts included participating in national workshops and training webinars related to conducting non-motorized counts. Finally, validation data were collected at several local sites identified by the Technical Advisory Committee and additional sites under the scope of a separate BYU study. Both subject expert interviews and field work revealed that measuring non-motorized access to transit is incredibly difficult. An intercept survey is likely the only way to determine how users accessed the station. Even with an intercept survey, however, there could be a substantial margin of error due to imprecision in identifying a catchment area of access or what actually qualifies as a pedestrian.

Next, Radar Signal and Micro Radar technologies were tested locally to identify their feasibility for use in counting non-motorized system users. Using signal and micro radar to collect data on non-motorized users may be promising. The installation of the micro radar pucks

is not difficult or disproportionately expensive when compared to other counters. Micro radar requires a qualified and experienced UDOT Engineer who is familiar with calibrating the counter. This may dissuade some users. Also, locations may be limited as the technology requires close proximity to a UDOT fiber optic enabled traffic signal for ease of data access. Lastly, very limited manual validation counts showed that micro radar consistently recorded similar usage rates when compared to on the ground site observations.

After evaluating all existing count methodologies and testing new potential methods, findings were summarized and compiled into a practical implementation guidebook. The guidebook is intended to educate local jurisdictions, government agencies, UDOT Region staff, MPOs, advocacy groups, or even members of the public on how to plan, prepare for, and conduct counts of non-motorized system users. This comprehensive resource was created using the data gathered through the literature review, interviews, workshops/trainings and site testing conducted for this project. The creation of the Utah Bicycle and Pedestrian Counts Guidebook will allow diverse groups across the state to confidently prepare for and conduct counts using standard techniques that promote uniformity and ensure that data no longer goes to waste.

While the Utah Bicycle and Pedestrian Counts Guidebook can promote and streamline the collection and use of non-motorized user data, larger scale data evaluation and usage may prove difficult. The final recommendation of this work encourages UDOT to evaluate options for creating a central web-based repository where local jurisdictions, agencies, advocacy groups, or any other group can upload and share their non-motorized count data. This would also allow for data aggregation and would simplify long term larger scale planning by providing all available data in a central location.

By examining which tools and methods have been effective elsewhere and testing new methods locally, this research develops a standard process for conducting bicycle and pedestrian counts as well as guidelines for analyzing the resulting data to provide meaningful results for UDOT planners and other agencies throughout the state.

1.0 INTRODUCTION

1.1 Problem Statement

Over the past five years Utah has experienced a significant increase in both the use of bicycles and walking for transportation as well as demand for bicycle and pedestrian friendly infrastructure. Historically, these modes have not been included in traffic counts nor are they accurately represented in the long range planning models used by UDOT and the MPOs. This exclusion creates an incomplete picture of both state and local transportation systems. Without accurate counts it is difficult to measure facility usage, evaluate pre-post analysis of projects, conduct performance management, evaluate polices, conduct safety and crash analyses, or calculate exposure and risk for non-motorized modes.

It is necessary to count non-motorized travel because what gets counted, counts. Providing accurate data on non-motorized travel is becoming increasingly important in prioritizing infrastructure improvements when funds are constrained. To make effective transportation decisions, it is necessary to have a more dynamic understanding of volumes and travel behavior for non-motorized travelers. Limited resources and constraints on existing right-of way leave local jurisdictions fighting to provide affordable and efficient transportation modes, such as walking and biking. Counts can often provide leverage by documenting existing demand for infrastructure/program funding applications.

With an unlimited budget and unlimited resources communities and agencies would have the flexibility to conduct bicycle and pedestrian counts across the entire transportation network. This would provide accurate data regarding where bicycles and pedestrians currently operate and would provide valuable insight into where investments should be made and infrastructure improved. However, budget, time, and labor constraints limit the capacity of municipalities, counties, planning agencies, and others to conduct continuous and ongoing counts at all sites. This means that planners and public officials must make decisions based on limited data gathered from a sample of locations, selected using a “best guess” methodology. To date, it has not been clear which tools/methods would be most effective to gather this data given the incredibly diverse range of environments and conditions in the state. Nor has it been clear how to present the data in a way that would be both meaningful and useful.

The recent tidal wave of interest in bicycle and pedestrian planning and forecasting has led many local jurisdictions to begin collecting non-motorized count data at a variety of locations in an attempt to provide a representative view of non-motorized traffic patterns. While this is beneficial and can provide each agency with valuable data, it also has its drawbacks. Most agencies have limited experience in conducting counts and do not know which types of counts to conduct, where to conduct them, or how to go about using the data once they have it. Also, because jurisdictions are each using different methods for conducting counts, the opportunity for aggregating or comparing the data is lost, and regional agencies such as UDOT and the MPOs are left attempting to compare the data equivalent of apples and oranges.

1.2 Objectives

This research employs a mixed methods approach to identify industry best practices for conducting non-motorized user counts, including which methods are most appropriate for conducting bicycle and pedestrian counts across Utah's diverse urban and rural environments. This is done by:

1. Identifying existing methods and technologies for counting non-motorized transportation users

2. Identifying which methods would be effective in different environments/conditions, and for different purposes (e.g. recreation, transportation, transit access)

3. Testing new local methods for counting non-motorized users

4. Creating a user-friendly guidebook outlining how to conduct bicycle and pedestrian counts in Utah

By examining which tools and methods have been effective elsewhere and testing new methods locally, this research develops a standard process for conducting bicycle and pedestrian counts as well as guidelines for analyzing the resulting data to provide meaningful results for UDOT planners and other agencies throughout the state.

1.3 Scope

To understand existing methods for collecting bicycle and pedestrian travel data, several avenues were pursued. First, a comprehensive literature review was employed to summarize existing methodologies used by professional researchers, academics, and practitioners. This included sources such as journal articles and publications examining count methodologies (further described in Chapter 2). Second, interviews were conducted with local agencies who have experience conducting non-motorized counts. Third, the research team consulted with several national experts (both researchers and practitioners) who are not only experienced in existing methodologies but are also on the forefront of creating new methodologies for improving the accuracy of counts. All of this data was then summarized into a literature review and existing research summary. The findings from those preliminary efforts were used to directly guide the creation of the Utah Bicycle and Pedestrian Counts Guidebook, a document which outlines the process for creating a counts program and conducting non-motorized counts in any given geographic area.

1.4 Outline of Report

This research report is organized according to the following sections. Chapter 2 provides a brief literature review examining existing count tools, technologies, and methodologies and how they are used. Chapter 3 outlines the research methods employed in this work including all primary data collection and site investigations. Chapter 4 presents the data collected for this study and provides a summary of preliminary findings and outcomes. Chapter 5 describes how the data were used to create the Utah Bicycle and Pedestrian Counts Guidebook. Chapter 6 explains conclusions and recommendations for implementation based upon the data provided in the previous chapters.

2.0 LITERATURE REVIEW

2.1 Overview

This chapter provides a brief overview of the existing research literature regarding methods, tools, and technologies for conducting non-motorized counts in urban and rural areas. The first major component of this research entailed conducting a thorough literature review of existing methods, as well as reviewing all sources describing the efficacy and accuracy rates for different technologies.

2.2 Types of Non-Motorized Counts

Because cyclists and pedestrians tend to follow their own path and do not follow set channels like vehicles do, they are more difficult to count. However, along any given corridor there are two main ways to collect volume data for cyclists and pedestrians, screenline counts and intersection counts (FHWA, 2013):

- Screenline counts are conducted by establishing a line across a roadway, sidewalk or path/trail (visible or invisible) and then counting the number of pedestrians and cyclists who pass over the line. Screenline counts provide general use information for segments of a roadway/trail.

- Intersection counts are conducted at locations where two or more roadways cross or meet. Bicycle and pedestrian turns and through movements are counted by each intersection leg. These counts are typically conducted to identify safety or operational issues at peak conditions.

For each type of count there are two main methods for collecting data; manual counts and automated counts. There are pros and cons of both data collection methods. Manual counts require placing people in specified locations to observe and record the number of bicycles and pedestrians that pass by. Automated counts employ technology to mechanically count and calculate the number of bicycles and pedestrians that pass the monitored location. Automated counts are less labor intensive and can provide a longer time frame for volume data, while manual counts can provide more detailed information about users and their specific behaviors (FHWA, 2013).

The following section provides a basic overview of the variety of technologies available to conduct automated counts as well as a description of techniques to standardize and ensure consistency in manual counts.

2.3 Manual Counts

Manual counts rely on people to physically go to a specified site and manually count the number of target users who either pass a point (screen line count) or navigate an intersection (intersection count). They can also be used to count bicycle parking occupancy and transit boarding. Manual counts are the most familiar type of data collection for many agencies and jurisdictions (FHWA, 2013). Manual counts are best used for collecting short-term snap shot data for a given location or facility, generally collected during discrete time periods (Active Living Research, 2013).

While manual counts are much more labor intensive than automated counts and have a variety of limitations, most notably frequency and duration, there are many benefits to conducting manual counts. For example, a person conducting a manual count can identify a number of attributes that only the most technically advanced automated methods can detect such as: age of the pedestrian/cyclist, impairments or special needs of the travel (wheelchair, vision-impaired), bicyclists riding on sidewalks, bicyclists riding the wrong way on the street, bicyclist helmet use, etc.). Manual counts do, however, come with the added risk of ensuring that all data collectors are properly trained and are conducting counts the same way no matter the location. If there is variation in the way the data are collected the final counts may be difficult to compare and may be relatively impossible to aggregate (NCHRP, 2014b).

Another drawback of manual counts is the potential for human counting error. Relying on people to conduct the data collection means relying on their ability to process information and multi-task (NCHRPS, 2014b). Since observers are required to watch the roadway or intersection as well as record the presence of cyclists or pedestrians there will almost always be an undercounting of users, particularly in busy areas or in complex locations where the observer must focus on a variety of movements simultaneously (e.g. intersection turning movements). The best way to compensate for this drawback is to ensure that there are enough people at each location to provide adequate coverage and limit each individual's field of observation.

2.3.1 Tally Sheets-

Tally sheets are the least expensive option for gathering manual data. Generally volunteers are provided with a standard paper form on which they can record all pertinent observations. Tally sheets can be used for both on site counts and video observations. Using tally sheets can lead to errors, when observers are required to take their eyes off the study area to record their counts. This method is best used in areas with light non-motorized traffic or in cases where a small number of user attributes are being recorded.

2.3.2 Mechanical Counting Devices-

Mechanical counting devices can be used by observers to keep track of their counts. The most common type of mechanical counting device is a hand tally counter, which is available in both analog and digital models. These handheld counters reduce error by allowing observers to count users without taking their eyes off the study area (NCHRP, 2014a). Mechanical counting devices are most effective when used for screen line counts, as they cannot differentiate direction or maneuvers (e.g. turns). Observers press the clicker each time a user travels past. Direction can be specified by using two counters (one in each hand). Data from the clickers can then be recorded at predetermined time intervals on a tally sheet.

2.3.3 Electronic Counting Device-

Electronic counting devices come in two primary forms, electronic counting boards and tablet/smart phone apps. Electronic counting boards can be used for either screen line counts or intersection counts. The counting board creates a timestamp and data point for each observation (by pushing the appropriate button) and can tally the data automatically. Tablet and smart phone apps have become more widespread and user friendly in recent years with a number of options on the market. These applications can also be used for either screen line counts or intersection counts. Similar to tally sheets, tablet or smart phone applications require observers to take their eyes off the study area to record counts. However, these technologies offer a strong advantage in their ability to process data and provide advanced analysis and graphical representation outputs (NCHRP, 2014a).

2.3.4 Video Observations-

Video observations rely on automated technology to collect the data, but require manual labor to process the counts. These counts are performed almost exactly the same as an on-site count, however, they have the added benefit of allowing observers to pause, stop, or replay footage to increase accuracy. Having a hard copy of the travel as it occurred in the study area also provides the opportunity to have multiple volunteers observe the same area for quality control and the potential to take a second look or double check data. Video recordings of a study area can also produce longer observation windows, as volunteers are not required to stay at a site and record observations in real time. The drawbacks are that video observations can be expensive, and they require cameras in specific locations to collect the data (which can be limited). Cameras are prone to theft and vandalism and can also malfunction (NCHRP, 2014b). Also, each hour of video footage will typically require about three hours of data processing. Several companies do provide an option to have video observations automatically counted. The user purchases the camera and a portable data collector that records the footage. Data is then uploaded through the internet and an automated count program provides accurate counts within a few days. Users pay per hour of analysis.

A recent analysis of non-motorized count methods conducted under the National Cooperative Highway Research Program (NCHRP) found that manual count data is most useful when combined with automated counts (NCHRP, 2014b). The automated counters can provide more accurate hard data for the number of users on a given facility while manual count data can provide more breadth of information such as user types and characteristics.

2.4 Automated Counts

Automated counters involve using a device to collect data in a set location. Information can either be gathered and stored on site or can be transmitted to a remote location (e.g. uploaded to a server). There are automatic counters capable of performing both screen line and intersection movement counts. Automated counters are typically used for collecting continuous data over longer periods of time (Pedestrian and Bicycle Information Center, 2016).

2.4.1 Pneumatic Tubes-

Pneumatic tubes are used for counting vehicles or bicycles and consist of two rubber tubes stretched across a roadway or other right-of-way. When a bicycle or other vehicle passes over the tubes, pulses of air pass through a detector which infers the vehicles axel spacing, thus classifying the vehicle type. Pneumatic tubes have been used for traffic counts (automobiles) for quite some time and are thus familiar to most jurisdictions. They are portable and easy to set-up and can capture directionality, but are also susceptible to theft, vandalism and wear and tear (NCHRP, 2014b). They do not capture pedestrian traffic and may even pose a tripping hazard to pedestrians.

2.4.2 Inductive Loop Detectors-

Inductive loop detectors (ILDs) are used to count bicycles. They can be placed on top of the roadway or paved trail surface (temporary counts) or can be embedded in the pavement (permanent counts). The devices detect bicycles through a disruption of an electromagnetic field (NCHRP, 2014a). Inductive loop detectors have the flexibility to be used for temporary or permanent counts, and they can distinguish bicycles from automobiles and other vehicles. They cannot be installed near sites of high electromagnetic interference, such as broadcast stations for radio and television, downtown areas, and even Bluetooth devices such as baby monitors, cell phones, or wireless headphones. (NBPD, 2016). ILDs require a nearby power source and must be calibrated to detect bicycles. Additionally, ILDs may fail to count bikes with non-metal frames such as many high-end road bikes that are typically made of carbon fiber (NCHRP, 2014a).

2.4.3 Piezoelectric Strips-

Peizoelectric strips (P-strips) are embedded across a paved right-of-way. The strips emit an electric signal when they are physically deformed by tires. P-strips provide speed data and directionality and can be battery-powered or externally-powered. This technology cannot distinguish bicycles in mixed flow traffic or bikes riding adjacent to vehicles traffic, and it cannot detect pedestrians (NCHRP, 2014a). The detectors also require careful skilled installation (NCHRP, 2014b).

2.4.4 Pressure or Acoustic Pads-

Pressure pads work by detecting weight when they come into contact with a pedestrian or cyclist. Acoustic pads detect the sound waves from the footsteps of pedestrians only. These pads work very well for detecting pedestrians on unpaved trails (NCHRP, 2014b). They are low profile and are not susceptible to tampering or vandalism, but bicycles and pedestrians must come in direct contact with the pads to be detected. They are susceptible to detection problems when the ground freezes and they do not distinguish between pedestrians and cyclists (NCHRP, 2014a). They are very expensive to install under paved paths and are not easily moved. They are best installed in areas where pedestrians and bicyclists must travel single file and will not linger (NCHRP, 2014b).

2.4.5 Active Infrared-

Active infrared detectors detect both pedestrians and bicyclists. A device is installed on one side of a count corridor and transmits a pulsed infrared beam to a receiver on the other side of the right-of-way. Pedestrians and cyclists are detected by breaking the beam. An internal algorithm distinguishes between bicycles and pedestrians (but not other users such as skateboarders, or people riding scooters). These devices are incredibly portable and relatively low cost. However, they cannot be used in mixed-vehicle locations and can be triggered by other objects such as falling leaves, snow, or animals. They also may not accurately count groups of individuals traveling side-by-side (NCHRP, 2014b).

2.4.6 Passive Infrared-

Also known as pyroelectric, passive infrared utilizes a device positioned on one side of a count corridor. It can be disguised inside a post or existing infrastructure. Passive infrared works by identifying a heat differential of bicyclists and pedestrians when they pass through the detection area. These devices are mobile and easy to install. They can be used with a bicycle-only count technology to differentiate users (they do not differentiate user types on their own). They also do not detect directionality unless two sensors are used (NCHRP, 2014b).

2.4.7 Laser Scanning-

In this method a laser scanner is installed at the side of or above the detection area, and can be used to detect both bicycles and pedestrians. Laser pulses are sent out in a range of directions, and pedestrians and bicyclists are recorded based on reflected pulses. While lasers can cover a large detection area and can be used in mixed-traffic areas, they do not function well in rain, fog, or snow and can be triggered by other objects such as leaves, snow, or animals. These units are expensive and may not capture side-by-side walking or biking (SCAG, 2012).

2.4.8 Radio Waves-

Radio waves can detect both bicycles and pedestrians by installing a radio transmitter and receiver on opposite sides of a count corridor. Detection occurs when the radio signal between the source and the receiver is broken. Dual beams with different frequencies can be used to differentiate between pedestrians and cyclists. These systems are mobile and easy to install, but may have difficulty in accurately counting groups or side-by-side pedestrians (NCHRP, 2014b).

2.4.9 Video Image Processing-

Video imaging has been found to be very flexible. Video recorders are mounted above a count area to record movements, coupled with a software program that processes the video to produce counts (NCHRP, 2014a). The software uses visual pattern recognition technology and computerized algorithms to detect pedestrians, cyclists, and vehicles. Video processing can count non-motorized users in mixed-traffic conditions and can provide full intersection turning movement counts as well as screening counts. These units are portable and easy to install, but are much more expensive to purchase and process data than other devices (SCAG, 2012). They are not practical for long-term counts. Lighting and weather can affect accuracy. The video feed must be manually submitted for processing.

2.4.10 Magnetometers-

Magnetometers are small devices that can be buried under or next to a trail to detect bicycles. They detect bicycles through changes in the normal magnetic field. They are invisible after installation and therefore are not susceptible to tampering. However they have a relatively small detection radius of only 3 feet (SCAG, 2012).

2.4.11 Bicycle Barometer-

While not a count method in and of itself, a bicycle barometer can be combined with a number of different count technologies to display counts at a particular location. The barometer is linked to a counter (such as an inductive loop or pneumatic tubes) and simply displays the number of bicycles passing that location each day. These can increase awareness of bicyclists and may be appropriate for high volume corridors or high visibility areas such as downtown areas or college campuses (North Central Texas Council of Governments, 2013).

2.5 Efficacy of Count Methods

In 2014, NCHRP set out to identify accuracy rates for a number of common non-motorized count technologies. Table 1 below shows each automated count technology along with its specifications for use and accuracy rates.

Table 1. Summary of Automated Count Technologies

Counter Type	Detection		Typical Location	Accuracy*
	Peds	Bikes		
Pneumatic Tubes		X	On-road bikeways Exclusive bike paths	96%
Inductive Loops		X	On-road bikeways Mixed-use paths	>95% on-road 90-95% off-road
Piezoelectric Strips		X	Paved locations with no vehicular traffic (e.g. bicycle and multi-use paths	90%
Pressure Pads	X	X	Unpaved trails Unpaved Walkways Public stairways	*Data not available***
Acoustic Pads		X	Unpaved trails Unpaved walkways Public stairways	*Data not available***
Active Infrared	X	X	Off-street paved or unpaved paths	90%
Passive Infrared	X	X	Sidewalks Off-street paved or unpaved paths	>97%
Laser Scanning	X	X	Large detection areas Transit station/plaza	*Data not available***
Radio Waves	X	X	Off-street trails On-street detection for bikes and vehicles	80% bicycles 60% pedestrians
Video Image	X	X	Roadway intersections and corridors	*Data not available***
Magnetometers		X	Mountain bike trails Off-street trails (no more than 6' wide)	*Data not available***

*Accuracy determined through extensive statistical analysis and validation (NCHRP, 2014b)
**Statistical testing was unable to identify a valid accuracy rating

Despite a thorough evaluation process, testing of some of the less popular count methodologies were unable to provide valid accuracy ratings. This is often due to a very wide range of accuracy differentiation between different brands of the same technology (i.e. Brand A may have been 90% accurate, while Brand B was only 65% accurate). To avoid the appearance of prejudice against specific companies, the authors of the NCHRP report avoided specifying accuracy rates by brand (NCHRP, 2014b).

2.6 Summary

There are two methods available to conduct both screenline and intersection counts of non-motorized users; manual and automated. There are pros and cons to both methods. Automated counts are less labor intensive and can provide a longer time frame for volume data, but manual counts can provide more detailed information about users and their specific behaviors. There are a large number of options available for conducting automated counts of non-motorized system users and they vary in terms of detection, location, and accuracy rates.

3.0 DATA COLLECTION

3.1 Overview

This chapter provides a discussion of the data analyzed in this report. It also presents an overview and description for the sources used in the analysis. This includes a detailed description of all interviews conducted and all on-site data collection.

3.2 Literature Review

As outlined in the initial scope and objectives, this research sought to identify existing technologies and methods for conducting non-motorized user counts. Therefore, a major component of this effort was a thorough and comprehensive literature review. While a summary of those findings was provided in Chapter 2 of this report, the complete details of that literature review were used to develop the Utah Bicycle and Pedestrian Counts Guidebook, as well as the final recommendations of this report. In total over 30 unique existing data sources were studied as a part of the literature review. These included published peer reviewed published papers, and a summary of recent efforts by agencies, jurisdictions, and advocacy groups. Some of these sources were synthesis papers and were expectedly redundant. Since a majority of the information in each source came from the same group of primary sources, only the primary sources are identified in the references section of this report.

3.3 Local Jurisdiction Interviews

As a part of this process, significant effort was made to contact local jurisdictions with experience conducting counts for non-motorized modes. Additionally, national experts were consulted regarding best practices in the field, preferred technologies, and lessons learned from past experience. Below is a list of individuals who were consulted, as well as a brief summary of the key points gleaned from each communication.

3.3.1 Mountainland Association of Governments

The Mountainland Association of Governments (MAG) began conducting non-motorized counts at intersections, but now primarily conducts counts on trails. They count both pedestrians and cyclists, but in different locations. While cyclists are counted on trails and along roadways, pedestrians are only counted on multi-use trails because MAG lacks the technology to count pedestrians on roadways. MAG primarily uses pneumatic tube and infrared counters (Eco-Counter brand) that provide data aggregated by the hour, but not differentiated by mode. They currently have 16 counters.

Jim Price, MAG's lead Bicycle and Pedestrian Planner, has reported that the data from their counters is very user friendly and that the counters they have used to date are self-contained and work well. The data is retrieved once per month (via Blue-tooth to laptop). To expand on the level of detail provided in the data, Jim recommends pairing automatic counts with intercept surveys to provide a bigger picture of what is happening on the ground. This can provide a breakdown of purpose, age group, gender, and other user attributes.

MAG has had great success using their count data to inform policy and planning, and the counts they have acquired to date are providing political backing for projects. For example, in 2014 there were over 2.2 million bike-ped trips in Utah County. Their count data is currently being coupled with the Utah Collaborative Active Transportation Study latent demand model to provide anticipated usage in a planned location. For example, because the Murdock canal trail has a specific usage rate, they can now estimate usage of a similar facility in a different location.

3.3.2 Salt Lake City

Salt Lake City began using the National Bicycle and Pedestrian Documentation Project (NBPDP) methodology to count bicycles in 2010 (NBPDP, 2016). They do not count pedestrians, but rather focus specifically on cyclists using a volunteer-based manual count method. Counts are conducted each September for two-hour windows on Tuesday, Wednesday, Thursday, Saturday and Sunday at the same base 16 locations around the city. This has allowed them to rudimentarily monitor trends and see the impact of constructing new non-motorized transportation facilities.

In a personal interview Becka Roolf, Salt Lake City's Bicycle and Pedestrian Coordinator, mentioned that the city has recently purchased some pneumatic tube counters for on-road facilities and has begun using them to acquire longer-term full week counts. However, the tube counters cannot be used in the winter due to temperature and interference with snow removal. The city plans to install additional permanent counters to better understand seasonal usage on specific facilities (Roolf, 2015).

For planning purposes, Salt Lake City uses a Google map-based interface to gather input from several agencies. This allows them to identify study areas based on existing and proposed bike facilities. When new construction is planned, the city conducts a one week count at the location prior to infrastructure improvements and then again one year after installation to identify usage changes.

Becka also commented that a "volunteer-based manual count can be helpful to show long-term trends and build a constituency for bicycling, but it requires additional resources such as coordinating and training the volunteers which can be difficult and tedious" (Roolf, 2015). Also, because Salt Lake City only counts for one week per year, their data is subject to skewing based on weather, special events, and other factors. Becka recommends using a rolling 3-year average rather than relying on data from any single year when making projections or assumptions about ridership.

