DEPARTMENT OF TRANSPORTATION

The Minnesota Bicycle and Pedestrian Counting Initiative: Institutionalizing Bicycle and Pedestrian Monitoring

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Research Project
Final Report 2017-02

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The Minnesota Department of Transportation (MnDOT) launched the Minnesota Bicycle and Pedestrian Counting Initiative in 2011, a statewide, collaborative effort to encourage and support non-motorized traffic monitoring. This report summarizes work by MnDOT and the University of Minnesota between 2014 and 2016 to institutionalize bicycle and pedestrian monitoring. The project team established a new statewide bicycle and pedestrian traffic monitoring network with 25 permanent monitoring locations and a new district-based portable counting equipment loan program. Other key accomplishments included Minnesota's first Bicycle and Pedestrian Annual Traffic Monitoring Report, a new MnDOT website for reporting annual and short-duration counts, and a new *Bicycle and Pedestrian Data Collection Manual* that local jurisdictions and consultants can use to design manual and automated non-motorized traffic monitoring programs. The project team also included provisions in MnDOT equipment vendor agreements that enable local governments to purchase bicycle and monitoring equipment; established new annual training programs for bicycle and pedestrian monitoring; and contributed provisions in the Statewide Bicycle System Plan and Minnesota Walks that call for bicycle and pedestrian traffic monitoring and creation of performance measures based on counts. Despite this progress, challenges in implementing monitoring remain and continued investment in and support for bicycle and traffic monitoring is needed.

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THE MINNESOTA BICYCLE AND PEDESTRIAN COUNTING INITIATIVE:
INSTITUTIONALIZING BICYCLE AND PEDESTRIAN MONITORING

FINAL REPORT

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EXECUTIVE SUMMARY

The Minnesota Department of Transportation (MnDOT) launched the Minnesota Bicycle and Pedestrian Counting Initiative in 2011, a statewide, collaborative effort to encourage and support non-motorized traffic monitoring by local, regional, and state governments and nonprofit organizations. This report summarizes work completed by MnDOT between 2014 and 2016 with support from the University of Minnesota to:

- Institutionalize automated bicycle and pedestrian traffic data collection, reporting and analysis within MnDOT and throughout the state; and
- Provide advice on manual and automated non-motorized traffic monitoring and the use of bicycle and pedestrian traffic data in current and future projects, studies, and plans.

Key accomplishments included:

- A statewide bicycle and pedestrian traffic monitoring network with at least 25 permanent monitoring locations, including a minimum of two stations in each of MnDOT's eight administrative districts on roads on multiuse trails;
- A new district-based portable counting equipment loan program to support MnDOT districts and local jurisdictions interested in bicycle and pedestrian traffic monitoring;
- Minnesota's first Bicycle and Pedestrian Annual Traffic Monitoring Report;
- A new MnDOT website for reporting annual and short-duration counts that enables local planners and engineers to download data for analysis;
- A new Bicycle and Pedestrian Data Collection Manual that local jurisdictions and consultants can use to design manual and automated non-motorized traffic monitoring programs and guide installation of permanent and portable automated monitoring equipment;
- Provisions in MnDOT equipment vendor agreements that enable local governments to purchase bicycle and monitoring equipment;
- New annual training programs for bicycle and pedestrian monitoring held in collaboration with motorized traffic monitoring training programs led by MnDOT Traffic Data Analysis; and
- Provisions in the Statewide Bicycle System Plan and Minnesota Walks that call for bicycle and pedestrian traffic monitoring and creation of performance measures based on counts.

In addition to these accomplishments, the Minnesota Bicycle and Pedestrian Counting Initiative supported local efforts to implement monitoring, including an automated bicycle traffic monitoring program implemented in Hennepin County, an automated trail traffic monitoring program implemented on the Gitchi-Gami Trail by the Arrowhead Regional Planning Commission, and plans to monitor traffic on state trails.

MnDOT and several different local agencies now have plans and procedures in place for bicycle and pedestrian monitoring, yet monitoring is not routine in most Minnesota jurisdictions. Therefore, continued efforts to share progress and innovations in bicycle and pedestrian traffic monitoring are warranted.

CHAPTER 1: INTRODUCTION

The Minnesota Department of Transportation (MnDOT) launched the Minnesota Bicycle and Pedestrian Counting Initiative in 2011, a statewide, collaborative effort to encourage and support non-motorized traffic monitoring by local, regional, and state governments and nonprofit organizations. MnDOT has funded three projects to support the Initiative:

1. Methodologies for Counting Bicyclists and Pedestrians in Minnesota (2011-13; Lindsey et al. 2013; http://www.cts.umn.edu/Publications/ResearchReports/reportdetail.html?id=2328).
2. Implementing Bicycle and Pedestrian Traffic Counts and Data Collection (2013-15; Lindsey et al. 2015; http://www.cts.umn.edu/Publications/ResearchReports/reportdetail.html?id=2454).
3. Institutionalizing the Use of State and Local Pedestrian and Bicycle Traffic Counts (2014-16).

This report summarizes the results of the latter project. Its goals were to build on the earlier projects to:

- Institutionalize bicycle and pedestrian traffic data collection, reporting and analysis within MnDOT and throughout the state; and
- Provide advice and direction on the use of bicycle and pedestrian traffic data in current and future projects, studies, and plans.