3.4 Subject Expert Interviews

Historically, many agencies and municipalities have attempted to utilize motorized traffic monitoring methods to count or measure non-motorized traffic. However, there are major differences between counting motorized and non-motorized traffic. To address these differences the most recent edition of the Federal Highway Administration's (FHWA) Traffic Monitoring Guide (TMG) has incorporated an entire chapter on "Non-Motorized Traffic" (FHWA, 2013).

Several researchers have also devoted considerable time and effort to improving non-motorized counts by both improving technologies and methodologies.

3.4.1 Portland State University Bicycle and Pedestrian Data Center

The Initiative for Bicycle and Pedestrian Innovation (IBPI), housed at Portland State University, has spent the past several years working with researchers on a national scale to improve count accuracy and validity for non-motorized modes. Their efforts have led to many ground breaking recommendations for conducting counts at a variety of scales. For example, Krista Norbeck, the director of IBPI, recommends segment or corridor counts over intersection counts. Intersections are very difficult because of all the variables that must be included and considered (Norbeck, 2015).

The Portland State University Bicycle and Pedestrian Data Center has reported that as of Fall 2015 they are working on creating an archive to house bike-ped count data from around the country (IBPI, 2014; Norbeck, 2015). They are focusing their efforts on automated counts, but there will be a way to upload manual counts (without a nice user interface). Additionally, the IBPI is working with the State of Washington to improve their statewide count program, which has been in place for about five years.

3.4.2 Methods for Conducting Transit Access Counts

Prior to conducting transit station counts (discussed below), the research team completed an exhaustive search for appropriate methods for accurately assessing non-motorized access to transit facilities. While no existing tools were found, additional effort was made to contact researchers and practitioners who specialize in transit access data. The research team conducted interviews with the following individuals in an attempt to identify appropriate methods for assessing bike-ped access to transit:

- Krista Nordbeck
- Eric Olsen, Transportation Planner, Blacksburg Transit (VA)
- Dr. Stephen Hankey, Assistant Professor, Virginia Tech University
- Jonathan Whitehurst, Kimley-Horn Associates

Ultimately, all of these individuals agreed that to date there is no passive method for accurately identifying non-motorized access to transit exists. In other words there is no way to accurately and effectively measure access in a way that does not involve directly asking passengers with some type of intercept survey. The closest method we could identify was used by Kimley-Horn in Blacksburg, VA and involved having bus drivers radio in to dispatch each time a bike was loaded on the vehicle at a stop. While this did provide location and stop specific data for bike access, it had several drawbacks, including flooding the radio with call-ins and requiring dispatch to keep a tally. This led to a very limited number of routes being measured (3 total) for only two separate days.

In an attempt to evaluate the difficulty of conducting transit access counts on site, our team spent three hours on two separate days (see Table 4) at both the Gardner Village and Salt Lake Central TRAX stations in an effort to determine any way to work around the limitations identified by the interviews described above. A discussion of outcomes from that fieldwork is outlined in Section 4.2.

3.5 Pedestrian Data Collection Workshop

In conjunction with the 2015 Annual Meeting of the Transportation Research Board, a pedestrian data collection workshop was convened by the Federal Highway Administration. The purpose of this workshop was to discuss the state of the practice regarding non-motorized data collection, including existing methods, guidelines, and programs. The research team attended this workshop to gather applicable data for inclusion in the Utah Bicycle and Pedestrian Counts Guidebook. Several initiatives were described including the Safer People, Safer Streets, program which will focus FHWA's efforts on improving infrastructure, identifying data needs, and acquiring intervention data nationwide.

Dan Goodman reported that FHWA is also working to create national bike-ped guidelines based off of the data currently being collected through assessments in each state, and that several new tools are available to assist in pedestrian planning. Examples include the Road Diet Guide, and the FHWA Non-Motorized Toolkit (Transportation Research Board, 2015). Krista Norbeck

(Portland State University) and Jeremy Raw (FHWA) outlined the new FHWA Traffic Monitoring Guide's inclusion of guidance for Non-Motorized Modes and encouraged analysis of existing data by highlighting the existence of multiple private databases, including Datanet, Ecovision, and Waycount.

The final portion of the workshop briefly summarized efforts performed under NCHRP Report #797 which would focus on count methodologies for bicycles and pedestrians (described in detail in the following section). At the time of the workshop the report was still forthcoming.

3.6 Non-Motorized Counts Methods Webinar

With the release of the NCHRP report on non-motorized count methods and technologies, the Transportation Research Board hosted a webinar to describe the contents of the report and guidebook, and provided the opportunity to ask questions of the project team responsible for its creation. The webinar was held on January 29, 2015, and was two hours long. Presenters included Paul Ryus (Kittleson and Associates, Inc.), Robert Schneider (University of Wisconsin-Milwaukee), Tony Hull (Toole Design Group), and Frank Proulx (UC Berkeley).

Report #797 evaluated six automated count technologies that capture pedestrian and bicycle volume data. The webinar provided a summary of the technologies and sites tested, evaluation criteria, research findings, and conclusions. Additionally, the findings included in NCHRP #797 provide correction values for calibrating each counter type based on a comparative analysis between manual and automatic counts during the same time period at their test sites. The intent of the research was to inform practitioners about the range of available non-motorized counting technologies and methods that may be useful in establishing non-motorized count programs that can serve as a comprehensive, long-term source of data on pedestrian and bicycle travel patterns within their community.

Along with the NCHRP report the authors provided a secondary research summary (web-only document #205) which outlined the methods they used to create and test each technology and come to the final conclusions. The information from that secondary methodological document was instrumental in the analysis conducted for this research (NCHRP, 2014b).

3.7 Local Test Sites

In addition to relying on the data presented through the national sources described above, seven local sites were selected by the TAC to represent a cross-section of appropriate Utah count locations. Effort was made to identify sites with existing count technologies already in place due to the limited budget and lack of funding to procure new equipment for conducting counts. Table 2 shows the locations that were initially selected, the technology or methodology that was employed, and the count time frame for both the automated counts and the manual verification counts.

Table 2. Test Sites for Automated Counts with Manual Validation

Site Location	Technology	Count Time Frame
Redwood Road-Porter Rockwell Blvd	Radar Manual Counts	-Ongoing -June 30, 2015
Murdock Canal Trail	Passive Infrared (Pyrobox) Manual Counts	-Ongoing -June 30, 2015
Big Cottonwood Canyon @ Wasatch	CCTV Radar	*Not operative* -Ongoing
UTA Stations	Video observations Manual Counts	*Methodologically prohibitive* *(see Ch-4)*
Weber River Trail (31st Street)	Radar Pucks Manual Counts	-Ongoing -July 2, 2015
Adams Canyon Trailhead	Radar Pucks Manual Counts	-Ongoing -July 2, 2015
Gardner Village TRAX Station	Manual Counts	-August 20 & 22, 2015
Salt Lake Central TRAX Station	Manual Counts	-August 27 & 29, 2015

In addition to the count locations originally identified through this project, a second UDOT research project (running concurrently and conducted by Brigham Young University (BYU)) sought to collect bicycle volume count data for evaluation. The count data from that project was integrated for further evaluation and calibration of the specific methods employed. The schedule and methods used by the BYU research team are outlined in Table 3 below.

Table 3. BYU Bicycle Count Locations and Technologies Employed

City	Location	Technology	Count Time Frame
Ogden	Grant Ave-2250 South	Manual	June 22
Ogden	Grant Ave-2125 South	Pneumatic Tube	June 22
Syracuse	1518 West 1700 South	Pneumatic Tube	June 23
Salt Lake City	550 South Main St.	Manual	June 23
Salt Lake City	750 South 500 East	Manual	June 29
Salt Lake City	1412 South 500 East	Manual	June 18
Salt Lake City	550 South 600 East	Manual	July 1
Salt Lake City	1400 South 600 East	Manual	June 30
Salt Lake City	550 South 700 East (SR71)	Manual	July 2
Salt Lake City	850 South 700 East (SR71)	Pneumatic Tube	July 2
Sandy	9662 South 700 East (SR71)	Manual	July 28
South Jordan	1450 West 10600 South	Pneumatic Tube	July 1
South Jordan	11400 S. River Front Pkwy	Pneumatic Tube	June 30
Orem	480 West 800 North	Pneumatic Tube	June 18
Orem	60 East 800 North	Pneumatic Tube	June 18
Orem	482 West 800 South	Pneumatic Tube	June 19
Orem	250 North Orem Blvd.	Pneumatic Tube	June 29
Provo	Marrcrest E. University Ave.	Pneumatic Tube	June 17
Provo	Provo River Trail 1720 North	Pneumatic Tube	June 17
Provo	400 West 800 West	Pneumatic Tube	June 15
Provo	260 East 800 North	Pneumatic Tube	June 16
Provo	450 South Freedom Blvd	Pneumatic Tube	July 9
Provo	650 North Freedom Blvd	Manual	July 9
Provo	450 North 200 East	Manual	June 16
Provo	350 East Center Street	Pneumatic Tube	June 18
Springville	300 East Center Street	Manual	June 17
St. George	320 North Diagonal Street	Pneumatic Tube	June 25
St. George	150 South 700 East	Manual	June 26
St. George	350 South 400 East	Manual	June 25
St. George	640 East 300 South	Pneumatic Tube	June 26

The research team worked with UDOT Traffic Operation Engineers to identify the complexity involved in installing and calibrating signal radar and micro radar for detecting and counting non-motorized users in a diversity of settings. Because radar has not been widely used for non-motorized detection it was not evaluated in any of the literature review sources. However, UDOT Engineers reported having success in using it for bicycle detection. It should be noted that prior to this research UDOT's primary reason for detecting bicycles in dedicated bike lanes using existing signal radar was to trigger a signal change rather than to count them. Additionally, micro radar had not been employed in Utah prior to this research.

3.8 Summary

The primary goal of this research was to synthesize and leverage existing efforts for conducting non-motorized counts. A comprehensive literature review was conducted covering published, peer reviewed research, as well as examining work that had been completed by agencies or advocacy groups. Second, interviews were conducted with both local agencies who have experience conducting counts (Salt Lake City and MAG) as well as subject matter experts from around the country. Additional efforts included participating in national workshops and training webinars related to conducting non-motorized counts, as well as validating data collected at several local sites identified by the Technical Advisory Committee and additional sites under the scope of a separate study conducted for UDOT by BYU. Finally, the research team worked with UDOT to install and calibrate new micro radar technology to assess its usefulness as a method for conducting non-motorized counts.

4.0 DATA ANALYSIS AND EVALUATION

4.1 Overview

This chapter summarizes three major evaluation efforts. First, based upon the limited information available for acquiring non-motorized transit access counts, field work was conducted to determine if any locally feasible methods could be identified for collecting that specific data. Second, because two of the automated count methods included in the Utah Bicycle and Pedestrian Counts Guidebook were not evaluated in the sources covered by the extensive literature review (signal radar and micro radar), additional local data was collected at predetermined test sites to determine the ease of installation and to calculate, on a limited scale, the expected accuracy rates for those methods. Third, additional manual counts were conducted in locations where permanent automated counters have been in place to ground verify the accuracy rates and validity of those count methods and technologies.

4.2 Measuring Non-Motorized Transit Access

Identifying non-motorized access to transit was one of the most difficult components of this project. As described in Section 3.4.2, a great deal of time and effort was spent examining potential methods for collecting accurate data on non-motorized access to transit. The literature review and subsequent interviews found no consensus (or even loose agreement) on a way to collect accurate data in a streamlined way. Very few methods have been tested, and the ones that have been tested have proven to be very labor intensive and not particularly effective.

The field work conducted for this study identified several major barriers to collecting accurate valid access data. The first major drawback faced when attempting to count non-motorized access to transit, particularly rail transit, is the definition of a catchment area and the determination of who is a pedestrian or cyclist. Cyclist access is typically easier to identify due to the presence of a vehicle (bicycle), however this is not always the case. Site observations found that many users likely rode a bike to a location near the station, parked or stored the bike there, and then proceeded to the station on foot as a pedestrian. This was assumed due to the presence of multiple locked bicycles along the corridors leading to but not at the station itself. This scenario would count the user as a pedestrian accessing that train. If riders bring their bicycle with them onto the train then a cyclist can be specifically identified within the count.

Identifying pedestrians became even more difficult. In all cases, TRAX riders must exit their access vehicle, whatever that may be (car, bike, bus), and access the station or platform either on foot or with a mobility assistance device. Therefore, it becomes nearly impossible to specifically classify a user as a pedestrian. Multiple scenarios immediately call into question who exactly counts as a pedestrian. For example, is a TRAX rider a pedestrian if they walked two blocks from their car's parking space location to the rail station, or are they only to be classified as a pedestrian if they walked from their primary origin? When conducting a count at the Trax station it is impossible to make those distinctions. There are too many confounding factors that impact the observer's determination of whether or not a user is a pedestrian or cyclists. Therefore, without using an intercept survey where users are directly asked how they accessed the station there would be no way to definitively say within an acceptable margin of error.

4.3 Evaluation of Radar Count Methods

In order to evaluate the effectiveness of utilizing radar technology for counting non-motorized travelers, this project included installing and calibrating new micro radar technology at two test sites and programming existing radar-equipped traffic signals to recognize bicycle traffic in designated lanes.

4.3.1 Installation and Calibration of Micro Radar

The research team participated with UDOT engineers and a local contractor to install radar pucks on the Weber River Trail and at the Adam's Canyon Trailhead on May 21, 2015. A "puck" was installed in the pavement on the Weber River Trail (adjacent to 31st Street in Ogden) by boring into the asphalt, positioning the puck, and covering it with a layer of quick drying epoxy (see Figure 1). Installation took less than 30 minutes.

Figure 1. Micro Radar Installation on Weber River Trail

Figure 2. Micro Radar Puck Installed on Weber River Trail

The puck has a self- contained 10-year battery that ensures little need for maintenance of the hardware once installed, and the near invisible profile of the puck after installation ensures a low probability of vandalism or tampering. As non-motorized trail users pass by the micro radar puck, a signal is recorded and relayed to the radar-enabled traffic signal at the I-15 northbound exit on 31st Street (UDOT Signal #5181). The signal box is connected by fiber optics to the UDOT Traffic Operations Center mainframe and allows for real-time monitoring of the micro radar.

Installation at the Adams Canyon Trailhead (located East of Highway 89 in Layton) was more complex due to its location further from a radar traffic signal and the conditions of the site. Because the trail is a dirt path and not a paved surface the radar puck could not be installed in the trail surface. Brainstorming by UDOT engineer Mark Taylor and the installation contractor (Michael Wright, PineTop Engineering) led to the creation of an elevated housing for the puck (see Figure 3). A PVC pipe was buried to the side of the trailhead's main access (ideally located at a pinch point for maximum coverage). The puck was positioned in the top of the pipe and was covered with a layer of quick drying epoxy. Because the trailhead was located further from the adjacent radar enabled signal (intersection of Oak Hills Drive and Highway 89, UDOT Signal #5136), a signal repeater was necessary. UDOT contacted Layton City to secure permission to install the small post and signal box (shown in Figure 4) to provide the necessary sight line from the traffic signal to the micro radar puck.

Figure 3. Micro Radar Puck Installed at Adams Canyon Trailhead (Layton, UT)

Because of the unique site conditions and the need to install a signal repeater, the installation took slightly longer, but was completed within three hours.

While the installation of the radar pucks went relatively smoothly, it took additional effort and finesse to position and calibrate the puck technology to effectively

Figure 4. Signal Repeater

capture trail users and process the data. After some trial and error the site team was able to ensure the data effectively transmitted from the radar puck to the signal. It is of note, however that this installation process required the expertise of UDOT engineers who were familiar with the technology and who were knowledgeable regarding how to position and calibrate the equipment to effectively process the data. This is one major difference between the micro radar technology and many of the other automated counters on the market that are more likely to contain “plug and play” technology that is simpler for inexperienced users.

4.3.2 Programming Radar Signals to Detect Bicycles

The Waveronix matrix radar that UDOT currently employs is installed at the top of a traffic signal and can detect cars and bicycles without having to configure the sensor differently for each mode. It detects both vehicle types automatically. To program a signal to specifically detect traffic in a bicycle lane, the technician setting up the radar draws in the lanes, and identifies virtual detection zones within the lanes. If a car or bike is within the green zone (shown as lane “4N” in Figure 5) they will activate the traffic light.

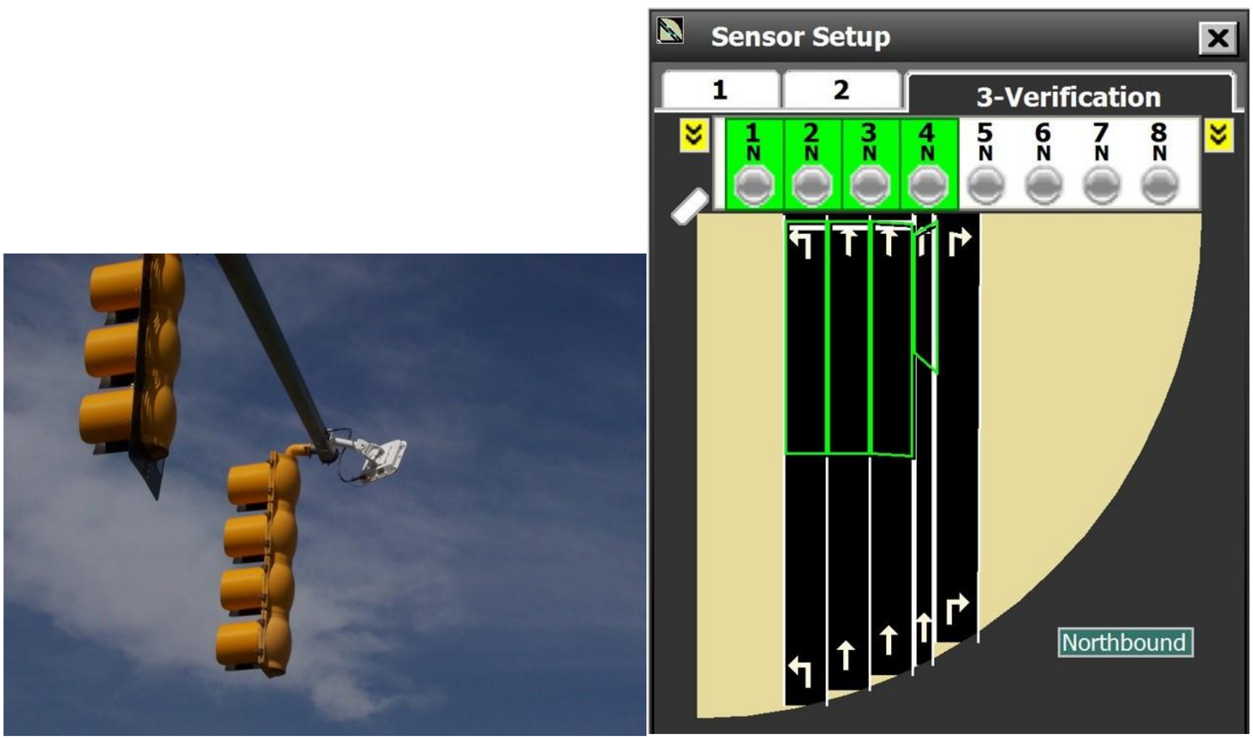

Figure 5. Radar Signal Installation and Detection Set-up

In addition to notifying the signal of their presence and activating the traffic light, the system also counts the number of occurrences. While not designed as a count technology per se, this record of occurrence could be used to determine the number of time a vehicle traveling in a bike lane triggered the signal.

For this project, the research team identified 69 intersections equipped with radar detection that also have existing bike lanes or a wide shoulder used by bike traffic. The locations and signal number for each are shown in Table 4 below.

Table 4. Radar Equipped Intersections with a Bike Lane

County	City	UDOT Signal Number: Intersection
Weber	Ogden	5096: Hinckley Dr. (Hwy 79) and Hwy 126
	Riverdale	5002: Riverdale Rd. and 1050 West (Hwy 60)
	Riverdale	5000: Riverdale Rd. and 700 West (Hwy 26)
Davis	Clearfield	5118: 700 South and State St.
	Clearfield	5127: 1700 South and 1000 West
	Clearfield	5393: 1700 South and 2000 West (Hwy 108)
	Layton	5158: Hwy 193 and US 89
	Layton	5199: US 89 and Antelope
	Layton	5193: Layton Pkwy and Main St.
	Layton	5194: Layton Pkwy and I-15 Interchange
	Kaysville	5382: 200 North and US 89
	Farmington	5209: Shephard Lane and Main St.
	Farmington	5203: Park Lane Interchange
	Bountiful	5350: 500 South and I-15 interchange
	Bountiful	5387: 500 South and 1100 West
	Bountiful	5375: 500 South and Redwood Road
Salt Lake	Salt Lake City	7120: Beck Street and Victory Road
	Salt Lake City	7121: Beck Street and 400 West
	Salt Lake City	7068: 1000 North and I-15
	Salt Lake City	7083: 1000 North and Redwood Road
	Salt Lake City	7085: 500 North and Redwood Road
	Salt Lake City	7410: North Star Drive and Redwood Road
	Salt Lake City	7090: 400 South and Redwood Road
	Salt Lake City	7095: 1700 South and Redwood Road
	Salt Lake City	7122: 600 North and 300 West
	Salt Lake City	7125: North Temple and 300 West
	Salt Lake City	7126: South Temple and 300 West
	Salt Lake City	7128: 200 South and 300 West
	Salt Lake City	7130: 500 South and 300 West
	Salt Lake City	7252: 500 South and Main Street
	Salt Lake City	7181: 500 South and 700 East
	Salt Lake City	7216: 500 South and Guardsman Way

	Salt Lake City	7371: Foothill Blvd and Thunderbird Drive
	Salt Lake City	7183: 700 East and 800 South
	Salt Lake City	7135: 800 South and West Temple
	Murray	7204: 5600 South and 900 East
	Murray	7206: Winchester St and 900 East
	Midvale	7208: Union Ave and 900 East
	Cottonwood Heights	7830: Cottonwood Canyon
	West Jordan	7116: 7800 South and Redwood Road
	West Jordan	7012: 7800 South and 3200 West
	West Jordan	7354: 7800 South and 3250 West (Old Bingham Hwy)
	West Jordan	7066: 7800 South and Bangerter Highway
	Sandy	7200: 700 East and 10600 South
	Sandy	7201: 700 East and 11000 South
	Sandy	7615: 700 East and 11400 South
	Draper	7202: 700 East and 12300 South
	South Jordan	7611: 10400 South and Baxter Drive
	South Jordan	7225: 10400 South and 2200 West
	South Jordan	7226: 10400 South and 2700 West
	South Jordan	7227: 10400 south and 3200 West
	South Jordan	7228: 10400 South and 3400 West
	South Jordan	7364: 10400 South and Bangerter Highway
	South Jordan	7627: 11400 South and 325 West
	South Jordan	7624: 11400 South and 1300 West
	Draper	7082: 12300 South and State Street
	Draper	7346: 12300 South and Lone Peak Parkway
	Draper	7349: 12300 South and 265 West
	Draper	7350: 12300 South and Galena Park Blvd
	Riverton	7023: 12600 South and 1300 West
	Riverton	7119: 12600 South and Redwood Road
	Riverton	7374: 12600 South and 2700 West
	Riverton	7375: 12600 South and 3600 West
	Riverton	7362: 12600 South and Bangerter Highway
	Riverton*	7359: Bangerter Highway and Redwood Road
	Bluffdale	7391: 14400 South and Redwood Road
	Bluffdale	7392: Porter Rockwell Blvd and SR-68
	Bluffdale	7507: Porter Rockwell Blvd and SR-85 NB
	Bluffdale	7508: Porter Rockwell Blvd and SR-85 SB

*Test Site for Radar Signal validation

4.3.3 Manual Count Validation of Radar Counters

After the micro radar pucks were installed and the test site radar signals were programmed to detect cyclists, the research team conducted limited on site manual counts to compare capture data from the automated counter with visual confirmation. Table 5 identifies the validation count dates and times for the radar test sites identified by the TAC. Also included are the total counts from the radar signal or puck and the manual counts from the same time frame. These manual validation counts do not provide a representative data sample from which to draw statistically significant results. The purpose of these validation counts was to perform a "heads-up" verification to simply identify if the new radar technologies closely resembled the patterns witnessed on the ground. Conducting a statistically valid evaluation of accuracy rates for radar technology was not within the scope of this project, but may be considered by UDOT in the future.

Table 5. Comparison of Automated and Manual Counts at Test Sites

Location	Date/Time	Counter Type	Auto Count	Manual Count
Redwood Road-Porter Rockwell Bike Lanes	6/30/15 10:00-11:00am	Radar Signal #7392	N=0 E=0	N=3 S=3 E=2 W=7
Weber River Trail (31st Street)	7/13/15 3:00-4:00pm	Micro Radar Puck #5181	6	7
Adams Canyon Trailhead	7/13/15 1:45-3:00pm	Micro Radar Puck #5136	23	25

The radar signal located on Redwood Road at Bangerter Highway (at the Porter Rockwell Trail; Riverton, UT) was programmed to detect northbound and eastbound bicycle lane traffic. A one hour manual site count at the intersection observed three cyclists traveling northbound and two cyclists traveling eastbound through the intersection in the bike lanes. The radar signal failed to detect all five users. There are a number of reasons that this could happen, including the possibility that the cyclists were traveling outside the programmed detection zone. A full explanation is provided in Section 5.2.2.

The micro radar showed promising results for this limited observation window. A one hour manual site count along the Weber River Trail identified seven trail users. The radar puck recorded six users during that time frame. A second 75-minute manual count at the Adams Canyon Trail Head observed 25 users. The radar puck recorded 23 trail users during that same time frame. While these results cannot validly be used to infer accuracy rates for the technology, the relative consistency between the manual and automated counts shows promise for employing this technology at other sites. It is also promising to see that radar technology may be employed in locations other than more traditional signalized intersection sites.

4.4 Summary

Identifying non-motorized access to transit is incredibly difficult. Field work confirmed that an intercept survey is likely the only way to determine how users accessed the station. Even with an intercept survey, however, there could be a substantial margin of error due to imprecision in identifying a catchment area or what actually qualifies as a pedestrian. Using signal and micro radar to collect data on non-motorized users may be promising. The installation of the micro radar pucks is not difficult or disproportionately expensive when compared to other counters. Micro radar does require a qualified and experienced UDOT Engineer who is familiar with calibrating the counter. This may dissuade some users. Also, locations may be limited as the technology requires close proximity to a UDOT fiber optic enabled traffic signal for ease of data access. Lastly, very limited manual validation counts showed that micro radar consistently recorded similar usage rates when compared to on the ground site observations.

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 Summary

Over the past five years non-motorized travel in Utah has unmistakably been increasing. However, there are not currently standard methods for determining traffic volumes or usage rates. Without accurate counts of bicycle and pedestrian infrastructure usage it is incredibly difficult to prioritize funding, protect traveler safety, or identify locations for necessary accommodations and improvements. This research employed a mixed methods approach to identify industry best practices for conducting non-motorized user counts, including which methods are most appropriate for conducting bicycle and pedestrian counts across Utah's diverse urban and rural environments. This included 1) identifying available methods and technologies for counting non-motorized transportation users, 2) identifying which methods would be effective in different environments, and for different purposes, 3) testing new local methods (radar) for counting non-motorized users, and 4) creating a user friendly guidebook for conducting bicycle and pedestrian counts in Utah.

By examining which tools and methods have been effective elsewhere and testing new methods locally, this research develops a standard process for conducting bicycle and pedestrian counts as well as guidelines for analyzing the resulting data to provide meaningful results for UDOT planners as well as agencies throughout the state.

5.2 Findings

In evaluating existing methods this research determined that several options that may be useful and applicable elsewhere are not appropriate or may have drawbacks when applied locally. Additionally, there are promising new technologies that have yet to be widely implemented that may provide a useful alternative to more mainstream methods.

5.2.1 Non-Motorized Access to Transit

As transit access counts were attempted for this study, which included loose guidelines for how to identify a cyclist or pedestrian, it quickly became evident that there were too many factors that played a role in making an accurate determination. Because of this, manual and video counts are not recommended for wide scale use in measuring non-motorized access. Rather, it is recommended that a specific intercept survey be used allowing users to directly specify how they accessed the station on that given trip. While this should improve accuracy significantly, it should be noted that even an intercept survey may have validity issues and drawbacks. For example, respondent burden and the likelihood that individuals will choose not to participate must be considered, as well as the potential for invalid data due to misinterpreting the question (e.g. do they want to know that I walked from my car three blocks away, or that I drove to a park and ride?). Consistency and specificity in questioning is critical.

It is assumed that non-motorized travel is a significant source mode for accessing transit. While this problem cannot likely be solved within the parameters of this project, it is recommended that UDOT, the Utah Transit Authority and the MPOs collaborate on additional research to identify solutions for measuring non-motorized access to transit.

5.2.2 Implementation of Radar Signals and Micro Radar

There are two main limitations of using radar signal technology for counting bicycles. The first is the inability of the radar signal to differentiate between bikes and motorized vehicles. This means that if a car travels through the bike lane detection zone in preparation to make a right turn, they would be counted as a bike. This could lead to over counting. The second limitation occurs if a cyclist does not travel through the designated detection zone. If a cyclist rides on the shoulder or in a vehicle travel lane, they will be counted as a vehicle, potentially undercounting. When taken together, there is a high likelihood that accuracy rates may vary widely depending on the facility and the type and experience levels of the cyclists using it. It is recommended that radar be used more for trend identification than for specific volume counts. At the present, the technology is not yet fine-tuned enough to warrant use as a reliable count method.

The micro radar pucks show great promise as a tool for counting. However, they are limited in the sense that they must be installed within line of site to a traffic signal with a fiber optic uplink. This means that a limited number of locations would be appropriate for implementation. The cost of the radar puck including equipment, installation, and calibration is nearly identical to the other automated counters but requires more technical expertise to calibrate. Additional testing will be necessary to determine if this technology can be reliably implemented. Lastly, the user interface, while easy to access, does not provide the user experience and software flexibility that some of the other technologies offer; and the outputs are not intuitively easy to understand.

5.3 The Utah Bicycle and Pedestrian Counts Guidebook

The final and perhaps most important portion of this research included creating a guidebook to educate local jurisdictions, government agencies, UDOT Region staff, MPOs, advocacy groups, and the public on how to plan, prepare for, and conduct counts of non-motorized system users. Using the data gathered through the literature review, interviews, workshops/trainings and site testing described in Chapters 3 and 4, a comprehensive guidebook was created. The creation of the Utah Bicycle and Pedestrian Counts Guidebook will allow diverse groups across the state to confidently prepare for and conduct counts using standard techniques that will promote uniformity and ensure that data no longer goes to waste.

The guidebook is structured as a manual and takes users step-by-step through the process of conducting counts. It includes the following sections:

5.3.1 Introduction

The introduction provides an overview of bicycle and pedestrian transportation in Utah and why counting non-motorized users is important. It describes that the purpose of the guidebook is to provide clear guidance on methods for collecting bicycle and pedestrian data in Utah and to maximize the value of future count data by providing a standardized format and approach. The guide provides both a step-by-step, Utah specific protocol, promoting consistency and direction for conducting counts, as well as providing guidance on choosing appropriate count technologies. This section also outlines what topics will be covered in each chapter of the guidebook and outlines the format and organization.

5.3.2 Types of Data Collection

Chapter 2 describes the two key types of data collection identified in Section 2 of this report -- screenline and intersections counts. Users are shown the difference between manual counts and automated counts, where each count type is appropriate for use, and a myriad of pros and cons for both.

5.3.3 Planning a Counts Program

The third Chapter of the guidebook provides step-by-step instructions regarding how to prepare for conducting counts and collecting data. This includes examining existing data sources, identifying which trip characteristics are of interest, which user types are of interest, how counts should be conducted, how long and how frequent counts should be, as well as preliminary guidance in selecting a count technology. This chapter also briefly describes what will happen after the count is complete.

5.3.4 Count Technologies

Chapter 4 of the guidebook explains the majority of the data contained in this report in layman's terms and in stepwise order. The chapter examines the full menu of count technologies that are currently available (as described in Section 2), and provides summaries of all existing count technologies alongside evaluations of effectiveness, descriptions of limitations, computed accuracy levels, ease of installation, and costs.

Because the detailed counter information included in the guidebook is available in a number of the sources described in Section 2, much of that information is not repeated in this report for brevity and to avoid repetition. The main take-away from this chapter in the guidebook, however, is based on the data analysis presented in Sections 4.1 through 4.3 of this report. Figure 6 shows a comprehensive flow-chart included in the guide (p. 44) outlining the methods that are most appropriate for conducting counts in any given location. The flow chart allows users to take into consideration their local conditions and context, and the intended purpose of their counts. This flow chart also incorporates the two radar technologies tested in this research.

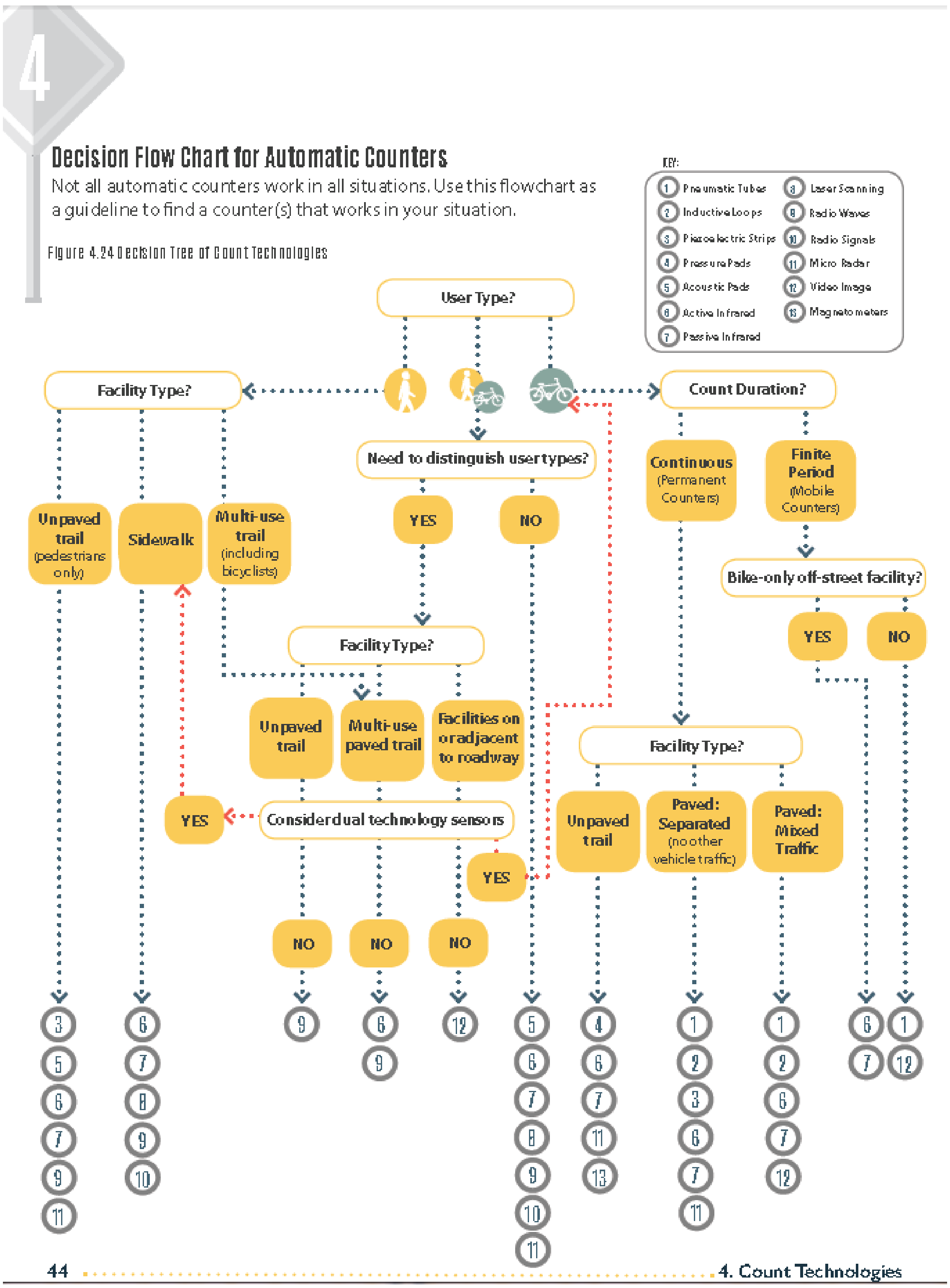

Figure 6. Technology Selection Decision Flow Chart

5.3.5 Preparing to Conduct Counts

After users are introduced to the large variety of count technologies and options for conducting counts, Chapter 5 of the guide walks users through the process of conducting a count from beginning to end, including how to prepare for a count, and what to do during the count and immediately following the count. Post- count procedures are described including quality checks on all data.

5.3.6 Data Analysis

Because many count programs fall short after the counts are conducted leaving the data sitting unused, Chapter 6 of the guidebook presents a variety of useful data analysis methods including summary and descriptive statistics as well as options for visualizations. The chapter also describes how to use the count data that has been collected in a meaningful way to assist in future planning, design, and decision making.

5.3.7 Resources

The final chapter of the guidebook provides a comprehensive list of available resources, including a number of sources reviewed in Section 2 which describe methods for conducting counts. Also included are reference examples of other agency experiences with conducting counts. A list of counter vendors is provided, however, the document text does not advocate or encourage any particular products or brands specifically. The guidebook also includes a complete appendix containing a variety of manual count forms and planning sheets.

5.4 Data Storage and Dissemination

The final recommendation of this research has to do with what happens to data after is has been collected. While the Utah Bicycle and Pedestrian Counts Guidebook can promote and streamline the collection and use of non-motorized user data, larger scale data evaluation and usage may prove difficult. It is recommended that UDOT evaluate options for creating a central repository of non-motorized count data. The Southern California Association of Governments (SCAG, 2012) has created an online portal where local jurisdictions, agencies, advocacy groups, or any other group can upload and share their non-motorized count data. This would also allow for data aggregation and would simplify long-term, larger-scale planning by providing all available data in a central location. By both promoting the collection of data and providing a central clearinghouse for data storage, planning for non-motorized modes could be dramatically improved statewide.

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APPENDIX A: Utah Bicycle and Pedestrian Counts Guidebook

January 2016

Utah Bicycle & Pedestrian Counts GUIDEBOOK

Utah Bicycle & Pedestrian Counts GUIDEBOOK

January 2016

Acknowledgments

Prepared By:

ACTIVE PLANNING

Shaunna K. Burbidge, PhD

Molly Marriott

Technical Advisory Committee:

Tom Hales, Utah Department of Transportation, Project Manager

Evelyn Tuddenham, Utah Department of Transportation

Mark Taylor, Utah Department of Transportation

Scott Jones, Utah Department of Transportation

Jim Price, Mountainland Association of Governments

Jory Johner, Wasatch Front Regional Council

Scott Hess, Wasatch Front Regional Council

Jennifer McGrath, Utah Transit Authority

Phil Sarnoff, Bike Utah

Special Thanks To:

Becka Roolf, Salt Lake City

Grant Schultz, PhD, Brigham Young University

Richard Brockmeyer, Fehr and Peers

Michael Wright, Pine Top Engineering

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UDOT

Keeping Utah Moving

Table of Contents

Glossary & Acronyms

ADT	Average Daily Traffic
AADT	Average Annual Daily Traffic
COG	Council of Governments
FHWA	Federal Highway Administration
MPO	Metropolitan Planning Organization
MUTCD	Manual on Uniform Traffic Control Devices
NBPDP	National Bicycle and Pedestrian Documentation Project
NCHRP	National Cooperative Highway Research Program
TEM	Traffic Engineering Manual
TMG	Traffic Monitoring Guide
TRB	Transportation Research Board
UDOT	Utah Department of Transportation

Automated count – collection of traffic data with automatic equipment which continuously records non-motorized traffic flow. Automated methods of data collection include both permanent and portable counters.

Annual Average Daily Traffic – the total volume of traffic on a given roadway for a year divided by 365 days. Many agencies use the terms ADT and AADT to define non-motorized volumes.

Bicycle – a wheeled vehicle 1) propelled by human power by feet or hands acting upon pedals or cranks; 2) with a seat or saddle designed for the use of the operator; 3) designed to be operated on the ground; and 4) whose wheels are not less than 14 inches in diameter. The term bicycle includes an electric assisted bicycle, but does not include scooters and similar devices (Utah Code 41-6a-102).

Commuter traffic – traffic volumes on a given facility that has morning and evening peaks Monday through Friday and typically has higher use on weekdays than weekends.

Continuous – count sites equipped with a permanently installed automated counting sensor that collects data 24 hours a day, 7 days a week, 365 days a year. Ideally these count locations collect data every day, but due to equipment failure or other unforeseen impacts such as weather, there can be gaps in the data.

Cordon – vehicle and person surveys that provide time series data of traffic flow across a given set of screen lines.

Coverage counts – short duration counts that cover many different areas in a region. This data may often supplement continuous traffic counts.

Crosswalk – that part of a roadway at an intersection included within the connections of the lateral lines of the sidewalks on opposite sides of the highway measured from: A) the curbs; or B) in the absence of curbs, from the edges of the traversable roadway. In the absence of a sidewalk on one side of the roadway, that part of a roadway included within the extension of the lateral lines of the existing sidewalk at right angles to the centerline. A crosswalk is also defined as any portion of a roadway at an intersection or elsewhere distinctly indicated for pedestrian crossing by lines or other markings on the surface (Utah Code 41-6a-102).

Glossary & Acronyms cont.

Index locations – index locations are count locations that are selected to be illustrative of the counts in a given jurisdiction. These sites are not fully representative or inclusive of every roadway nor are they a statistically random sample.

Intersection counts – counts conducted where non-motorized facilities cross another facility of interest.

Manual count – method of counting by observation of number, classification, and direction of travel. This counting may be performed in person at the site or by analyzing video. Data is typically tracked using a tally sheet or an electronic counting board.

Multipurpose traffic – traffic volumes on a given facility with traffic volumes that peak during the afternoon and evening hours and have similar weekday and weekend traffic patterns with a slightly higher usage on weekends.

Occlusion – the undercounting of actual traffic volumes. This can occur when two or more travelers pass a screen line count location simultaneously and the counter does not recognize more than one user, or when something blocks a counter and it fails to detect properly.

Peak volume – the volume of traffic that uses a facility or lane during the hour of the day that observes the highest traffic/user volumes for that location.

Pedestrian – a person traveling: A) on foot; or B) in a wheelchair (Utah Code 41-6a-102).

Project counts – these counts are taken before and after construction projects to support planning and forecasting efforts and/or to determine the effectiveness of new infrastructure.

Safety Zone – the area or space officially set apart within a roadway for the exclusive use of pedestrians and that is protected, marked, or indicated by adequate signs as to be plainly visible at all times while set apart as a safety zone (Utah Code 41-6a-102).

Screen line – imaginary line typically drawn along features such as rivers or railways, or at mid-block. Since these areas have a minimum number of crossing points it is more manageable to count traffic going from one side to the other. Although these are spot counts they are often applied to the full segment length to calculate pedestrian-miles traveled and bicycle-miles traveled.

Short duration – count sites that are either manual or automated counting locations that collect data for a specific period of time. Count durations can be anywhere from several hours to several weeks.

Sidewalk – that portion of a street between the curb lines, or the lateral lines of a roadway, and the adjacent property lines intended for the use of pedestrians (Utah Code 41-6a-102).

Traffic – pedestrians, ridden or headed animals, vehicles, streetcars, and other conveyances, either singly or together for purposes of travel (Utah Code 41-6a-102).

Vehicle – every device in, upon, or by which any person or property is or may be transported or drawn upon on a highway, except devices used exclusively on stationary rails or tracks (Utah Code 41-6a-102).

photo: Amazon News

1.
Introduction

1

Introduction

Over the past five years Utah has experienced a significant increase in both the use of bicycles and walking for transportation as well as demand for bicycle and pedestrian friendly infrastructure. Historically, these modes have not been included in traffic counts nor are they accurately represented in the long range planning models used by UDOT and the MPOs. This exclusion creates an incomplete picture of both state and local transportation systems. Without accurate counts it is difficult to measure facility usage, evaluate pre-post analysis of projects, conduct performance management, evaluate polices, conduct safety and crash analyses, or calculate exposure and risk for non-motorized modes.

It is necessary to count non-motorized travel because what gets counted, counts. Providing accurate data on non-motorized travel is becoming increasingly important in prioritizing infrastructure improvements when funds are constrained. To make effective transportation decisions, it is necessary to have a more dynamic understanding of volumes and travel behavior for non-motorized travelers. Limited resources and constraints on existing rights-of-way leave local jurisdictions fighting to provide affordable and efficient transportation modes, such as walking and biking. Counts can often provide leverage and support documenting existing demand or need for infrastructure program funding applications.

photo: SFMTA

With an unlimited budget and unlimited resources communities and agencies would have the flexibility to conduct bicycle and pedestrian counts across the entire transportation network. This would provide accurate data regarding where bicycles and pedestrians currently operate and would provide valuable insight into where investments should be made and infrastructure improved. However, budget, time, and labor constraints limit the capacity of municipalities, counties, planning agencies, and others to conduct continuous and ongoing counts at all sites. This means that planners and public officials must make decisions based on limited data gathered from a sample of locations, selected using a “best guess” methodology. To date, it has not been clear which tools or methods would be most effective to gather this data given the incredibly diverse range of environments and conditions in the state, and to present the data it in a way that would be both meaningful and useful.

The recent tidal wave of interest in bicycle and pedestrian planning and forecasting has led some local jurisdictions to begin collecting non-motorized count data at a variety of locations in an attempt to provide a representative view of non-motorized traffic patterns. While this is beneficial and can provide each agency with valuable data, it also has its drawbacks. Most communities have limited experience in conducting these types of counts and do not know which types of counts to conduct, where to conduct them, or how to go about using the data once they have it. Also, because jurisdictions are each using different methods for conducting counts, the opportunity for aggregating or comparing the data is lost, and regional agencies such as UDOT and the MPOs are left attempting to compare the data equivalent of apples and oranges.

Reasons for Conducting Bicycle and Pedestrian Counts

- Identify current non-motorized traffic volumes
- Identify which routes cyclists and pedestrians are using
- Determine travel demand for new infrastructure
- Provide evidence of need for funding applications
- Measure risk exposure in dangerous areas
- Identify funding mechanisms for new infrastructure

1

Introduction

The purpose of this guidebook is to provide clear guidance on methods for collecting bicycle and pedestrian data in Utah and to maximize the value of future count data by providing a standardized format and approach. This guide provides both a step-by-step, Utah specific protocol, promoting consistency and direction for conducting counts, as well as providing guidance on choosing appropriate count technologies.

This guidebook is organized as follows:

Chapter 2- Describes the two key types of data collection. Users will gain an understanding of the difference between manual counts and automated counts, where each count type is appropriate for use, and a myriad of pros and cons for both.

Chapter 3- Provides step-by-step instructions regarding how to prepare for conducting counts and collecting data. This includes examining existing data sources, identifying which trip characteristics are of interest, which user types are of interest, how counts should be conducted, how long and how frequent counts should be, as well as preliminary guidance in selecting a count technology. This chapter also briefly describes what will happen after the count is complete.

Chapter 4- Examines the full menu of count technologies that are currently available. This chapter provides summaries of all existing count technologies alongside evaluations of effectiveness, descriptions of limitations, computed accuracy levels, and ease of installation. Information provided in this chapter is based upon the latest peer reviewed research and product evaluations and will help users identify the best technology options for a given site and situation.

Chapter 5- Guides users through the process of conducting a count from beginning to end, including how to prepare for a count, and what to do during the count and immediately following the count. Post count procedures are described including quality checks on the data.

Chapter 6- A variety of potentially useful data analysis methods are described including summary and descriptive statistics as well as options for visualizations. Also described is how to use the count data that has been collected in a meaningful way to assist in future planning and design.

Chapter 7- Provides comprehensive list of available resources, including a number of sources describing methods for conducting counts, and other agency experiences conducting counts. A variety of manual count forms and resources is also provided.

NOTES


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Clementina Ave
JAGUAR

2.
Types of Data Collection

2 Types of Data Collection

▷▷ *Differences between Motorized and Non-Motorized Counts*

According to the Federal Highway Administration's Traffic Monitoring Guide[1] there are four major differences between non-motorized and motorized traffic measurement. The first major difference is the scale of data collection. Most non-motorized data collection programs have significantly fewer monitoring locations, and these limited location samples may not accurately represent the entire geographic area of interest.

The second major difference is the location of users for motorized versus non-motorized modes. Non-motorized traffic volumes are typically higher on lower functional class roads as well as on shared use paths, trails, and pedestrian facilities, simply because of the more pleasant environment of slower speeds and lower volumes of motorized traffic. Because cyclists and pedestrians can follow their own path and do not necessarily need to follow set channels like vehicles do, they are more difficult to count.

Third, non-motorized counts tend to take place over short durations (as short as only a few hours). This is because there is a perception that counting non-motorized users is difficult and labor intensive, as there is often a desire to collect more detailed user information about non-motorized travelers (e.g. helmet use, gender, etc.).

The final difference between counting automobiles and bikes/pedestrians is the types of technology employed. Many of the automated non-motorized counters currently on the market employ newer types of technology. While state of the art in many ways, these technologies have not been field tested to the extent that motorized counters have been and error rates are still relatively unknown. The pros and cons of all existing technologies are described in detail in Chapter 4.

▷▷ *Types of Non-Motorized Data Collection*

Along any given corridor there are two main ways to collect volume data for cyclists and pedestrians; screen line counts and intersection counts:

- Screen line counts are conducted by establishing a line across a roadway, sidewalk or path/trail (visible or invisible) and then counting the number of pedestrians and cyclists who pass over the line. Screen line counts provide general use information for segments of a roadway/trail.

- Intersection counts are conducted at locations where two or more roadways cross or meet. Bicycle and pedestrian turns and through movements are counted by each intersection leg. These counts are typically conducted to identify safety or operational issues at peak conditions.

1 Federal Highway Administration- Traffic Monitoring Guide (Ch-4 Non-Motorized Traffic) http://www.fhwa.dot.gov/policyinformation/tmguide/

For each type of count there are two main methods for collecting data. Automated counts use technology to mechanically count and calculate the number of bicycles and pedestrians that pass the monitored location. Manual counts require placing staff/volunteers in specified locations to observe and record the number of bicycles and pedestrians that pass by. There are pros and cons to both data collection methods. Automated counts are less labor intensive and can provide a longer time frame for volume data, while manual counts can provide more detailed information about users and their specific behaviors.

Screen line counts are highly encouraged for agencies that are planning to do manual data collection using existing staff/volunteers. A number of sample count forms are provided in the Appendix of this manual.

Chapter 4 provides a comprehensive look at the different technologies available for conducting automated counts as well as simplifying the manual count process.

Figure 2.1 Screen Line Counts

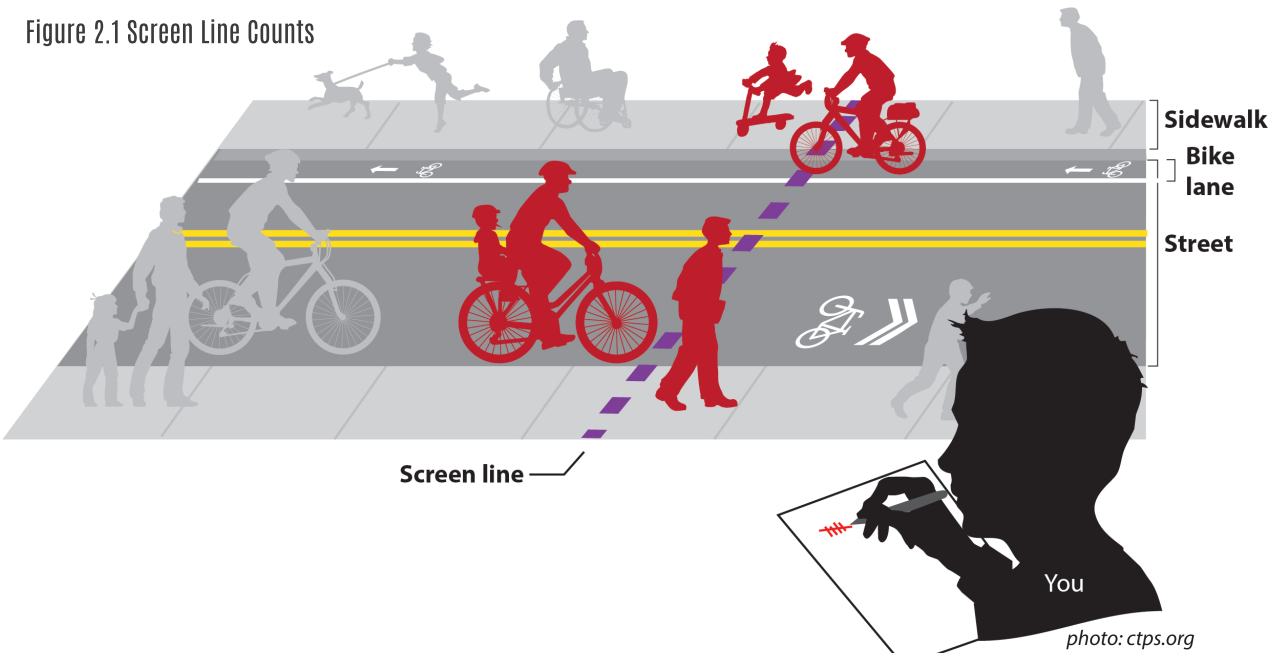


photo: ctps.org

Figure 2.2 Intersection Counts

photo: Miovision

photo: LA-Bike.org

Transit Counts

Bicycle and pedestrian counts can also be conducted in terms of access to transit stations or transit boardings. Manual methods are typically used for this type of count. Locally, UTA has traditionally used an onboard survey to identify which travel mode riders used to access the transit station or stop (bike, walking, auto, etc). To date, no automated method has been identified to streamline transit access data collection. Several transit agencies and a small number of university research centers have attempted to create an automated method, but without much success. There is not currently an accurate and valid way to automatically or even manually count non-motorized transit access without employing some type of intercept survey or user questionnaire.

Kimley-Horn & Associates in Blacksburg Virginia utilized a methodology in which bus drivers would radio in to dispatch each time a bike was loaded on the vehicle at a stop. While this did provide location and stop-specific data for bike access, it had several drawbacks, including flooding the radio with call-ins and requiring dispatch to keep a tally. This led to a very limited number of routes being measured (3 total) for only two separate days. Additional research is needed to streamline a process for conducting transit access counts for non-motorized modes.

NOTES

photo: Cycling Utah

3.

Planning a Counts Program

3

Planning a Counts Program

Before beginning data collection and conducting counts, objectives and intended outcomes should be clearly identified. For example, if the goal is to quantify the number of cyclists commuting along a route in order to justify infrastructure improvements, different strategies will be employed versus identifying the total number of weekly users on an existing trail or shared-use path. By planning the process up front, there is less room for error and a greater likelihood that goals and objectives will be accomplished. Clarifying each step beforehand lowers the likelihood that mistakes will be made. Such mistakes can sacrifice a large amount of effort and resources.

There are a number of questions that should be answered before counts begin. These might include:

- ***What types of users do we want to count?***
- ***What constitutes a cyclist or pedestrian?***
- ***Where will we conduct the counts?***
- ***How many locations will we count?***
- ***What methods do we intend to use for our counts?***
- ***What will our count durations be?***
- ***How often should we conduct counts?***
- ***Who will be collecting the data?***
- ***What do we intend to do with the data after it is collected?***

3

▷▷ Gathering Existing Data

In any data collection effort it is always best to begin by identifying what information is already available. By taking the time to survey existing data sources you may save a great deal of time and effort in the long run. A number of different sources may contain bicycle and pedestrian count data. For example, safety reports, traffic impact studies, health impact assessments, feasibility studies, and environmental reports may all contain valuable non-motorized count data.

Bicycle and pedestrian count data is also valuable to a number of different departments and agencies. Do not make the mistake of assuming that just because one division does not have existing count data, that it is not available somewhere else. By checking in with other agencies during the planning phase of the count process you may save time and resources and reduce the overall burden and scope of the effort.

Some examples of groups who may have existing count data include:

- Transit agencies
- Health departments
- MPOs
- Air quality districts
- School districts
- Parks and recreation departments
- U.S. Forest Service
- Bicycle and pedestrian advocacy groups
- Local cycling and running clubs
- Non-profits and trail maintenance organizations (e.g. Jordan River Commission, Weber Pathways)
- Universities
- Chamber of Commerce or business associations
- County Council of Governments (COG)
- City, County, and State Governments

Create a Geodatabase of Count Data

Use a Geographic Information System or other geodatabase to compile existing count data from all available sources. This allows existing data to be overlaid with the existing and planned non-motorized facility network and can assist in distinguishing gaps and needs. It will also provide a single source for maintaining data as your counts program matures.

3

▷▷ Data Collection Type and Purpose

Prior to conducting any data collection it is critical to determine what type of data will be collected and how it will be used. The type of data will determine which methodology will be most appropriate for the counts program. For example, who is the target population?

User Types

What user types are of interest; pedestrians, cyclists, motorists, or some combination of the three? According to Utah State Code[1] (UT41, 6a.43) a pedestrian is "a person traveling a) on foot; or b) in a wheelchair", and a bicycle refers to "a wheeled device propelled by human power (by feet or hands)…whose wheels are not less than 14 inches in diameter." While these legal definitions technically describe the two major methods of non-motorized travel, they do not fully encompass the diversity of users often implied by the terms. You will need to determine what constitutes a pedestrian or cyclist for the purpose of the specific count. For example, how would individuals traveling on a non-motorized scooter or rollerblades be classified, and are these other modes of interest? Will these individuals be counted as pedestrians, cyclists, or as "other users"?

Level of Detail

One common presumption of data collection is that data can always be aggregated when collected at a fine scale with a large amount of detail. However, data that is collected en masse with fewer details can never be deconstructed. Typically greater detail comes with a higher cost. Therefore the purpose and long-term goals of the counts program should be clear.

Will cyclists and pedestrians be counted together or separately? If counts are conducted on a facility that is regularly used by both pedestrians and cyclists (e.g. a shared use path or trail) they will be sharing travel space. Specialized equipment or methods will be needed to differentiate between the two if that is an objective of the data collection process. On a single-use facility such as a sidewalk, typically only a single mode is present which simplifies the data collection process.

Another important component to address early in the planning process is the level of importance being placed on collecting user characteristics such as gender, age, ethnicity, cyclist type (commute vs recreation), or helmet use. Is a complete user profile necessary or will volume counts suffice? Accurately identifying who exactly will be counted will inform the subsequent steps of determining where to count and what methods to employ. Both current and future uses of the data should be considered.

1 Utah Code. Motor Vehicles: Traffic Code, General Provisions (2014). http://le.utah.gov/xcode/Title41/Chapter6a/41-6a-S102.html

▷▷ *Identifying Resources*

The resources available will ultimately determine the type of methods employed. Creating a counting program that requires multiple automated counters in a variety of locations may be unrealistic if the budget cannot accommodate the expense. A successful counts program may start small using only manual counts at a limited number of locations. As resources increase the number of sites and sophistication of technology can increase as well (data collection methods and technologies are described in detail in Chapter 4).

Complexity comes with a cost, but just because more detailed information can be gathered does not mean it is necessary. Basic local counts will likely not require the most technically advanced automated counters in a large number of locations. Manual counts conducted in small numbers of targeted locations can be just as valuable.

▷▷ *Determine Count Locations and Time Frame*

Count sites can be selected in a number of ways, but the data collection purpose should always be a consideration when selecting sites. In addition to identifying the geographic scope of the count program, the plan will also need to identify how long and how often counts will occur.

Count Locations

Determining where to conduct non-motorized counts can be one of the most daunting and uncertain parts of the process. Because little is known about measuring the spatial distribution of non-motorized travel, especially when a count program does not currently exist, the number of count sites will most likely be determined based on the available budget. The National Bicycle and Pedestrian Documentation Project recommends conducting counts at one location per 15,000 residents. However, the U.S. Federal Highway Administration (FHWA) suggests conducting counts at 3-5 sites for each identified factor group (trip purpose, school aged, etc.) In general the following location types should be considered:

- Corridors that are known for having high volumes of bicycle or pedestrian traffic.
- Intersections or corridors with a high number of non-motorized crashes, or areas with particular safety concerns.
- Major destinations for cyclists and pedestrians such as schools, parks, high-density residential areas, transit stations, and trail heads.
- Locations where bicycle or pedestrian facilities and improvements are planned. This provides an opportunity for before-after counts and measures of impact.
- Existing public facilities including on-street bike lanes, trails, and major walkways. Also include crossings where there may be limited choices for non-motorists.
- Any locations where counts have been conducted in the past since there is already a history of data on non-motorized travel.

When selecting locations it is good to keep in mind all anticipated count methods you plan to employ (screen line or intersection) and what resources are available for conducting the counts.

Count Time Frame

Because traffic for non-motorized modes can be unpredictable and variable it is important to gather data over an appropriate time frame. If the time frame used is too short, it will limit the ability to identify long-term changes in traffic volumes and travel patterns. If the count period is too long, it can be a drain on resources and may not add significant additional value.

For short-term counts the following time frames are recommended and should provide the most representative data:

Weekday Peak	Weekday 12-Hour	Weekend Peak	Weekend 12-Hour
7:00-9:00am and 4:00-6:00pm on consecutive weekdays (Tues, Wed, Thurs)	**7:00am-7:00pm (choose one weekday, broken into shifts to avoid fatigue)**	**10:00am-2:00pm on Saturday**	**7:00am-7:00pm on Saturday (broken into shifts to avoid fatigue)**

The minimum duration at each location should be two hour segments on weekdays and 3 hours on weekends. Mid-week days tend to best represent normal weekday traffic, and Saturday is preferable for conducting weekend counts due to Utah demographics and reduced Sunday activity. Take into consideration context sensitivity. For example, if counts are planned near a school, make sure they are not conducted during the summertime or on a school holiday.

Seasonal variation and short-term weather should also be taken into consideration and planned for before beginning a counts program. Weather can significantly impact bicycle and pedestrian travel behavior and contingencies should be included in case inclement weather occurs on a scheduled count day. Weather conditions should always be recorded for each count day. Variation in count data due to seasonal weather patterns is expected, and therefore counts are taken during the same general time frames each year. To avoid the effects of unexpectedly hot or cold weather Spring and Fall are the best times to collect short-term count data.

Collecting Weather Data on a Count Day

The FHWA Traffic Monitoring Guide recommends collecting data on three weather-related attributes:

1. Precipitation (yes/no): Did measurable precipitation fall at some time during data collection?

2. High temperature: Approximate high temperature for either the day (if a day or longer count) or the duration of the count (if the count is less than a day in duration).

3. Low temperature: Approximate low temperature for either the day (if a day or longer count) or the duration of the count (if the count is less than a day in duration

Historical weather data can be obtained from several different sources and does not necessarily have to be collected at the exact count location.

3

Count Frequency

Counts should be collected on a regular recurring basis. In order to maintain the ability to identify trends and compare data, the timeframe of all counts should be similar. For example counts could be collected quarterly during the same weeks or months each year. This will ensure data continuity and will allow you to identify patterns over extended periods of time.

If resources are limited, counts can be conducted annually. If counts are only planned for once per year, it is recommended that they be conducted in mid-September to coincide with the dates provided by the National Bicycle and Pedestrian Documentation Project (available at http://bikepeddocumentation.org/)

▷▷ *Other Considerations*

In addition to simply counting bicycles and pedestrians, there are a number of other data characteristics that may be of interest. Depending on the needs and goals of the jurisdiction, recording the following conditions should be considered:

- People using special assistance devices (wheelchairs, vision impaired guidance, etc.)
- Other user types (scooters, skateboards, rollerblades, etc.)
- User attributes, such as gender, estimated age group, helmet use, clothing type and gear (used to identify recreation vs utilitarian trips), etc.
- Cyclists riding on the sidewalk or against traffic (on the wrong side of the street)

photo: Salt Lake City

photo: UDOT

NOTES

4.
Count Technologies

4

Count Technologies

At this point, the goals of the counts process have been determined and the targeted system users have been identified. Locations where counts will be conducted and a generalized time frame for conducting the counts have also been outlined. Now it is time to identify which methods will be used for the data collection. As alluded to in earlier chapters, there are two main ways to collect count data: manual counts and automated counts.

▷▷ *Manual Counts*

Manual counts rely on volunteers or staff to physically go to a specified site and manually count the number of target users who either pass a point (screen line count) or navigate an intersection (intersection count). They can also be used to count bicycle parking occupancy and transit boarding. Manual counts are the most familiar type of data collection for many agencies and jurisdictions. Manual counts are best used for collecting short-term snap shot data for a given location or facility, generally collected during discrete time periods.

While manual counts are much more labor intensive than automated counts and have a variety of limitations, most notably frequency and duration, there are many benefits to conducting manual counts. For example, a person conducting a manual count can identify a number of attributes that only the most technically advanced automated methods can detect such as: age of the pedestrian or cyclist, impairments or special needs of the travel (wheelchair, vision-impaired), bicyclists riding on sidewalks, bicyclists riding the wrong way on the street, or bicyclist helmet use. Manual counts do however, come with the added risk of ensuring that all data collectors are properly trained and are conducting counts the same way no matter the location. If there is variation in the way the data is collected the final counts may be difficult to compare and may be relatively impossible to aggregate.

Another drawback of manual counts is the potential for human counting error. Relying on people to conduct the data collection means relying on their ability to process information and multi-task. Since observers are required to watch the roadway or intersection as well as record the presence of cyclists or pedestrians there will almost always be an undercounting of users; particularly in busy areas or in complex locations where the observer must focus on a variety of movements simultaneously (e.g. intersection turning movements). The best way to compensate for this drawback is to ensure that there are enough volunteers or staff at each location to provide adequate coverage and limit each individual's field of observation.

Manual Counts at a Glance:

Pros	Cons
• Less expensive due to the use of volunteers and staff • Can be used at all site types for all users • Reduced need for technology, permanent infrastructure, and installations • Ability to collect more detail or enhanced user characteristics	• Lack of continuous data • Difficult to identify short-term trends or patterns • Risk human error resulting in an undercount • Requires recruiting a large labor force

Cost: < $500 (depending on duration)

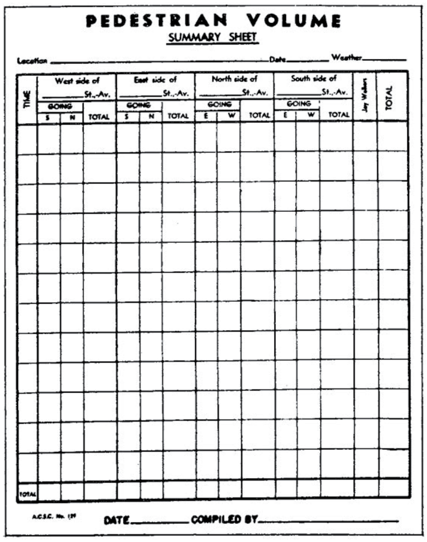
The following tools and techniques can help ensure consistency across locations when conducting manual counts:

- Tally Sheets
- Mechanical Counting Devices
- Electronic Counting Devices
- Video Observations

Tally Sheets

Tally sheets are the least expensive option for gathering manual data. Generally volunteers are provided with a standard paper form on which they can record all pertinent observations. Tally sheets can be used for both on site counts as well as video observations. Using tally sheets can lead to errors, when observers are required to take their eyes off the study area to record their counts. This method is best used in areas with light non-motorized traffic or in cases where a small number of user attributes are being recorded. An example tally sheet is provided in the appendix.

Figure 4.1 Example Tally Sheet



PEDESTRIAN VOLUME

SUMMARY SHEET

Location ________ Date ________ Weather ________

TIME	West side of ____ St.,-Av.			East side of ____ St.,-Av.			North side of ____ St.,-Av.			South side of ____ St.,-Av.			Jay Walkers	TOTAL
	GOING		TOTAL	GOING		TOTAL	GOING		TOTAL	GOING		TOTAL		
	S	N		S	N		E	W		E	W			
TOTAL														

DATE ________ COMPILED BY ________

photo: planning.org

Mechanical Counting Devices

Mechanical counting devices can be used by observers to keep track of their counts. The most common type of mechanical counting device is a hand tally counter, which is available in both analog and digital models. These handheld counters reduce error by allowing observers to count users without taking their eyes off the study area. Mechanical counting devices are most effective when used for screen line counts, as they cannot differentiate direction or maneuvers (e.g. turns). Observers press the clicker each time a user travels past. Direction can be specified by using two counters (one in each hand). Data from the clickers can then be recorder at predetermined time intervals on a tally sheet.

Figure 4.2 Micro Tally Mechanical Counter

photo: Diamond Traffic

Electronic Counting Devices

Electronic counting devices come in two primary forms; electronic counting boards, and tablet or smart phone apps. Electronic counting boards can be used for either screen line counts or intersection counts. The counting board creates a timestamp and data point for each observation (by pushing the appropriate button) and can tally the data automatically.

Tablet and smart phone apps have become more widespread and user friendly in recent years with a number of options on the market. These applications can also be used for either screen line counts or intersection counts. Similar to tally sheets, tablet or smart phone applications require observers to take their eyes off the study area to record counts. However, these technologies offer a strong advantage in their ability to process data and provide advanced analysis and graphical representation outputs.

Figure 4.3 Intersection Counting Board

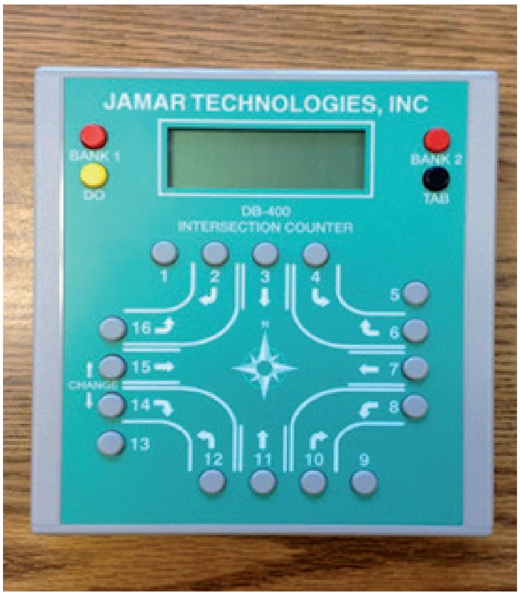


photo: Jamar Technologies

There's an App for That

As mobile computing has become common it should come as no surprise that there are a variety of smartphone and tablet applications available to assist with non-motorized traffic counts. These applications provide a user friendly interface, often based on simple Google Maps imagery. Staff or volunteers can download an app to their device, identify a count location or intersection geometry, and begin collecting data almost immediately. Data can then be manipulated, analyzed and exported in a simple pdf format. Prices for these smart counting apps range from $15-$50 and are available on both iOS and Android platforms.

Figure 4.4 Trafdata Intersection Counting App

photo: Trafdata

Video Observations

Video observations rely on automated technology to collect the data, but require manual labor to process the counts. These counts are performed almost exactly the same as an on-site count, however they have the added benefit of allowing observers to pause, stop, or replay footage to increase accuracy. Having a hard copy of the travel as it occurred in the study area also provides the opportunity to have multiple volunteers observe the same area for quality control and the potential to take a second look or double check data. Video recordings of a study area can also produce longer observation windows, as volunteers are not required to stay at a site and record observations in real time. The drawbacks are that video observations can be expensive, and they require cameras in specific locations to collect the data (which can be limited). Cameras are prone to theft and vandalism and can also malfunction. Also, each hour of video footage will typically require about three hours of data processing. Several companies do provide an option to have video observations automatically counted. The user purchases the camera and a portable data collector that records the footage. Data is then uploaded through the internet and an automated count program provides accurate counts within a few days. Users pay per hour of analysis.

Figure 4.5 Traffic Video Data Collection

photo: miovision

The key to quality valid manual counts is properly recruiting and training volunteers or staff. The success of counts depends on the number of volunteers and their dedication to the project. Additionally, the more volunteers there are, the more shifts can be covered providing larger time slots or more sites. Typically the number of volunteer shifts is equal to the number of count locations, multiplied by the number of time periods to be measured, plus additional shifts for high-volume locations. Agencies can partner with community organizations to identify staff and volunteers for counts. Incentives such as tee-shirts, snacks, or prizes can help increase volunteer recruitment and participation. Volunteers should all attend a training session prior to their shifts. Training sessions provide an opportunity for the agency to distribute materials such as count forms, provide information on what volunteers should bring to the count site, go over definitions of demographic variables to be counted, and describe how to record special cases, such as two people on a tandem bike.

Manual count data is most useful when combined with automated counts. The automated counters can provide more accurate hard data for the number of users on a given facility while manual count data can provide more breadth of information such as user types and characteristics.

Salt Lake City's
Manual Counts Program

In 2010 Salt Lake City began conducting annual bicycle counts based on the National Bicycle & Pedestrian Documentation Project methodology. Using a collaborative Google Map with input from several agencies (UDOT, UTA, and the University of Utah) the city's Transportation Department identified base count stations along existing bikeways and also identified several locations distributed throughout the city. Base stations were also located in areas where future infrastructure was planned.

Using a completely volunteer-based program, counts are conducted each September in 2-hour time blocks. Counts are taken on Tuesday, Wednesday, Thursday, Saturday and Sunday at the same 16 base locations around the city. This has allowed them to monitor trends, and see the impact of construction or other physical changes in a given year. Additionally, Salt Lake City conducts a one week count before new infrastructure is installed, typically at 2-3 locations each year. Follow-up counts are then conducted at those locations the year after to provide before and after data comparisons.

Salt Lake City has created an adjusted calculator that will allow the city to input their 2-hour counts and get an estimated daily, weekly, monthly, or annual count. The calculator has been calibrated based on city specific characteristics, such as lower ridership on Sundays (as a percentage of weekly riders). This calculator was based off of a national trip calculator and then calibrated using three years of local count data.

The capital city's volunteer-based count process (80+ volunteers participated in 2014) has proven helpful for showing long-term trends, and build constituency for bicycling.

Becka Roolf, the Bicycle and Pedestrian Coordinator for Salt Lake City summarized their experience stating that *"[Manual Counts] are a good way to get started – the primary resource needed is someone to coordinate volunteers and enter data. In the long-term, they should ideally be complemented by automated counting – both week-long and permanently mounted counters. Additionally, don't count too much on any one year of data. There are too many variables. Some locations will skyrocket at the same times as others plummet. Rolling 3-year averages are a good idea, and comparing this data with Utah Household Travel Survey and American Community Survey data will provide a clearer picture of non-motorized travel in your city".*

4

▷▷ *Automated Counts*

Automated counters involve using a device or counter to collect data in a set location. Information can either be gathered and stored on site or can be transmitted to a remote location (e.g. uploaded to a server). There are automatic counters capable of performing both screen line and intersection movement counts. Automated counters are typically used for collecting continuous data over longer periods of time.

There are a number of different technologies available for use in conducting automated counts. They include:

- Pneumatic Tubes
- Inductive Loop Detectors
- Piezoelectric Strips
- Pressure or Acoustic Pads
- Active Infrared
- Passive Infrared
- Laser Scanning
- Radio Beams
- Radar
- Micro Radar
- Video Image Processing
- Magnetometers

The following section describes each automated count method in detail including specifics on how the technology works, how the counter is installed, typical durations for counts, cost, and advantages and drawbacks for each technology type. Icons identify which modes are detected (cyclist, auto, pedestrian). Estimated accuracy rates are also provided and are taken from the data collected as a part of NCHRP Report #979.

Pneumatic Tubes

How it Works: Rubber tubes are stretched across a roadway, trail, or paved path. When a bicycle or other vehicle passes over the tubes a pulse of air passes through the tube to the detector registering a count. If multiple tubes are used the counter will be able to determine the speed and direction of each count.

Installation: Tubes should be installed on a paved surface across the entire area of interest. They should be located in areas where users are not likely to stop. The counter is powered by an internal battery pack and must be mounted to nearby posts or vegetation.

Duration: Non-permanent short-term counts

Accuracy: 95%

Pros:

- Portable and easy to set up
- Captures directionality and speed
- Familiar technology for most jurisdictions

Cons:

- Susceptible to theft, vandalism, and wear and tear
- Not appropriate when temperatures drop below freezing
- Cannot be used when street sweeping or snow plowing occurs
- Not permanent

Cost: $1,000-$3,000

Figure 4.6 Installing Pneumatic Tubes

4

Inductive Loop Detectors

How it Works: Wires are installed either on top of the pavement or embedded within the pavement. An electrical current is run through the wires that form the loops to create an electromagnetic field. When a bicycle crosses the wires, the metal frame disrupts the field and registers a count. Inductive loop detectors are used for screen line counts and they can distinguish bicycles from automobiles and other vehicles. Bikes can be detected within several feet of the wire loops.

Installation: The device can be placed on top of the roadway or paved trail surface (temporary counts) or can be embedded in the pavement (permanent counts). It should be located in a channelized location where bikes will be riding single file and are unlikely to stop. Embedded loop detectors require saw cutting of pavement and may require permits. Installation may also need to be completed by a licensed contractor if the agency does not have appropriate in-house expertise. The data logger must be mounted to nearby posts or vegetation.

Duration: Intended for permanent count locations

Accuracy: >95% on-road; 90-95% off-road

Pros:
- Can be used for on-street bike facilities (e.g. bike lanes, shoulders)
- Long lasting equipment

Cons:
- Labor intensive installation
- Electromagnetic interference can cause errors in data
- Newer bikes contain less metal (more carbon fiber) and may be under counted
- Less accurate in mixed traffic (bikes riding near cars)
- Little mobility without purchasing new loop wire for the data logger

Cost: $1,000-$3000 for equipment; more if a contractor is hired

Figure 4.7 Inductive Loop on a Shared Use Path

photo: Waterloo Bikes

Figure 4.8 Inductive Loop on a Bike Path

photo: M. Wojtaszek

Piezoelectric Strip

How it Works:
Peizoelectric strips detect bicycles by embedding two P-strips across a right-of-way within a paved surface. The strips emit an electric signal when they are physically deformed by the tires which is recorded by a data logger. Because two strips are used, this technology can record both speed and directionality. The strips and data logger can be battery-powered or externally powered and are best used in permanent locations.

Installation: P-strips should be located away from intersections in a location where bikes are unlikely to stop. Installing the strips requires saw cutting of pavement and may require permits. Installation may also need to be completed by a licensed contractor if the agency does not have appropriate in-house expertise. The data logger must be mounted to nearby posts or vegetation.

Duration: Permanent count locations

Accuracy: 90%

Pros:
- Provides speed and direction data
- Not susceptible to tampering or vandalism
- Flexible power source

Cons:
- Requires skilled installation
- Cannot distinguish bicycles riding in mixed traffic
- Difficulty detecting bicyclists riding in groups
- Cyclists avoiding the tube; vandalism; wear and tear; adverse weather

Cost: $2,500-$3,000; more if a contractor is hired

Figure 4.9 A Piezoelectric Strip

photo: Metrocount

Figure 4.10 P-Strips Installed Across a Bike Lane

photo: Metrocount

Pressure or Acoustic Pads

How it Works: Pressure pads work by detecting weight when they come into contact with a pedestrian or cyclist. Acoustic pads detect the sound waves from the footsteps of pedestrians only. These pads work very well for detecting pedestrians on unpaved trails. They are low profile and are not susceptible to tampering or vandalism, but bicycles and pedestrians must come in direct contact with the pads to be detected. They are susceptible to detection problems when the ground freezes and they do not distinguish between pedestrians and cyclists.

Installation: The pads require that pedestrians or bicyclists pass directly above them and are thus suited to situations where pedestrians or bicyclists would normally be moving, ideally single file. Areas where travelers may deviate from the path or cut corners are not ideal. The number of pads installed should match the facility width, to the extent possible, to minimize bypass errors. Pads may be able to be installed in paved locations, but this will require the pavement to be removed and replaced. Pads are not appropriate for locations with ground freezes, because counts will typically not register in a hard frost.

Duration: Long-term or permanent count locations

Accuracy: Data not available

Pros:

- Battery Powered
- Resistant to theft and vandalism

Cons:

- Require users to pass directly over the sensor
- Most appropriate for unpaved trails
- Acoustic pads can only count pedestrians
- May be susceptible to erosion

Cost: $2,000-$3,000

Figure 4.11 Installation of Pressure Pads on a Trail

photo: Scottish National Heritage

4

Active Infrared

How it Works: A device is installed on one side of a count corridor which transmits a pulsed infrared beam to a receiver on the other side of the right-of-way. Pedestrians and cyclists are detected by breaking the beam. This technology is commonly used to produce screen-line counts on a trail or mixed-use path. An internal algorithm can distinguish between bicycles and pedestrians (but not other users, i.e. skateboards, scooters, etc). Data can either be uploaded remotely using a wireless signal or can be downloaded on site using Bluetooth.

Installation: The receiver and transmitter need to be installed facing each other with a clear line of sight between them, at distances up to 90 feet apart for some products (vendor recommendations may vary). They can be installed temporarily or permanently, however finding appropriate mounting locations on both sides of a trail can be difficult for temporary counts. Installation can be done quickly (< 1 hour) with little need for specific expertise. Avoid installing sensors at locations where users are likely to congregate or stop.
Duration: Short-term and long-term counts

Accuracy: 90%

Pros:

- Good mobility, equipment is easy to move and install at a new site
- Battery powered

Cons:

- Cannot be used for on-street monitoring
- Can be triggered by other objects such as falling leaves, snow, or animals
- Errors of occlusion with side-by-side pedestrians or cyclists
- Must be mounted to fixed objects on both sides of the trail or sidewalk

Cost: >$3,000

Figure 4.12 Infrared Transmitter and Receiver

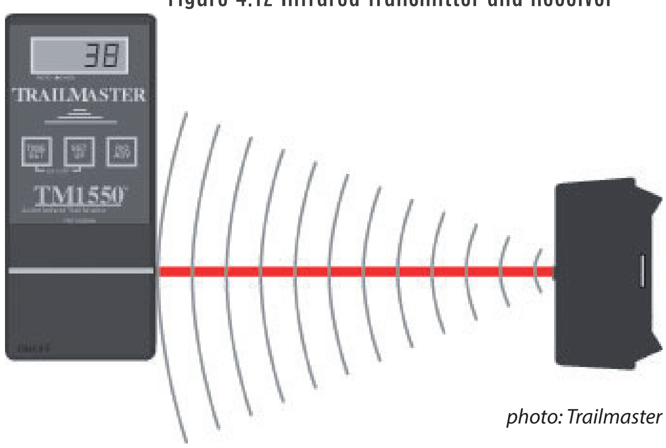


photo: Trailmaster

Passive Infrared

How it Works: A pyroelectric sensor identifies bicyclists and pedestrians by comparing background temperature to the temperature emitted by persons passing through the detection area (less than 10 feet). The sensor is located on one side of the facility being counted. These devices can be used for collecting short or long-term screen line counts. Data can either be uploaded remotely using a wireless signal or can be downloaded on site using Bluetooth.

Installation: Sensors have a self-contained battery pack and are easy to install and can be disguised inside a post or existing infrastructure. Sensors must be installed at the recommended height (2-3 feet), and work best when pointed against a fixed object (e.g. a wall). It is best to avoid areas where pedestrians or cyclists may stop or congregate. The sensor will produce the best results when located at a 45 degree angle to the pathway being counted in an area away from heavy vegetation, water, reflective surfaces, or background traffic.

Duration: 2+ weeks

Accuracy: 97%

Pros:

- Good mobility, equipment is easy to move and install at a new site
- Small and unobtrusive
- No construction or pavement intrusion required
- Can be used on paved or unpaved paths

Cons:

- Cannot differentiate between bicyclists and pedestrians
- Cannot identify travel direction unless two sensors are used
- May suffer from occlusion with groups of pedestrians
- Extreme temperatures (95+ degrees) can impact measurements
- Functionality can be limited by weather (snow, fog, rain, etc.)
- Wildlife may be inadvertently counted in off-road locations

Cost: $1,000-$3,000

Figure 4.13 Passive Infrared on a Trail

photo: Be Counted New Zealand

Figure 4.14 Passive Infrared Installed at a Crossing

photo: Be Counted New Zealand

4

Laser Scanning

How it Works: Laser pulses are sent out in a range of directions to determine characteristics of the device's surroundings. Pedestrians and bicyclists are recorded based on reflected pulses. Two varieties of laser scanners exist: horizontal and vertical.

Installation: Each scanner is installed at the side of or above the detection area. Horizontal detectors should be installed in a location free from obstructions. Avoid installing scanners at locations where users are likely to congregate or stop.

Duration: Short-term on battery power; long-term/permanent with a power source

Accuracy: Data not available

Pros:

- Limited time and effort to collect data

Cons:

- Limited use in the United States
- Tailored for indoor application
- Difficulty in inclement weather (rain, snow, fog) due to interference with laser pulses

Cost: Unknown due to limited implementation in the United States

Figure 4.15 Laser Scan Output in Visualization Software

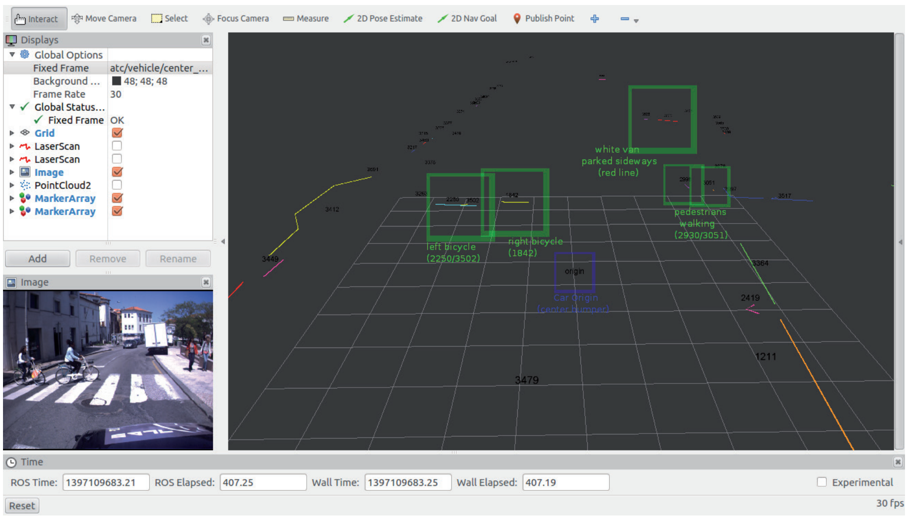


photo: Rui Azevedo

4

Radio Beams

How it Works: Radio waves can detect both bicycles and pedestrians by installing a radio transmitter and receiver on opposite sides of a count corridor. Detection occurs when the radio signal between the source and the receiver is broken. Dual beams with different frequencies can be used to differentiate between pedestrians and cyclists. This technology can be used to conduct screen line counts on sidewalks, trails, or cycle tracks.

Installation: These systems are mobile and easy to install, but may have difficulty in accurately counting groups or side-by-side pedestrians. The receiver and transmitter need to be installed facing each other with a clear line of sight between them. The receiver and transmitter should ideally be located no more than 10 feet apart. It is best to identify an installation located at a narrow location along the target corridor. The radio beam can pass through thin wood and plastic, so the devices can be hidden behind certain types of objects. The devices can be mounted on existing infrastructure or installed in a post, so the device is completely hidden from sight.

Duration: Short-term and long-term counts

Accuracy: 80% bicycles, 60% pedestrians

Pros:

- Mobile and easy to install
- Can be hidden to reduce risk of theft or vandalism
- Battery powered

Cons:

- Cannot differentiate between bicycles and pedestrians without multiple products
- Errors with large groups
- Equipment must be mounted to fixed objects
- Distance is limited

Cost: $3,000-$6,000

Figure 4.16 Radio Transmitter and Receiver along a Trail

photo: snh.gov.uk

Figure 4.17 Radio Beam Detection at a Crossing

Radar Signals

How it Works: High frequency radio frequency pulses are transmitted, bounced off a target object, and the return pulses are measured by a time-gated radio frequency mixer. Radio frequency reflections are analyzed to produce presence, distance, and motion measurements.

Installation: The Utah Department of Transportation is currently in the process of updating their traffic signals to include radar vehicle detection. Within the next 5-10 years most UDOT signals will be equipped with radar detection. Radar detection can also be installed on locally operated traffic signals.

Duration: Long-term or permanent counts

Accuracy: Up to 90% in limited local testing

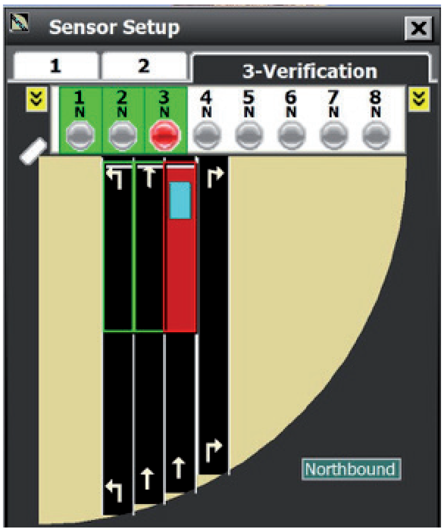
Pros:
- Can be programmed to detect specific areas (i.e. bike lanes, sidewalks)
- Hardware is already in place or will likely be in the near future

Cons:
- Automobiles can be counted as bikes if they enter the detection zone
- Potential occlusions problems counting bicycles as automobiles
- Narrow bike lanes (<4 ft) can make detection very difficult
- Cannot differentiate between bicycles, pedestrians, and vehicles

Cost: $6,000 per approach (approximately $24,000 per intersection)

Figure 4.18 Matrix Radar Installed on Traffic Signal

Figure 4.19 Radar on Screen



Micro Radar

How it Works: High frequency radio frequency pulses are transmitted, bounced off a target object, and the return pulses are measured by a time-gated radio frequency mixer. Radio frequency reflections are analyzed to produce presence, distance, and motion measurements. Small micro radar sensors or "pucks" are installed near a pathway or flush with the pavement and can detect bicycles and pedestrians that pass within 4-10 feet. Filters can be applied to fine tune detection parameters. Data can be downloaded automatically using a fiber connected traffic signal (if located close enough), or a cellular signal.

Installation: Micro radar is installed in pavement using a hammer or core drill. The radar "puck" is installed in the pavement and then sealed with epoxy. Radar pucks can also be installed above ground using raised PVC pipe (as shown in the graphic).

Duration: long-term or permanent counts

Accuracy: 95% in limited local testing

Pros:

- Battery powered
- Resistant to vandalism and theft

Cons:

- Installation may require a contractor
- Requires calibration
- Cannot differentiate between bicycles, pedestrians, and vehicles

Cost: $1,000-$3,500; more if a contractor is hired or if a cellular subscription is needed

Figure 4.20 Installation of a Micro Radar Puck

photo: Mark Taylor, UDOT

Figure 4.21 Micro Radar at a Trailhead

Video Image Processing

How it Works: Video images can count pedestrians and cyclists by using pattern recognition and computer algorithms to measure each time a user enters a specific target area. Cameras can capture a study area of up to 150 feet.

Installation: Cameras should be mounted at least 25 feet above ground level for maximum coverage and should be at least 12 feet away from the segment of roadway being measured. Cameras can be purchased directly from the vendor for installation on site, or separate software can be purchased that is designed to pair up with existing traffic cameras.

Duration: Short-term counts

Accuracy: Not available

Pros:

- Limited time and effort to collect data
- Can provide intersection turning and screen line counts
- Video can be used for secondary purposes

Cons:

- Data storage limitations
- Data must be uploaded to the vendor for processing
- Short-term data collection only
- Multiple cameras may be needed to capture an entire intersection
- Limited by weather and lighting conditions
- Require cleaning and maintenance

Cost: $1,200-$4,000+

Figure 4.22
Video Processing
Detection of Pedestrians

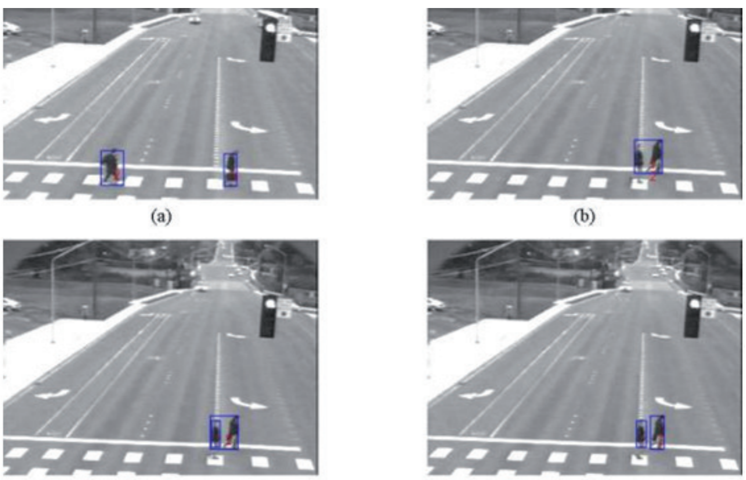


photo: Miovision

Magnetometers

How it Works: Magnetometers are small devices that can be buried under or next to a trail to detect bicycles. They detect bicycles through changes in the normal magnetic field. They are invisible after installation and therefore are not susceptible to tampering. Magnetometers are best suited to rural locations because the device is highly sensitive to metal objects. Due to the magnetometer's limited detection range (approximately 3 feet), they are preferably installed where bicyclists will travel single file.

Installation: Installation requires excavating an unpaved area or removing pavement from a bicycle facility, followed by replacement. They are not appropriate for locations with ground freezes.

Duration: Long-term counts

Accuracy: Data not available

Pros:

- Battery Powered
- Resistant to vandalism and theft

Cons:

- Small detection area
- Sensitivity to metal objects other than bicycles

Cost: $1,000-$3,500

Figure 4.23
Bicycle Barometer in Seattle, WA

photo: City of Seattle - SFMTA

Bicycle Barometers

While not a count method in and of itself, a bicycle barometer can be combined with a number of different count technologies to display counts at a particular location. The barometer is linked to a counter (such as an inductive loop or pneumatic tubes) and simply displays the number of bicycles passing that location each day. These can increase awareness or bicyclists and may be appropriate for high volume corridors or high visibility areas such as downtown areas or college campuses.

Table 4.1 Summary of Automated Count Technologies

Counter Type	Detection		Typical Location	Accuracy
	Peds	Bikes		
1 **Pneumatic Tubes**		✓	On-road bikeways Exclusive bike paths	> 96%
2 **Inductive Loop**		✓	On-road bikeways Mixed-use paths	>95% on-road 90-95% off-road
3 **Piezoelectric Strips**		✓	Paved locations with no vehicle traffic (e.g. bicycle and multi-use paths)	90%
4 **Pressure Pads**	✓	✓	Unpaved trails Unpaved walkways Public stairways	Data not available
5 **Acoustic Pads**	✓		Unpaved trails Unpaved walkways Public stairways	Data not available
6 **Active Infrared**	✓	✓	Off-street paved or unpaved paths	90%
7 **Passive Infrared**	✓	✓	Sidewalks Off-street paved or unpaved paths	>97%
8 **Laser Scanning**	✓	✓	Large detection areas Transit station/plaza	Data not available
9 **Radio Waves**	✓	✓	Off-street trails On-street detection for bikes and vehicles	80% bicycles 60% pedestrians
10 **Radar Signals**	✓	✓	Signalized intersections with bike lanes	90-95% (limited local testing)
11 **Micro Radar**	✓	✓	Off-street paved or unpaved paths	> 95% (limited local testing)
12 **Video Image**	✓	✓	Roadway intersections and corridors	Data not available
13 **Magnetometers**		✓	Mountain bike trails Off-street trails (no more than 6' wide)	Data not available
Bicycle Barometer		✓	High volume corridor High visibility location	Depends on count technology used with the barometer

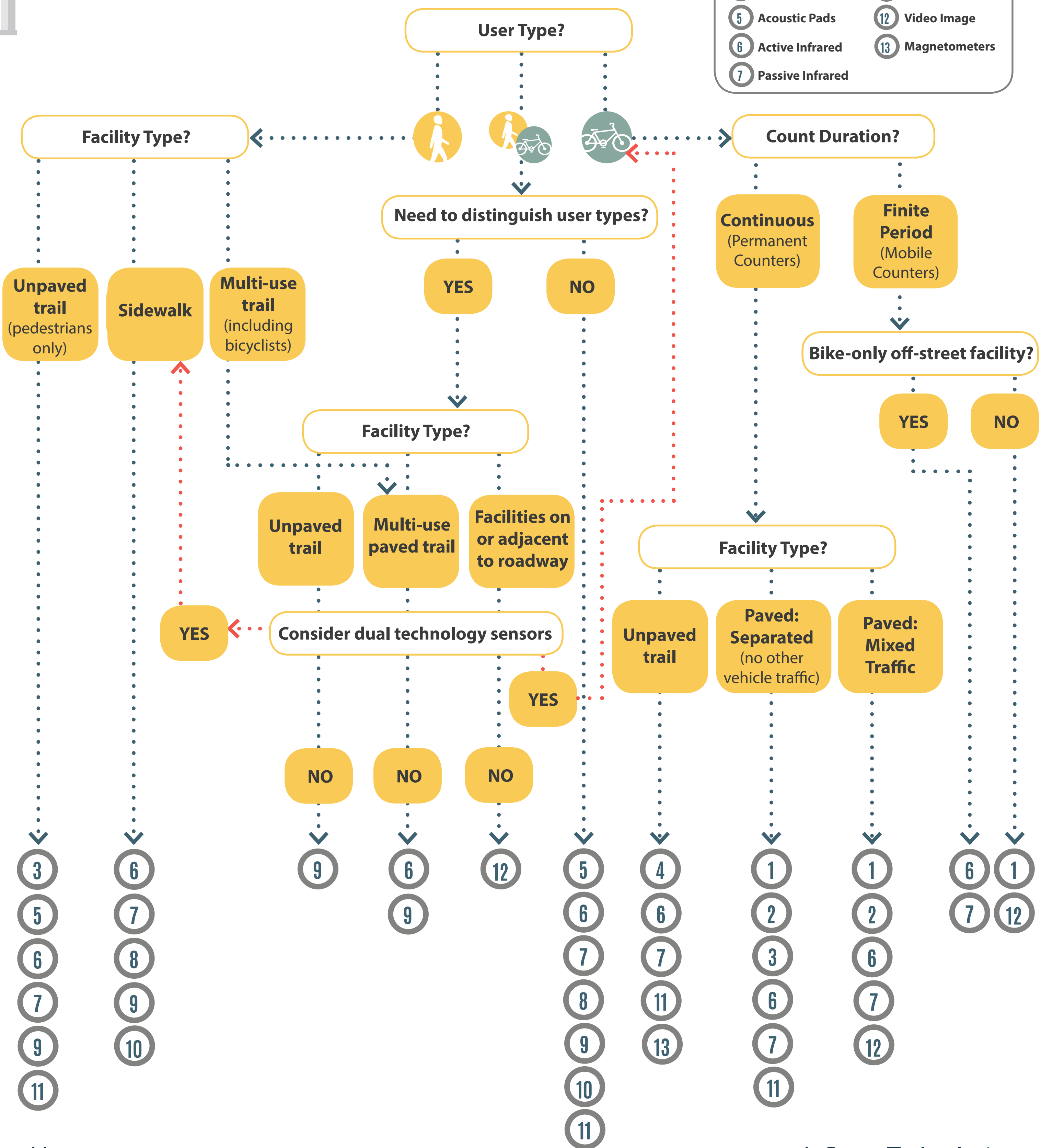
Decision Flow Chart for Automatic Counters

Not all automatic counters work in all situations. Use this flowchart as a guideline to find a counter(s) that works in your situation.

Figure 4.24 Decision Tree of Count Technologies

KEY:

1. Pneumatic Tubes
2. Inductive Loops
3. Piezoelectric Strips
4. Pressure Pads
5. Acoustic Pads
6. Active Infrared
7. Passive Infrared
8. Laser Scanning
9. Radio Waves
10. Radio Signals
11. Micro Radar
12. Video Image
13. Magnetometers



NOTES

5.

Preparing to Conduct Counts

5

Preparing to Conduct Counts

The previous chapters have described how to create and plan a counts program, and have described all the available technologies including details on how to select appropriate data collection methods. This chapter provides additional details on how to implement the program and conduct the actual counts.

There are four major steps that must be taken before counts can begin.[1] They include: obtaining appropriate and required permissions, acquiring the necessary equipment, training volunteers and staff, and installing and validating any automated counters.

▷▷ *Obtaining Permission*

Depending on the location where the counts will be conducted, installing counters or conducting counts may require securing permission from the property owner. If your organization owns the right of way (e.g. UDOT, local municipality) or the location where the equipment/counter will be installed, it is likely that no permission will be required. It is always best to double check with all applicable agencies or property owners before installing any equipment. If manual counts are going to be conducted, make sure staff or volunteers stationed on the property have permission to be there for the duration of the counts. Keep in mind that multiple agencies may have jurisdiction over a single location. Try to get any permissions (including permits or bonds) in writing and maintain a copy with whomever will be on site during the installation or manual site counts.

▷▷ *Acquiring Necessary Equipment*

Chapter 4 provided a veritable menu of options for conducting non-motorized counts. There are appropriate and effective methods and technologies available for most count scenarios, and the flow chart at the end of the chapter (Figure 4.24) provided a decision tree to help identify which methods are best for any specific circumstance. After identifying which types of counters or methods will be employed, the next step is to acquire the equipment.

There are a number of qualified vendors who provide automated count technology. Selecting high-quality equipment will help ensure the collection of high-quality data. Most automated counters include a sensor as well as mounting equipment and data loggers. It is strongly recommended that several vendors be considered. Follow-up with a representative to get as much specific information as possible egarding program needs and the appropriate product for the job. A list of potential questions for vendors is provided below.

1 Steps taken from the "Guidebook on Pedestrian and Bicycle Volume Data Collection". Transportation Research Board. (2015). National Cooperative Highway Research Program. Report No. 797. Available online at: http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_797.pdf

Questions to ask potential vendors:

- ***How will the product be shipped and what will come with it?***
- ***Will the counter require any additional equipment to be functional (e.g. electrical connection, batteries)?***
- ***How will the device communicate data (cellular data signal, Bluetooth, etc.)?***
- ***Does the device come with a warranty, and what is the expected use life?***
- ***Will certain environmental conditions impact the effectiveness of the device?***
- ***Are there specific geometric conditions required for the device to operate effectively (e.g. height above ground, installation on a specific type of pole/wall)?***
- ***How much time will it take to install, and how difficult is the installation process?***
- ***Do you provide guidance on calibrating the counter and making adjustments?***
- ***Will it be necessary to hire a contractor to install the device?***
- ***How secure is the device after installation? Are there extra security options available?***
- ***Is there an option to rent or lease the equipment?***
- ***How is data downloaded from the device?***
- ***What data formats are used and is software included?***
- ***Has the equipment been used elsewhere and has it received positive reviews?***
- ***What kind of customer service is provided to assist with installation or troubleshooting?***
- ***Does the vendor regularly provide software and equipment upgrades? Are there fees associated with these upgrades?***

A more comprehensive list of questions for vendors can be found in Section 3.3.2 of the NCHRP "Guidebook on Pedestrian and Bicycle Volume Data Collection".

While UDOT does not recommend or endorse specific products or manufacturers, several local communities have had experience using a variety of automated counters and would likely be willing to discuss their individual experiences. A list of automated count technology vendors is provided in Chapter 7.

5

▷▷ *Training Volunteers & Staff*

Proper training of volunteers and staff is essential to ensure the most accurate and consistent manual counts. As discussed in Chapter 4, manual count training should be provided to people who are counting in the field and to people who are taking counts from video recordings. The National Cooperative Research Program has provided the following detailed guidance for training volunteers.

Training should help data collectors understand the following:

- *The overall purpose of the counting effort*. Data collectors who understand how the data will ultimately be used are more likely to concentrate and take the job seriously.

- *Definitions of "pedestrian" and "bicyclist" (or "bicycle")*. Make sure the data collectors understand the definitions of pedestrian and bicyclist used in the community. Tricky aspects of these definitions include skateboarders (typically counted as pedestrians), babies being carried or pushed in a stroller (typically counted as pedestrians), people walking their bicycles (typically counted as pedestrians), dogs on leash (not typically counted, but their owners are), and bicyclists on a tandem bicycle (typically counted as two bicyclists but one bicycle).

- *Exactly when a person should be counted.* For trails or roadway segments, pedestrians and bicyclists are typically counted when they pass an imaginary line from either direction. At intersections, some methods count pedestrians only when they cross the street (specifically, when they pass the centerline of the roadway being crossed). In this case, pedestrians who turn right or left at a corner but do not cross the street are not counted. Furthermore, should pedestrians be counted at an intersection if they cross outside the crosswalk lines? Some methods specify that all pedestrians crossing within 50 feet of the crosswalk lines should be counted. Finally, some methods count bicyclists when they arrive at an intersection, while others do not count a bicyclist until he or she goes left, straight, or right—an important consideration to correctly classify bicyclists who dismount and walk their bicycle after arriving at an intersection.

- *Priority of characteristics to count.* While most automated technologies register a single count each time a pedestrian or bicyclist enters the counter's detection zone, manual data collectors can observe pedestrian and bicyclist characteristics and behaviors. Manual observers may be asked to also document age, gender, helmet use, assistive-device use, turning movements, or behavior each time a pedestrian or bicyclist is counted. This information can provide a rich set of data for analysis. However, collecting more characteristics and behavioral data increases the complexity of the data collection effort and can diminish counting accuracy, especially in locations with high pedestrian and bicycle volumes. Therefore, it is important for the data collector to know which characteristics are the most important to document. The highest priority should be to collect volume by mode (i.e., get the total count right). It may be necessary to use additional observers to document pedestrian and bicyclist characteristics and to count complex sites effectively.

Source: NCHRP Report #797- Section 3.3.4

Additional Guidance

Regardless of a volunteer's willingness to participate, there are times when individuals should not participate in counting activities. During training, agency staff should make an effort to evaluate the ability of each volunteer for conducting the count. Things like availability of transportation to the study site, punctuality, ability to follow directions, and trustworthiness, should all be considered. Remember, these individuals will be representing the agency/jurisdiction during the count. You want to make sure that they will behave in a professional way.

During training all staff and volunteers should be instructed to be aware of their surroundings, to be cautious near vehicle travel lanes, and should be provided with a letter or some other form of official documentation that describes the counting effort and the individual's role. Emphasize the importance of each volunteer having that documentation on hand as it can provide legitimacy and clarity if member of the public approaches them to ask questions. When planning manual counts, identify ahead of time which sites may need more than one data collector. Locations with higher user volumes or a greater mix of pedestrians and bicyclists will require more data collectors to ensure accuracy.

Finally, provide volunteers with guidance on contingency plans for a number of potential scenarios. For example, what should they do if the weather takes a turn for the worse while they are counting, or how to react if an angry property owner or member of the public approaches them challenging their right to be in that location?

Notify Local Authorities

Make sure that prior to conducting manual counts all appropriate local agencies or divisions are informed of the effort, including: police, fire, streets, parks and recreation, etc. Having volunteers and staff approached by police for looking suspicious as they observe traffic and take notes could jeopardize the counts process.

Figure 5.1 Volunteers Receiving Count Training

photo: Dr. S. Park, Villanova University

5

▷▷ *Installing and Validating Equipment*

When the count equipment arrives from the vendor, conduct an inventory to ensure that all necessary components are included and identify if any additional tools or equipment may be necessary for installation. Also, test all components to make sure they are in working order before installing them at the count site. The equipment will include specific detailed directions on installation procedures. Reputable vendors will also provide technical support if you need assistance or have questions during the installation process.

Where to install counters

The FHWA Traffic Monitoring Guide provides the following additional guidance on selecting optimal count locations. Count should be conducted:

- On straight, level sections of road or trail, not on curves or on or near a steep grade;
- On smooth pavement or other compacted surface;
- Where the traveled way is clearly delineated and deviation is not common;
- For infrared sensors, not near water or in direct sunlight;
- For infrared sensors, not directly facing the roadway unless a vertical barrier exists; and
- For inductance loop detectors, not near high-power utility lines that could disrupt or distort the detection capability.

Manufacturer instructions will provide more specific data on installation locations for each specific technology and model. It is important to pay strict attention to these instructions and recommendations when identifying locations for installation. It makes little sense to spend the money on a state-of-the-art count equipment only to ignore the recommendations and introduce error by installing the counter improperly or in a poor location.

Once general monitoring locations have been identified, the most suitable counter positioning should be determined. The NBPD Project recommended the following guidance for counter positioning:

- For multi-use paths and parks, locations near the major access points are best.
- For on-street bikeways, locations where few if any alternative parallel routes are best.
- For traditional downtown areas, a location near a transit stop or in the center of downtown is best.
- For shopping malls, a location near the main entrance and transit stop is best. Count at one access point.
- For employment areas, either on the main access roadway or near off-street multi-use paths is best. Count at one access point, typically a sidewalk and street.
- For residential areas, locations near higher density developments or near parks and schools are the best. Count at one access point, typically a sidewalk or street.

In many cases, these recommended counter-positioning locations will result in the highest non-motorized traffic volumes. Given limited data collection resources and specific data uses, this focus on high-use locations may be appropriate. However, one should recognize that these high-use locations might represent a biased estimate of use levels and trends for an entire city jurisdiction.

Validating Equipment

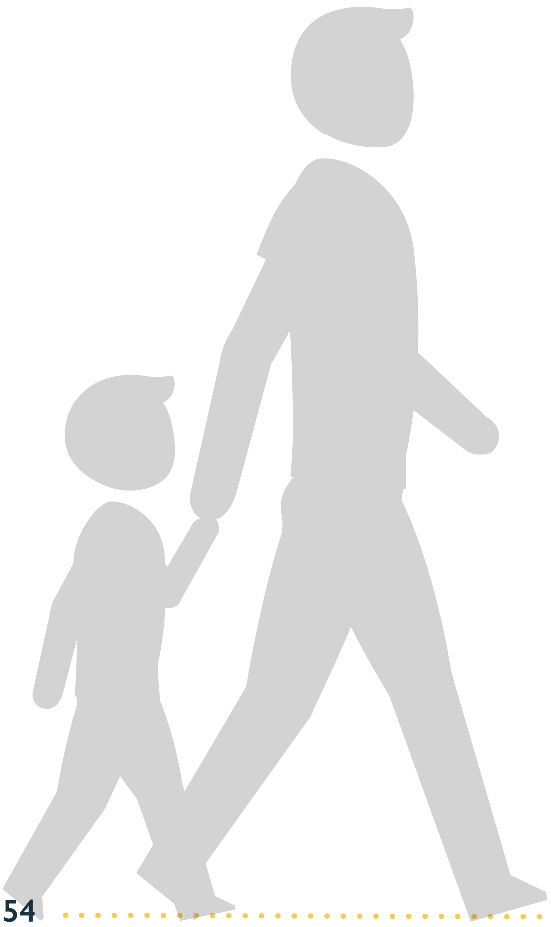
Once counters are installed in an optimal location, the technology should be tested and validated on site. Choose a predetermined time period to collect counts using the technology. Ideally these preliminary counts should be ground checked by sending staff to the location during the same time period to collect manual counts. Video surveillance can also be used to ground check your counts. Do this several times in a variety of conditions (hot/cold, wet/dry, etc.). Manual counts that are comparable to the automated counts within a reasonable margin of error can provide confidence in the numbers being produced. It is recommended that this ground checking occur at regular intervals throughout the life of the counter (e.g. every quarter, twice per year, or annually) to ensure that error is not being introduced over time due to slippage in the calibration. If the counters are off by a significant margin, follow-up with the manufacturer or vendor. Most vendors will provide free customer support in recalibrating or troubleshooting potential problems with the device.

Figure 5.2 Bicycle Counting Equipment, Portland, OR

photo: Eco Counter

Figure 5.3 Receiver Box for Downloading Count Data

photo: Jamar Technologies



NOTES


START CROSSING
WATCH FOR TURNING VEHICLES
DO NOT START
FINISH CROSSING IF STARTED
DO NOT CROSS
TO CROSS
PUSH BUTTON

6.
Data Analysis

6

Data Analysis

Counts have now been collected, and there is now a repository of data that should not go to waste. This chapter will walk through the basics of how to ensure data quality, process the count data, extrapolate meaningful information, and how to employ it to promote policy change.

▷▷ *Determining Data Quality*

The concluding section of Chapter 5 described the importance of validating the count equipment after installation is complete and conducting ongoing ground checks over the lifespan of the equipment. This is an incredibly important step in ensuring that the data outputs from the counts program remain high-quality. There are several steps that can be taken check data quality. First, performing a manual visualization of the data by looking for consistency over space (e.g. two count locations that are located near one another). If one location shows substantially higher volumes there may be a problem. Second, double up on technology. Using multiple counters or methods at a single location can ground check count data in real time. Third, if historic data is available it can be used to provide insight into seasonal variation or trends that can be expected in a given location even if different methods were used to collect the data. Keep in mind that pedestrian and cyclist volumes can vary quite a bit from year to year or season to season.

If, after validating your counter, there are substantial inaccuracies in the data, it may be due to one of the following factors:

Occlusion- When conducting screen line counts high volumes may lead to multiple users crossing the measurement line simultaneously. If the counter fails to recognize more than one user occlusion occurs and the total volume of users is underreported. This is especially prevalent with higher user volumes and during peak periods.

Environmental Factors- As described in Chapter 4, many of the existing count technologies do not perform well in extreme weather conditions. Very hot (>90°) or very cold (<10°) temperatures, and precipitation (rain, snow, fog) can cause counting inaccuracies.

Counter Bypassing- Even if the counters are accurately counting users that pass through the detection zone, the number of actual users may still be undercounted. In some cases the technology does not span the entire width of the travel area (e.g. inductive loops) or users may travel off path near the counter (e.g. cyclists may try to avoid crossing tubes). This creates blind spots and results in an underreporting of actual facility usage. Identifying appropriate locations for installation based on specifications of the technology can significantly limit this type of counting error.

6

Data Processing

In reviewing non-motorized count data, it is important to understand the basics of how data is processed by the field equipment and imported to wherever it is being stored; whether that be a stand-alone spreadsheet, a mode-specific database, or a traffic monitoring data warehouse. The following elements should be considered:

- What formats (e.g., data structure, time intervals, metadata) are available and/or being reported from the field equipment?
- What quality assurance and quality control processes are applied to the field data?
- Are questionable or erroneous data flagged and/or removed?
- What summary or adjustment procedures are applied to the field data?
- How does the current process/system address missing data (e.g., due to equipment hardware, software, or communications errors)?
- Are estimated or imputed values flagged or documented?
- Are the non-motorized data stored/integrated with motorized data? Alternatively, is there an entirely separate process?
- Are data summarization processes automated to the fullest extent possible? Is manual review and/or intervention required?

Source: FHWA Traffic Monitoring Guide

▷▷ *Data Analysis*

Once the count data has been checked for quality, it can be analyzed in a number of ways. Beginning with the most basic summaries, the following traffic patterns and profiles can be identified:

- How do counts vary throughout the day?
- How do counts vary by day of the week?
- How do counts vary by month or season?
- How do counts vary for inclement weather and other special events?
- How does traffic vary by street functional class or the presence of bike or pedestrian facilities?
- How do traffic patterns and profiles compare at different locations in areas with different land use and demographic characteristics?

In order to determine which type of data analysis is appropriate, it is best to revisit the purpose of the counts program. If counts are being collected to provide evidence based support for future infrastructure investment, then data should be presented in a way to demonstrate specific location or infrastructure needs.

▷▷ *Types of Data Visualizations*

When presenting ideas that include references to data, it can be helpful to make the point using a graph or table. These visual methods can make the point much stronger than simply describing the data. While they can be powerful methods, they also have the potential to ruin a presentation if they convey the wrong message or they confuse the audience. There are four main types of data visualizations that can be produced with count data: tables, graphs, charts, and maps. Each visualization type is described below with examples of outputs and how they can be used effectively to communicate count data. Many of the existing count technologies and equipment come with data analysis and visualization software than can easily provide graphical outputs for all count data.

Tables

Tables can be very beneficial at conveying a large amount of specific data in an organized fashion. The basic structure of a table is a set of columns and rows that contain the data and usually contain either a row or column (or both) of headings that organize the data. In selecting the size of the table, make sure that the font size of the text in each cell of the table is big enough to be read clearly when displayed. A table is generally less effective than a graph because it only shows the data, whereas the graph shows an interpretation of the data, which is easier for the audience to understand. When you are presenting a table, you will need to provide the interpretation of the data for the audience. One way to make certain cells stand out is to change the background color of the cell or enhance the text by changing the color or making it bolder. Column and/or row headings should be bolded to distinguish them from the data.

Figure 6.1 Demographic Breakdown for Nashville Trail Users

	7-9 AM		4-6 PM	
	2013	2014	2013	2014
Bike Men	333	346	429	576
Bike Women	108	87	114	275
Bike Total	**441**	**433**	**543**	**851**
Walk Men	1109	1341	1323	1725
Walk Women	1112	1239	1165	1402
Walk Total	**2221**	**2580**	**2488**	**3127**
Bike Gender Ratio	3.1	4	3.8	2.1
Walk Gender Ratio	1	1.1	1.1	1.2
Walk/Bike Ratio	5	6	4.6	3.7
24th/Blakemore gender ratio		2		2.2
Demonbreun/8th gender ratio		11.5		5

Figure 6.2 Count Comparisons by Month in Seattle, WA

Bicycle Count Comparisons for Jan, May and July, 2011 and 2012				
2011 vs 2012	**AM**	**PM**	**SAT**	
Jan 2011	708	1253	1290	
May 2011	1415	4111	1948	
July 2011	2216	6108	3835	
2011 Total	**4339**	**11472**	**7073**	**22884**
Jan 2012	1248	2075	1051	
May 2012	1863	6487	3836	
July 2012	1513	3776	2099	
2012 Total	**4624**	**12338**	**6986**	**23948**
Overall Increase				**+4.7%**

Figure 6.3 Non-Motorized Intersection Movements in Fairbanks, AK

North South Road	**East West Road**	Cyclists Heading South	Pedestrians Heading South	Cyclists Heading East	Pedestrians Heading East	Cyclists Heading West	Pedestrians Heading West	Cyclists Heading North	Pedestrians Heading North
Steese Hwy	3rd Street	4	7	16	13	12	5	15	9
Old Steese Hwy	Trainor Gate Road	18	9	0	3	5	2	30	16
Barnette Street	Airport Way	19	19	6	8	12	10	12	8
Goldhill Road	Sheep Creek Rd Ext	4	0	11	0	11	3	0	0
University Avenue	Airport Way	23	13	23	5	14	5	12	9
Caribou Way	College Road	3	2	25	1	23	4	4	0
Nordale Road	Badger Road	1	0	3	0	1	2	0	0
Old Steese Hwy	Johansen Expy	1	0	11	1	8	1	3	1
Old Richardson Hwy	5th Avenue (NP)	0	0	11	5	12	2	1	0
Sheep Creek Road	Parks Highway	4	0	11	3	16	3	0	0
Chena Pump Road	Chena Ridge Road	19	9	4	3	2	6	13	5
Illinois Street	Minnie Street	23	3	1	0	7	2	31	6
Badger Road	Hurst Road	4	12	0	2	0	1	3	16
Dawson Road	Plack Road	1	0	4	0	1	0	0	0
Farmers Loop Road	Ballaine Road	21	3	5	4	0	0	57	3
Peger Road	Airport Way	17	10	32	8	19	4	15	5
Peger Road	Phillips Field Road	17	1	10	0	7	1	28	5
TOTAL		179	88	173	56	150	51	224	83
								726	*278*

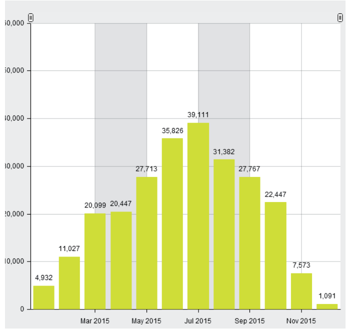
6

Graphs and Charts

There are four basic types of graphs/charts that are used most frequently.

1. **Column** - This graph shows the differences in individual values vertically. It can be used to show the differences between values in different time periods or other data groupings. Examples include showing the total number of bikes passing through an intersection each month for the past year or the number of pedestrians traveling on each of three shared-use paths over the last month. This graph works best with fewer (1-3) data series.

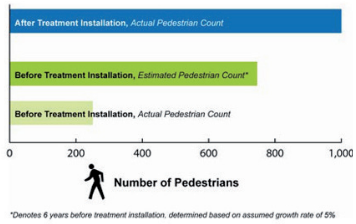
Figure 6.4 Monthly Trail Users in Utah County



graph: Mountainlands Association of Governments

2. **Bar** - This graph shows the differences in individual values horizontally. It is not a good choice for showing values in different time periods. It works better for showing the results of one or two data series. One example would be to show the popularity of the top eight answers to a survey question.

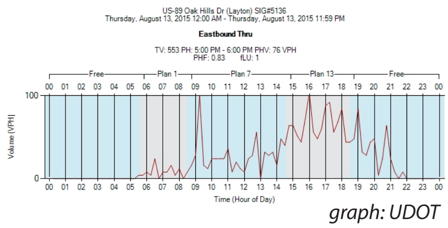
Figure 6.5 Change in Trail Usage Before/After Treatment



graph: FHWA

3. **Line** - This graph shows values at different points in time. It is usually best to have equal time intervals along the horizontal axis of the graph. One example would be to show the trend in the number of trail users each hour over an entire day. A line graph can display many (4-6) data series quite well.

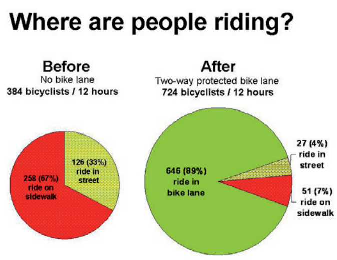
Figure 6.6 Micro Radar Output of Trail Users- By hour



graph: UDOT

4. **Pie** - This graph shows the proportions of each segment of a whole. This graph only handles one data series. An example would be to show the breakdown of non-motorized user types (cyclists, pedestrians, other) on a shared-use path over a predetermined time period.

Figure 6.7 Location of Cyclists Before/After Bike Lane Installation



graph: Honolulu.gov

It is often best to experiment with different graph types to see which graph best conveys the intended message. For example, it may be more compelling to show a time series of total users on a facility each month over a calendar year than to show the number of daily users.

6

Data Analysis

Key Graph Elements

Colors – Make sure to set the background color and the color of each data series so that there is enough contrast to be seen clearly by the audience. These colors should also be consistent with the overall color scheme of the slides so that the graph does not look out of place.

Axes – All of the above graph types (except the pie graph) have two axes. One is for the data values and the other is for the time scale or how the data is separated. It is important to set the scale of the axes to be appropriate to the data being shown. Also, make sure that axis labels that indicate the values along each axis are big enough to be clearly read when the graph is displayed. If the axes are not clear, the graph may be misinterpreted because it is not clear to the audience what the difference between the data is.

Data Labels – When a data value in a graph is not clear, use a data label. This is a text box that contains the actual data value and it should be placed close to the graphical representation of the data point, whether it is at the end of a bar or column, above a data point on a line graph or inside the pie section in a pie graph. Make sure that the text is big enough to be read clearly and that the text color has enough contrast with the color underneath it.

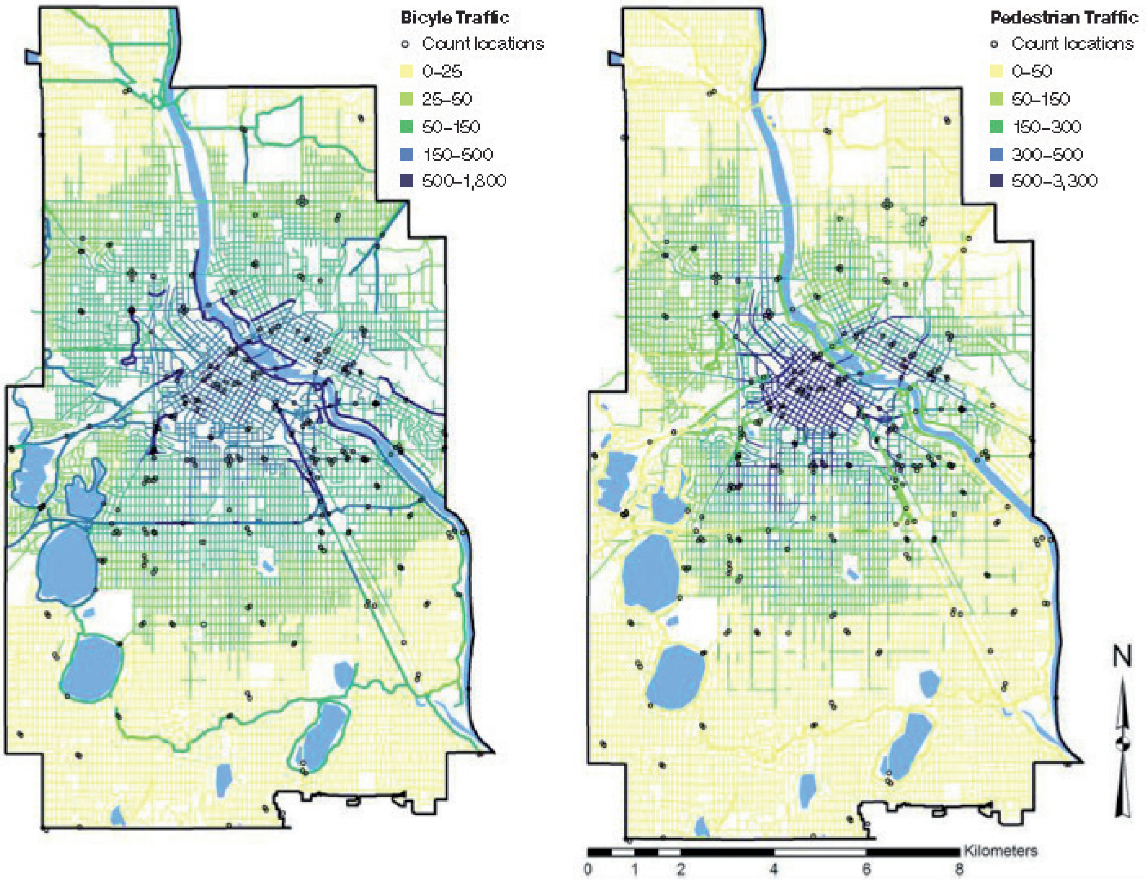
Title – The title of the graph should focus on the interpretation of the data, not the data itself. Remember that the graph is being used to help make a point, and the title will be a key factor in the audience interpreting the graph properly. For example, instead of using a title like "Trail Users 2015", say "Trail Usage Increased 42% in 2015". There is usually no need for a separate title on a graph since the slide headline will communicate the meaning of the graph.

Legend – If there is more than one data series on a graph, text labels should be added to indicate each series instead of using a legend on the graph. Research shows that a legend distracts the audience by forcing them to split their attention between the data in the graph and the explanantory text in the legend, reducing their understanding of the graph. Instead, put any explanatory text in the graph using text boxes.

Maps

Many options are available for making a data-driven map, based on what message is to be conveyed, what data is available, and what kind of data it is. The popular symbolization styles like choropleth maps, point density, and scaled points all have advantages and disadvantages, and certain uses that are more natural than others. If the count data has been geocoded, a Geographic Information System can make creating a data-based map incredibly easy. The Geodatabase will also provide the functionality to conduct additional complex analysis and fine tune any visualizations. Heat maps or graduated symbol maps are arguably the most effective way to display count data. Heat maps use a graduated color to imply count volume or density over a given time period. A graduated symbol map displays count data with a point or symbol's size corresponding to the absolute or relative count value in a given location.

Figure 6.8 Choropleth Map of Bicycle and Pedestrian Traffic in Minneapolis, MN



graph: City of Minneapolis

Ultimately, data analysis is not as much about visualizations and graphics as it is about telling a story. The key is to find a way to effectively tell the story of the count data in a meaningful way. This may change depending on the audience and the purpose of narrative (e.g. reporting to a city council or technical advisory committee, versus writing a grant proposal for additional project funding). Determining the audience's level of understanding and objectives will clarify how to display the data.

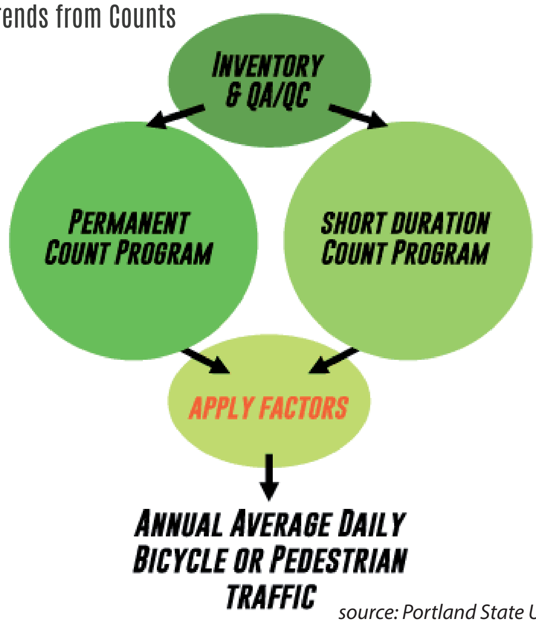
▷▷ Extrapolating Data

If data is available that is representative of a variety of time periods and conditions, the data may be extrapolated. For example, peak one-hour counts may be used to estimate daily non-motorized traffic volumes. This can provide comparisons to other daily traffic volumes. Extrapolation is often used for motor vehicle counts to calculate Average Daily Traffic (ADT). This can be an average of weekday, weekend, various seasons, etc. The FHWA Traffic Monitoring Guide (2013) provides a preferred method for computing ADT from sample short-term counts (Chapter 4.5). They suggest that "a factoring process may be necessary to adjust short-duration counts to best represent an annualized estimate. Depending on the count duration, type of automated equipment used, and presence of inclement weather, there may be up to five factors that could be applied":

1. **Time-of-day:** If less than a full day of data is collected, this factor adjusts a sub-daily count to a total daily count.
2. **DOW:** If data is collected on a single weekday or weekend day, this factor adjusts a single daily count to an average daily weekday count, weekend count, or day of week count.
3. **Month/season-of-year:** If less than a full year of data is collected, this factor adjusts an average daily count to an annual average daily count.
4. **Occlusion:** If certain types of automatic counter equipment are used, this factor adjusts for occlusion that occurs when pedestrian or cyclists passing the detection zone at the same time (i.e., side-by-side or passing from different directions).
5. **Weather:** If short-duration counts are collected during periods of inclement weather, this factor adjusts an inclement weather count to an average, typical count.

Creating locally based factors for computing ADT would require significant long-term data collection in Utah (specific to each metropolitan area). In the meantime, factors can be borrowed from other locations but should only be used when conditions are very comparable in terms of weather, destination types, and user demographics.

Figure 6.9 Extrapolating Trends from Counts



source: Portland State University

Data Warehousing

The Southern California Association of Governments (SCAG) and the Los Angeles Metropolitan Transportation Authority (METRO) have created a Bike Data Clearinghouse to serve as a "one-stop repository for bicycle count data throughout Los Angeles County and beyond". The clearinghouse tool allows users to easily view, query, and download bicycle count volumes using a map-based interface. Bicycle count data collected in Los Angeles County prior to December 2012 is currently available in the clearinghouse, and in the future SCAG is working with local jurisdictions throughout the region to upload their count data to the clearinghouse website. The goal of this collaborative effort is to "streamline and enhance the use of count data in active transportation planning and policy". The clearinghouse can be accessed at: http://www.bikecounts.luskin.ucla.edu/

Researchers at Portland State University are currently working to create a national bicycle and pedestrian data archive to house non-motorized count data from around the country. They are focusing their efforts on automated counts, but plan to incorporate a way to upload manual counts as well.

photo: City of Porltand

7.
Resources

7
Resources

Manual Count Forms and Training Materials

The National Bicycle and Pedestrian Documentation Project has compiled a comprehensive set of count and survey forms for conducting manual counts, as well as ready-to-use presentations and training materials for survey/count volunteers.
These resources can be downloaded directly at: http://bikepeddocumentation.org/downloads/

Automated Count Technology Vendors

Chambers Electronics- www.chambers-electronics.com www.trailcounters.com
Cognimatics- www.cognimatics.com
Compu-tec Systems- www.computec-systems.com
Counters and Accessories Ltd.- www.ca-traffic.com
Cuesta Systems Corporation- www.cuestasystems.com
Diamond Traffic Products- www.diamondtraffic.com
Eco-Counter- www.ecocompteur.com
Ivan Technologies- www.ivantechnologies.com
Jamar Technologies Inc.- www.jamartech.com
Metrocount- www.metrocount.com
Miovision- www.miovision.com
Sensource- www.sensourceinc.com
Sensys Networks- www.sensysnetworks.com/products/microradar
TDC Traffic Systems- www.tdcsystems.co.uk
Trafdata- www.trafdata.com
Trailmaster- www.trailmaster.com
Trans-Plan Inc.- www.trans-plan.com

Federal Highway Administration- Recreational Trails Program. Trail Traffic Counters. https://www.fhwa.dot.gov/environment/recreational_trails/publications/fs_publications/99232835/page03.cfm#compu

Additional Information

Active Living Research. 2013. Counting Bicyclists and Pedestrians to Inform Transportation Planning. http://atfiles.org/files/pdf/Bike-PedCounts-ALR-Feb2013.pdf

Bicycle Facilities and the Manual on Uniform Traffic Control Devices (MUTCD) http://www.fhwa.dot.gov/environment/bicycle_pedestrian/guidance/mutcd/

Conducting Bicycle and Pedestrian Counts Manual, Los Angeles Bike Count Data Clearinghouse: http://www.bikecounts.luskin.ucla.edu/

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Federal Highway Administration. Bicycle and Pedestrian Crash Mapping Tool http://hepgis.fhwa.dot.gov

Federal Highway Administration. Bicycle and Pedestrian Program http://www.fhwa.dot.gov/environment/bicycle_pedestrian/resources/

Federal Highway Administration- Traffic Monitoring Guide (Ch-4 Non-Motorized Traffic). 2013. http://www.fhwa.dot.gov/policyinformation/tmguide/

Initiative for Bicycle and Pedestrian Innovation (IBPI, Portland State University) Guide to Pedestrian and Bicycle Count Programs: http://www.pdx.edu/ibpi/count

National Bicycle and Pedestrian Documentation Project http://bikepeddocumentation.org/

North Central Texas Council of Governments. Peer Exchange on Bicycle and Pedestrian Count Programs. http://www.planning.dot.gov/Peer/Texas/arlington_5-29-13.pdf

Pedestrian and Bicycle Information Center. Planning and Data Collection Tools http://www.pedbikeinfo.org/planning/tools_counts.cfm

Transportation Research Board. (2015). "Guidebook on Pedestrian and Bicycle Volume Data Collection". National Cooperative Highway Research Program. Report No. 797. Available online at: http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_797.pdf

Utah Bicycle and Pedestrian Master Plan Design Guide
http://walkbikeplan.com/wp-content/uploads/2012/03/UDOH-Bike-Ped_Final_11-1-11.pdf

Agency Contacts

UDOT Bicycle and Pedestrian Coordinator
Box 143600
Salt Lake City, UT 84114-3600

Federal Highway Administration Utah Field Office
Steve Call
FHWA UT Division
2520 West 4700 South, Suite 9A
Salt Lake City, UT 84118
801-955-3513, Fax: 801-955-3529
steven.call@dot.gov

Utah Department of Public Safety -
Highway Safety Division
Jack Lasley
5500 Amelia Earhart Drive #155
Salt Lake City, Utah 84116
801-366-6040
jlasley@utah.gov

Appendix

STANDARD SCREENLINE COUNT FORM

Name: ____ Location: ____________________________________

Date: ______________________ Start Time: _____________________ End Time: _______________________

Weather: _____________________

Please fill in your name, count location, date, time period, and weather conditions (fair, rainy, very cold). Count all bicyclists and pedestrians crossing your screen line under the appropriate categories.

- Count for two hours in 15 minute increments.
- Count bicyclists who ride on the sidewalk.
- Count the number of people on the bicycle, not the number of bicycles.
- Pedestrians include people in wheelchairs or others using assistive devices, children in strollers, etc.
- People using equipment such as skateboards or rollerblades should be included in the "Other" category.

	Bicycles		**Pedestrians**		**Others**
	Female	**Male**	**Female**	**Male**	
00-:15					
15-:30					
30-:45					
45-1:00					
1:00-1:15					
1:15-1:30					
1:30-1:45					
1:45-2:00					
Total					

STANDARD BICYCLE INTERSECTION COUNT FORM

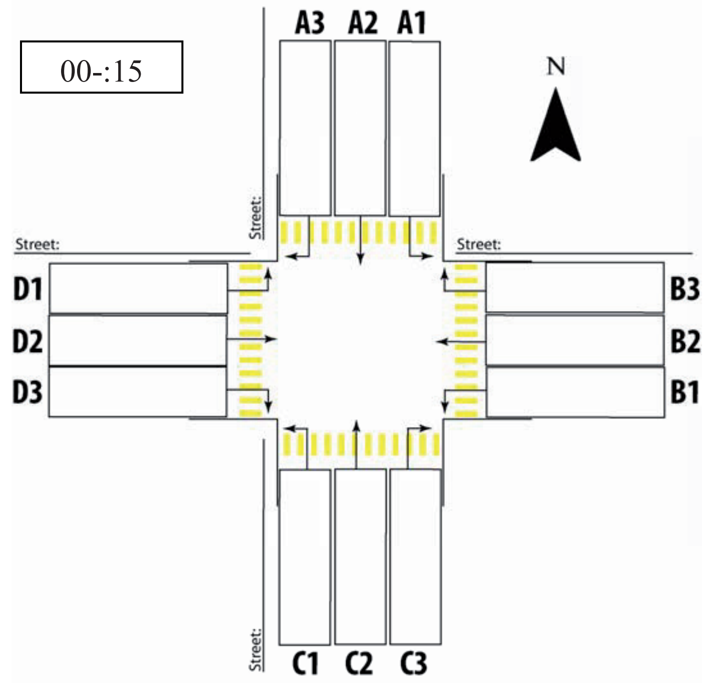
Name: ____ Location: ____

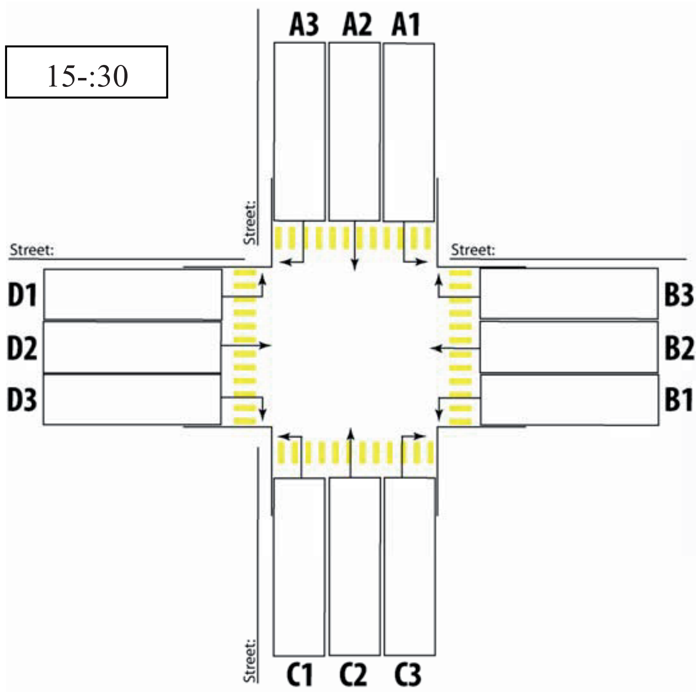
Date: ___________________________ Start Time: _________________________ End Time: ____________________________

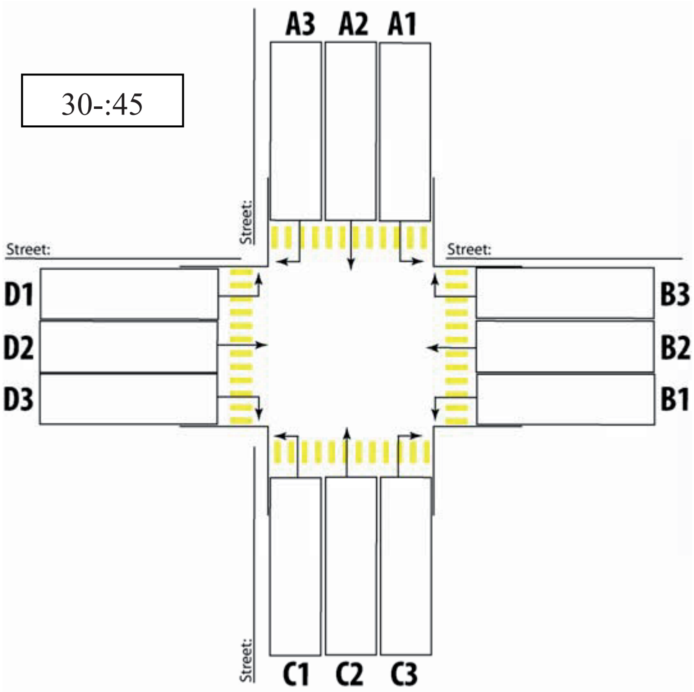
Weather: _________________________

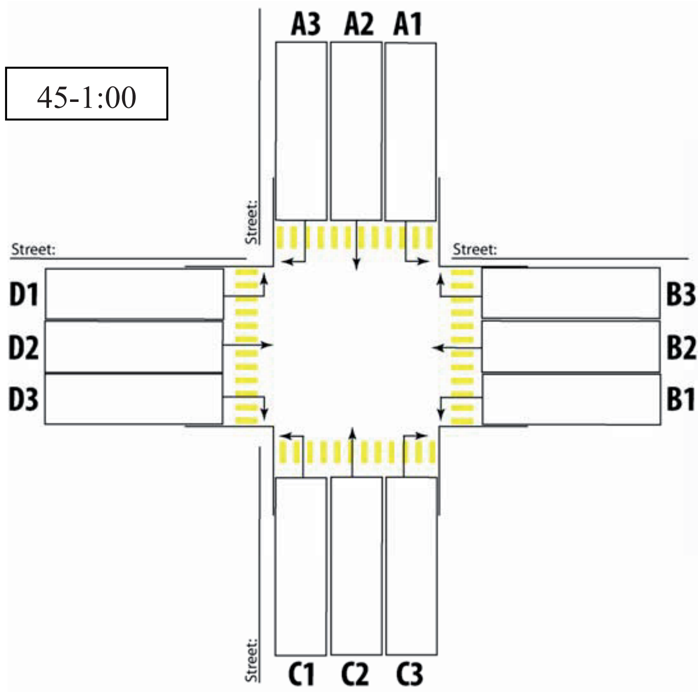
Please fill in your name, count location, date, time period, and weather conditions (fair, rainy, very cold). Count all bicyclists crossing through the intersection under the appropriate categories.

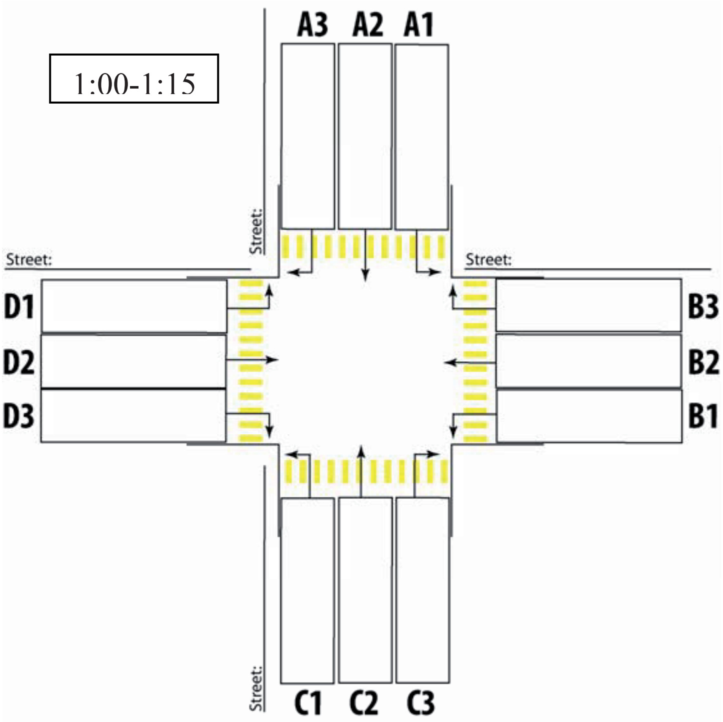
- Count for two hours in 15-minute increments.
- Count bicyclists who ride on the sidewalk.
- Count the number of people on the bicycle, not the number of bicycles.
- Use one intersection graphic per 15-minute interval.

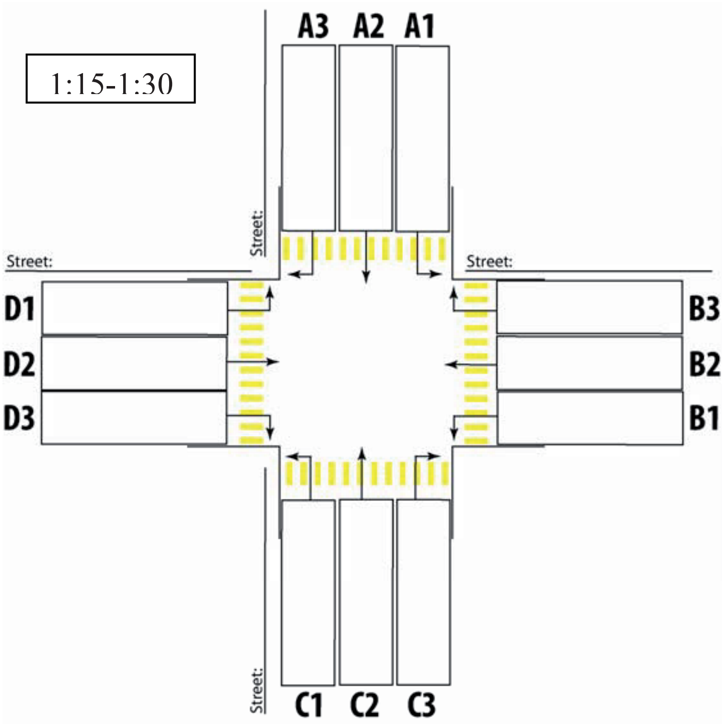




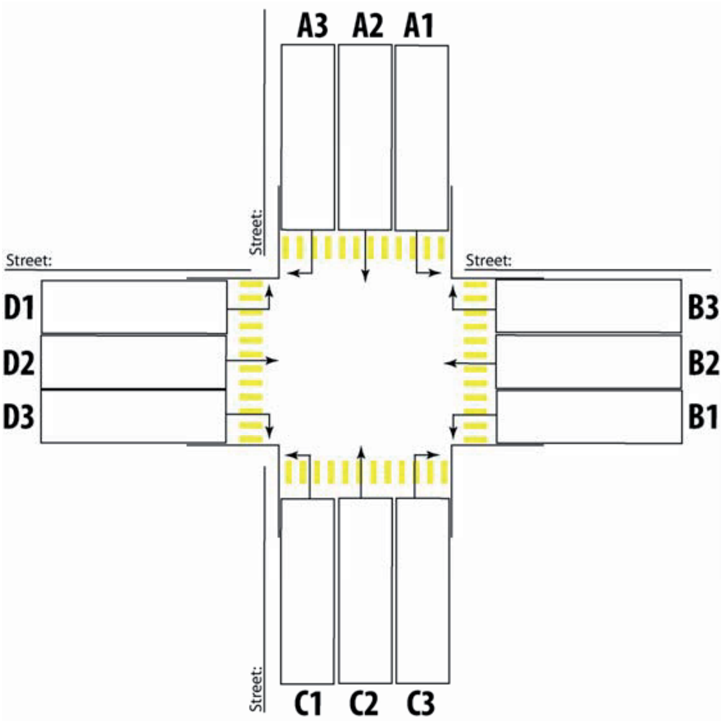




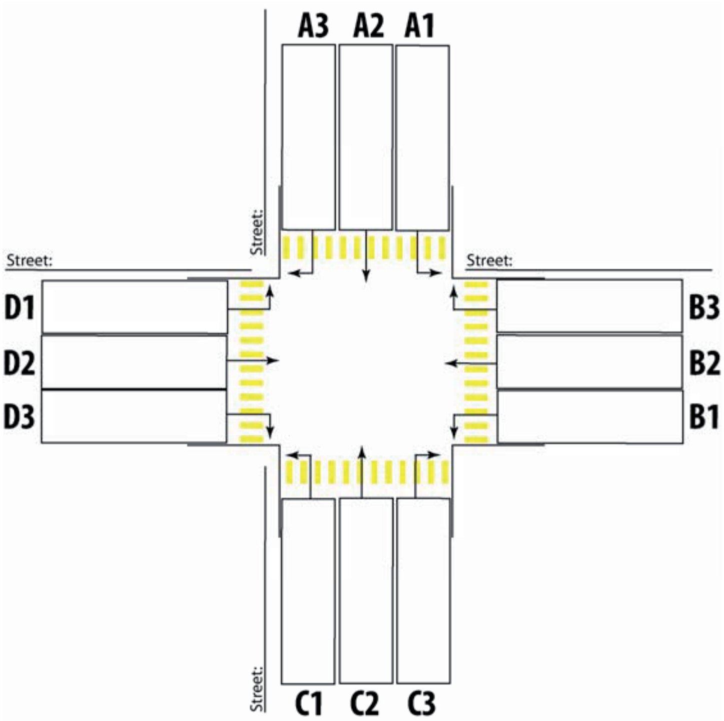




1:30-1:45



1:45-2:00



Notes:

STANDARD BICYCLE INTERSECTION COUNT TALLY SHEET

	Bicycle Counts											
Time Period	**Leaving Leg A**			**Leaving Leg B**			**Leaving Leg C**			**Leaving Leg D**		
	A1	**A2**	**A3**	**B1**	**B2**	**B3**	**C1**	**C2**	**C3**	**D1**	**D2**	**D3**
00-:15												
15-:30												
30-:45												
45-1:00												
1:00-1:15												
1:15-1:30												
1:30-1:45												
1:45-2:00												
Total												
Total Leg:												

Street Name A to C:	**Location 1 (Total Leg A + Total Leg C) =**
Street Name B to D:	**Location 2 (Total Leg B + Total Leg D) =**

STANDARD PEDESTRIAN SURVEY

Location: _________________________ Date: _____________ Time: ________

Surveyor: _________________________ Weather: _______________________________

(sunny, cloudy, rainy, windy, hot, and/or cold)

"Excuse me, but may I ask you a few questions? I'm with [name of agency] and we want to learn more about why people walk where they do. This will take less than two minutes and the information will be kept confidential."

1. What is your home zip code?

Home zip code: _______________

2. What best describes the purpose of this trip?

☐ Exercising (a) ☐ Work commute (b) ☐ School (c)

☐ Recreation (d) ☐ Shopping/doing errands (e) ☐ Personal business (medical, visiting friends, etc.) (f)

3. In the past month, about how often have you walked here?

☐ First time (a) ☐ 0 – 5 times (b) ☐ 6 – 10 times (c) ☐ 11 – 20 times (d) ☐ Daily (e)

4. Please check the seasons in which you walk.

☐ All Year (a) ☐ Summer (b) ☐ Fall (c) ☐ Winter (d) ☐ Spring (e)

5. What is the total length of this trip (start to finish)? ***(complete one or more of the following)***

1. Distance: _______ miles		***and / or***	***2. Time:*** _______ minutes
and / or	***3. Origin (zip code)*** __________ *Or location description other than zip code:** _________________________________ ** Address, intersection, landmark, etc.*	***and***	***Destination (zip code)*** __________ *Or location description other than zip code:** _________________________________ ** Address, intersection, landmark, etc.*

6. Will any part of this current trip be taken on public transit?

☐ Yes (a) ☐ No (b)

7. If you were not walking for this trip, how would you be traveling?

☐ Car (a) ☐ Carpool (b) ☐ Transit (c) ☐ Bicycle (d) ☐ I would not make this trip (e)

8. Why are you using this route as opposed to walking somewhere else? ***(please check all that apply)***

☐ Accessible/close (a) ☐ Direct (b) ☐ Lower traffic volumes (c) ☐ Heard about it through friends, media, etc.(d)

☐ Scenic qualities (e) ☐ Level (f) ☐ Personal safety (g) ☐ Connection to transit (h)

9. What would you like to see improved along this route (mark with an 'X') and community in general (mark with an 'O')? ***(please check all that apply)***

☐ Wider sidewalks (a) ☐ Better surface (b) ☐ Better street crossings (c)

☐ More shade trees (d) ☐ Benches (e) ☐ Access to shops, etc. (f)

☐ More sidewalks (g)

10. What ethnic group do you belong to? ***(please check all that apply) (optional)***

☐ Hispanic/Latino (a) ☐ African American (b) ☐ Anglo/Caucasian (c) ☐ Asian (d)

STANDARD BICYCLE SURVEY

Location: __________________________ Date: ______________ Time: ________

Surveyor: __________________________ Weather: _________________________________
(sunny, cloudy, rainy, windy, hot, and/or cold)

"Excuse me, but may I ask you a few questions? I'm with [name of NTPP agency] and we want to learn more about why people bike where they do. This will take less than two minutes and the information will be kept confidential."

1. What is your home zip code?

Home zip code: ________________

2. What best describes the purpose of this trip?

☐ Exercising (a) ☐ Work commute (b) ☐ School (c)

☐ Recreation (d) ☐ Shopping/doing errands (e) ☐ Personal business (medical, visiting friends, etc.) (f)

3. In the past month, about how often have you ridden a bicycle here?

☐ First time (a) ☐ 0 – 5 times (b) ☐ 6 – 10 times (c) ☐ 11 – 20 times (d) ☐ Daily (e)

4. Please check the seasons in which you bicycle.

☐ All Year (a) ☐ Summer (b) ☐ Fall (c) ☐ Winter (d) ☐ Spring (e)

5. What is the total length of this trip (start to finish)? ***(complete one or more of the following)***

***1. Distance**:* _______ miles (a)		***and / or***	***2. Time**:* _______ minutes (b)
and / or	***3. Origin (zip code)*** __________ (c) *Or location description other than zip code:** _______________________________ ** Address, intersection, landmark, etc.*	***and***	***Destination (zip code)*** __________ (d) *Or location description other than zip code:** _______________________________ ** Address, intersection, landmark, etc.*

6. Will any part of this current trip be taken on public transit?

☐ Yes (a) ☐ No (b)

7. If you were not biking for this trip, how would you be traveling?

☐ Car (a) ☐ Carpool (b) ☐ Transit (c) ☐ Walking (d) ☐ I would not make this trip (e)

8. Why are you using this route as opposed to riding somewhere else? ***(please check all that apply)***

☐ Accessible/close (a) ☐ Direct (b) ☐ Lower traffic volumes (c) ☐ Scenic qualities (d)

☐ Level (e) ☐ Bike lanes (f) ☐ Wider lanes (g) ☐ Separation from traffic (h)

☐ Connection to transit (i) ☐ Heard about it through friends, media, etc. (j)

9. What would you like to see improved along this route (mark with an 'X') and community in general (mark with an 'O')? ***(please check all that apply)***

☐ Bike lanes (a) ☐ Better surface (b) ☐ Shoulders (c) ☐ Less traffic (d)

☐ Signs/stencils (e) ☐ Better maintenance (f) ☐ Signal detection (g) ☐ Better crossings (h)

10. What ethnic group do you belong to? ***(please check all that apply) (optional)***

☐ Hispanic/Latino (a) ☐ African American (b) ☐ Anglo/Caucasian (c) ☐ Asian (d)

BACKGROUND DATA SHEET

The Background Data Sheet is included in the Data Tabulation Form Excel Spreadsheet. The Spreadsheet is downloadable from the NBPD website (www.bikepeddocumentation.org).

Each count and survey location will be identified by a Location Number that in turn is associated with a Background Data Sheet. If possible, include a numbered digital photo with each count and survey location. The Background Data Sheet is intended to allow researchers to test the impact of various background materials against count and survey results. Please fill out the data to the best of your ability. Most of this data is available through published sources such as the U.S. Census (demographics, journey to work), Bureau of Transportation Statistics (National Household Travel Survey), or by regional agencies.

The Bicycle Friendly Community website (www.bicyclefriendlycommunity.org) website also provides direct links to most of the relevant U.S. Census and other data sources. You may leave these blank if you do not know the answers, or if the information is not available.

The following key will help you fill in the required fields in the excel spreadsheet:

General Area Background:
General area is described as the jurisdictions where the counts or surveys are being conducted, which could range from a community to a region

- Name of Jurisdiction: region, city, town, county, or community
- If County or Region, number of local agencies included in count or survey area
- Source of demographic data
- Year of data
- Population of survey or count area
- Density (people per square mile)
- Bicycle mode share: Journey to Work
- Pedestrian mode share: Journey to Work
- Average age
- Average income
- Number of annual visitors to area (if not published, enter best guess in round numbers)

Count and Survey Location Description:
To be completed for each count and survey location.

Type of facility:

1 = paved multi use path at least 8 feet wide
2 = unpaved trail
3 = bike lane with standard signing and striping
4 = signed bike route
5 = street or road with marked shoulders (min. 2 feet wide)
6 = street or road with no shoulders or less than 2 feet wide
7 = sidewalk (at least 4 feet wide)
8 = unimproved (dirt, gravel) shoulder

Type of setting:

1 = urban
2 = suburban
3 = rural

Scenic Quality:

1 = high scenic qualities (views, shaded, quiet, historical)
2 = neutral or better scenic qualities
3 = poor scenic qualities

Surrounding land uses (within 1 to 2 miles):

1 = residential
2 = rural/agricultural/open space
3 = retail
4 = office
5 = manufacturing/warehouse
6= mixed use

Schools, parks, visitor destinations adjacent or close to the facility:

1 = none
2 = 1-2
3 = 3-5
4 = 6 and over

Quality of connecting facilities (paths, bike lanes, routes):

1 = no connections, poor access
2 = limited connections (one end only)
3 = good system connections (both ends)
4 = excellent system connections (both ends and intermediate)

Length of Facility:

1 = less than 1 mile
2 = 1-2 miles
3 = 2-5 miles
4 = 5-10 miles
5 = over 10 miles
6 = part of sidewalk network

Access:

1 = poor direct access from adjacent neighborhoods
2 = adequate access
3 = excellent access, including trailheads
4 = part of sidewalk system

Quality of overall network:
- 1 = poor community system of bikeways or walkways
- 2 = adequate community system (intermittent)
- 3 = good community system (continuous, good condition)

Traffic volumes (ADT) of adjacent road:
- 1 = under 2,500 ADT
- 2 = 2,500 – 7,500 ADT
- 3 = 7,500 – 15,000 ADT
- 4 = over 15,000 ADT

Traffic speeds (posted) of adjacent roads:
- 1 = 25mph
- 2 = 26-35 mph
- 3 = 36-45 mph
- 4 = 46-55mph
- 5 = 56mph or over

Crossings and Intersections (average number per linear feet):
- 1 = every 400 feet or less
- 2 = every 400-1,000 feet
- 3 = every 1,000-5,000 feet
- 4 = 5,000-10,000 feet
- 5 = none

Crossing and Intersection Traffic:
- 1 = all minor streets (less than 2,500 ADTs)
- 2 = minor to moderate traffic (2,501 – 7,500 ADTs)
- 3 = minor to high traffic (7,501 – 15,000 ADTs)
- 4 = minor to very high traffic (over 15,001 ADTs)

Crossing and Intersection Protection:
- 1 = inadequate (no crosswalks, stop signs, or signals)
- 2 = minimal: crosswalks only
- 3 = adequate: crosswalks, stop signs, and signals as needed

Condition:
- 1 = poor condition (rough surface, vandalism, debris, etc.)
- 2 = good condition (smooth surface, good maintenance)

Topography:
- 1 = level
- 2 = moderate grades
- 3 = steep topography

Count or Survey Data
To be completed for each count or survey

Date: date of count or survey

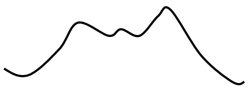
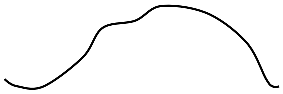
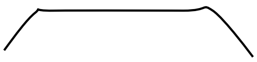
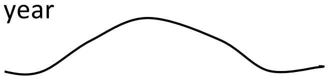
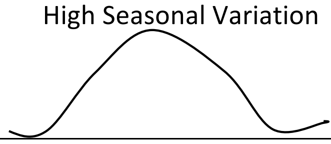
Time period:
- 1 = weekday, 7-9am
- 2 = weekend, 12-2pm
- 3 = weekday, 5-7pm
- 4 = weekday, 7am – 7pm
- 5 = weekend, 7am – 7pm

Weather:
- 1 = extreme (heavy rain, snow, freezing, very humid, over 95 degrees)
- 2 = poor (32-50 degrees, 90-95 degrees, light rain, wind)
- 3 = acceptable (50-90 degrees, no rain)

Bicycles: number of bicycles counted or interviewed during period

Pedestrians: number of pedestrians counted or interviewed during period

Other: number of equestrians, skaters, bladders, skateboards, and others counted or interviewed

Permanent Count Program Checklist	Done?
1&2. **Review the existing program and create an inventory.** Make sure to ask around! Reach out to parks departments, business districts, and health departments. All are potential data collectors. • Where are they? • What are they counting? • What technology do they use? • How long have they been counting there? • Have they evaluated accuracy? QA/QC the data. For example, count bikes/peds for 1 or 2 peak hours and compare to the automated counts[1]. Compute a correction factor (actual /automated count) to account for under or overcounting. Also, check for unusually high counts and suspect zero counts.	
3. **Look at the data. What patterns do you see?** Plot the patterns over the day — Commute  Non-Commute  Plot the patterns over the week — Low Weekends  High Weekends  Plot the average counts over the year — Low Seasonal Variation  High Seasonal Variation 	
4. **Group count stations by pattern.** For example, commute, non-commute, mixed.	
5. **Do you have enough count stations?** Are there any patterns you expected to see but didn't? Are all regions represented? Do you have at least 3 stations per group? If you answer "no" to any of these questions, consider installing additional count stations.	
6**. Select locations for additional count stations, if needed.** Develop selection criteria and a data collection plan. (see TMG Chapter 2)	
7**. Compute monthly, day-of-week, and hour-of-day (if applicable) factors to use in annualizing short duration counts.** In the absence of a full set of counters: 1. Use whatever accurate permanent count datasets you have to create factors. 2. If you have no permanent count data, check with your state or region. 3. If you find no data or factors, use the NBPDP[2] factors for now, and install one or more permanent counters soon.	

Short-Duration Count Program Checklist	Done?
1. **Select Count Locations**	
2. **Select Intersection vs. Segment** (aka screenline) **Count** and Counter Technology	
3. **Select Count Duration** (7-days recommended, 24-hrs minimum, but 2-hrs still usable)	
4. **Schedule Counts** (Choose months with high bike/ped traffic.[3])	
5. **Annualize Short-duration Counts** by applying factors from Step 7 above. For example: Annual Average Daily Bicyclists = (24-hr Count) X (Daily Factor) X (Monthly Factor)	

For more details see Chapter 4 of the Traffic Monitoring Guide (TMG) 2013. The steps numbered above match TMG steps. http://www.fhwa.dot.gov/policyinformation/tmguide/

[1] Observe at least 100 bicyclists or pedestrians. For sites with high to medium volumes this can be done in 1 or 2 hours.

[2] The National Bicycle and Pedestrian Documentation Project (NBPDP) posts information on manual counting programs and generalized factors. http://bikepeddocumentation.org/

Bicycle/Pedestrian Data Collection - Screenline Supervisor Form

Date

DAY ____ MONTH ____ YEAR 20____

Location ____________ STREET / PATH

BETWEEN ____________ AND ____________

Count Periods at This Location

1. START __:__ AM/PM END __:__ AM/PM
2. START __:__ AM/PM END __:__ AM/PM
3. START __:__ AM/PM END __:__ AM/PM

Pages

PAGE ____ OF ____ TOTAL

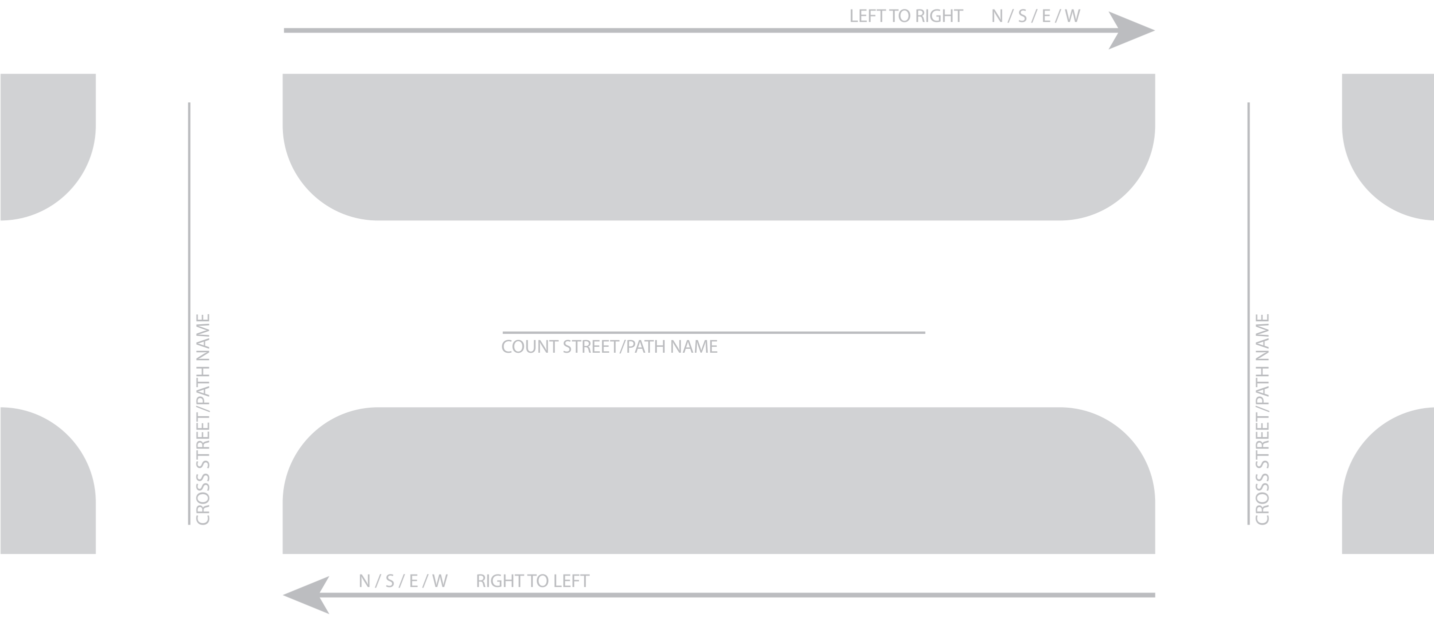
Show Them Where to Count...

Mark where the counter should be located with an "X" on the Count Location Schematic below. Then, draw in the counter's screenline.

Label the street the counter will be counting on, as well as the nearest cross streets, as they will appear from the count location.

Indicate which way will be "left to right" and "right to left" on the arrows below.
Also mark cardinal directions (N, S, E, or W. Note that NW, SE, etc. are not allowed) as they will appear to the counter.
If you are not sure which cardinal direction to assign because the street does not run exactly north-south or east-west, please consult any previous counts and be consistent with what has been chosen in the past.

Count Location Schematic



Bikeway Type at This Location

Record the bikeway type present at this location, if any, including sub-options.

- ☐ BIKE PATH
- ☐ BIKE LANE
  - ☐ *COLORED*
  - ☐ *PAINTED BUFFER*
  - ☐ *PHYSICAL BUFFER*
- ☐ BIKE ROUTE
  - ☐ *SHARROWS*
- ☐ BIKE BOULEVARD
  - ☐ *SHARROWS*
- ☐ NONE

Additional Variables to Count

Indicate any additional attributes the counter should count using the checkboxes below.

Bicycle ☐ FEMALE ☐ WRONG WAY RIDING ☐ SIDEWALK RIDING ☐ OTHER: ____ ☐ OTHER: ____

Pedestrian ☐ WHEELCHAIR/ SPECIAL NEEDS ☐ SKATEBOARD/ SCOOTER/SKATES ☐ CHILD ☐ OTHER: ____ ☐ OTHER: ____

Bicycle/Pedestrian Data Collection - Screenline Count Form

Date ____ DAY ____ MONTH 20__ YEAR

Location ________ STREET PATH

BETWEEN ________ AND ________

This Page ___:___ AM PM FROM ___:___ AM PM TO

Count Period ___:___ AM PM START ___:___ AM PM END

Pages ____ PAGE OF ____ TOTAL

Rain ☐ YES ☐ NO

Bicyclists

Count bicyclists when they cross this imaginary line

Make additional marks to count other characteristics

Bikes - Right to Left

TOTAL

Bikes - Left to Right

TOTAL

Female
TOTAL

Sidewalk Riding
TOTAL

Wrong Way Riding
TOTAL

Other:
TOTAL

Other:
TOTAL

Pedestrians

Count pedestrians when they cross this imaginary line

Make additional marks to count other characteristics

Pedestrians - Right to Left

TOTAL

Pedestrians - Left to Right

TOTAL

Wheelchair/Special Needs
TOTAL

Skateboard/Scooter/Skates
TOTAL

Child
TOTAL

Other:
TOTAL

Other:
TOTAL

Bicycle Parking Counts

Your Name:

Date
20
DAY MONTH YEAR

Time of Day
1st pass : AM PM
2nd pass (optional) : AM PM

Pages
PAGE OF TOTAL

Count Location

Your count location may be located at a transit station, a block of a city street, or at a particular destination, like a school or a shopping center. Use the space below to illustrate the location of your bike parking count. Label streets, buildings, and other landmarks as well as the location of the bike parking facilities.

Photo and Notes:

Please take a photo of the bike parking facility and attach it to this form or submit it via email. Make sure the photo shows the whole rack or set of racks clearly.

Note if the racks are damaged or obstructed (too close to a building; too close to parked cars; etc):

What to Count

1st pass

of parking spaces
Assume two spots per loop rack
TOTAL

# of parked bikes on racks
Don't include bikes parked elsewhere
TOTAL

# of bikes locked to other objects
Include bikes within ~100 feet of the rack or count location
TOTAL

# of bikes that appear abandoned
Count bikes that are vandalized.
TOTAL

Weather during your count:
SUNNY, RAINY, WINDY? TEMP

2nd pass (optional)

of parking spaces
Assume two spots per loop rack
TOTAL

# of parked bikes on racks
Don't include bikes parked elsewhere
TOTAL

# of bikes locked to other objects
Include bikes within ~100 feet of the rack or count location
TOTAL

# of bikes that appear abandoned
Count bikes that are vandalized.
TOTAL

Weather during your count:
SUNNY, RAINY, WINDY? TEMP

Bicycles on Transit Count Form

Your Name:

Observer counting on transit vehicle - one observer per car or bus

Date: ______ DAY ______ MONTH 20____ YEAR

Count Period: ____ : ____ AM/PM START ____ : ____ AM/PM END

Pages: ______ PAGE OF ______ TOTAL

Transit Line____________ Car # ______ Direction ____________
(Lead car is "1", count back from lead car. Buses are "1")

USE MARKINGS: O = Female; X = Male; + = Unknown

Station or Transit Stop	# Boarding with Bike	# Alighting with Bike
Total:	____ MALE ____ FEMALE ____ UNKNOWN	____ MALE ____ FEMALE ____ UNKNOWN

Folding Bike: ______ TOTAL

Other: ______ TOTAL

Bicycles on Transit Count Form

Your Name:

Observer counting at transit station or stop

Date ______ ______ 20____
DAY MONTH YEAR

Count Period ___:___ AM/PM ___:___ AM/PM
START END

Pages ______ OF ______
PAGE TOTAL

Stop or station ______________________ # of lines using stop ______

USE MARKINGS: ○ = Female; ✕ = Male; + = Unknown

Time & Direction	Transit Line / Bus Number	# Boarding with Bike	# Alighting with Bike
: AM PM Circle one: ↑ NB ↓ SB ← WB → EB			
: AM PM Circle one: ↑ NB ↓ SB ← WB → EB			
: AM PM Circle one: ↑ NB ↓ SB ← WB → EB			
: AM PM Circle one: ↑ NB ↓ SB ← WB → EB			
: AM PM Circle one: ↑ NB ↓ SB ← WB → EB			
: AM PM Circle one: ↑ NB ↓ SB ← WB → EB			
: AM PM Circle one: ↑ NB ↓ SB ← WB → EB			
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: AM PM Circle one: ↑ NB ↓ SB ← WB → EB			
: AM PM Circle one: ↑ NB ↓ SB ← WB → EB			
: AM PM Circle one: ↑ NB ↓ SB ← WB → EB			
: AM PM Circle one: ↑ NB ↓ SB ← WB → EB			
: AM PM Circle one: ↑ NB ↓ SB ← WB → EB			
	Total:	MALE FEMALE UNKNOWN	MALE FEMALE UNKNOWN

Folding Bike: ______ TOTAL

Other: ______ TOTAL

ACTIVE PLANNING