This project was set up as ten interrelated tasks. Each task involved substantive collaboration between the University of Minnesota and MnDOT staff from the Offices of Transit, Traffic Data Analysis, and Research Services (i.e., the project team). The focus of each task was on development of methods, procedures, or reports that MnDOT and its partners can use to institutionalize automated monitoring of bicycle and pedestrian. Some tasks involved providing input to related MnDOT projects, reports, or activities. Appendix A is a summary of work accomplished by task.

Institutionalizing an activity in an organization or network of organizations means to establish it as a routine practice or cultural norm. This report summarizes substantive accomplishments related to institutionalizing bicycle and pedestrian monitoring within MnDOT and in Minnesota.

- Chapter 2 summarizes MnDOT's plan for monitoring bicycle and pedestrian traffic
- Chapter 3 describes progress in implementing the plan
- Chapter 4 provides methods and tools for managing, analyzing, and reporting bicycle and pedestrian traffic data
- Chapter 5 describes the technical assistance provided to state and local partners in the Counting Initiative
- Chapter 6 discusses MnDOT plans and policies that support bicycle and pedestrian traffic monitoring
- Chapter 7 discusses lessons learned and issues that remain to be addressed as MnDOT continues to make bicycle and pedestrian traffic monitoring a routine practice in Minnesota

CHAPTER 2: OVERVIEW OF THE MINNESOTA BICYCLE AND PEDESTRIAN COUNTING INITIATIVE

A principal objective of the project was to develop and implement an overall plan for monitoring bicycle and pedestrian traffic in Minnesota. This chapter provides an overview of key elements of MnDOT's Bicycle and Pedestrian Traffic Monitoring Plan. These elements include permanent and short duration monitoring sites; a counter loan program, technical assistance, collaboration, and encouragement.

2.1 BICYCLE AND PEDESTRIAN MONITORING PLAN OVERVIEW

The project team initially prepared a concept plan in February, 2015, which is provided in Appendix B. During the project, with the allocation of new funding for acquisition of bicycle and pedestrian monitoring devices, the scope of the concept plan was increased, and the concept plan evolved into a working plan.

The purpose of bicycle and pedestrian traffic monitoring is to generate information about traffic volumes and patterns to inform state, regional, and local planning and engineering initiatives, including project design, funding, programing, maintenance and traffic safety. Non-motorized traffic data also will be used to inform and assess important transportation policies and programs such as Complete Streets and Toward Zero Deaths. In addition, other agencies and organizations are interested to use the data to analyze physical activity and health outcomes, tourism, economic development, parks and trails usage and environmental impacts.

The MnDOT approach to non-motorized traffic monitoring is based on technical guidance in the Federal Highway Administration's (FHWA) *Traffic Monitoring Guide* and on well-established principles of vehicular traffic monitoring that are the framework for MnDOT's motorized traffic data program (FHWA 2013). MnDOT's non-motorized traffic monitoring program is designed to be integrated with its vehicular monitoring programs long-term.

MnDOT's approach involves establishment of permanent, continuous automated monitoring stations at a limited number of locations throughout the state along with a larger number of short-duration monitoring locations. The purposes of the permanent monitoring stations are to track trends in traffic over time, to identify patterns in non-motorized traffic that can be used to interpret and extrapolate short-duration counts into annual traffic estimates, and to develop performance indicators to track progress relative to MnDOT goals and objectives.

Additional purposes of short-duration monitoring are to document variations in non-motorized traffic volumes on different types of roads, to provide broad geographic coverage across the state, to provide insight into exposure to risk for safety analyses, and to assist with evaluation of transportation investments and innovative safety treatments. Because of resource limitations, the plan does not propose comprehensive monitoring for the entire state. Instead, the plan proposes a limited number of permanent "index" sites and a greater number of short-duration monitoring sites that can inform transportation planning and engineering in each district or region of Minnesota.

2.2 PERMANENT INDEX MONITORING SITES FOR NON-MOTORIZED TRAFFIC

Consistent with the plan, MnDOT is establishing a network of at least 25 permanent index monitoring sites throughout the state, with a minimum of two locations in each of MnDOT's eight operations districts. The general goals for location of the index sites are to include a range of types of bicycle and pedestrian infrastructure (e.g., arterials or collectors with and without bicycle lanes, local streets, county roads, and multi-use trails) in a range of settings (e.g., urban, suburban, rural) that are near different types of land uses that may generate different traffic patterns (e.g., commercial, mixed-use, universities). Because of local interest and to facilitate collaboration with the Department of Natural Resources, the project team established a short-term objective of establishing permanent monitors on one roadway and one multiuse trail (or shared-use path) in each MnDOT district.

The project team made the decision to establish permanent monitoring sites in each MnDOT district so that district engineers, planners and project managers would become familiar with non-motorized traffic monitoring and to identify regional variations in traffic patterns. The index sites have been and are being selected in consultation with MnDOT district staff and representatives of local, regional, and state agencies in each district. MnDOT is facilitating implementation and covering the cost of the counting equipment and may not install or maintain all sites. Implementation of the network is based on partnerships and agreements established with local agencies. In the long term, permanent sites established by other agencies may be integrated into the network.

Figure 2-1 is a map of permanent monitoring sites established or scheduled to be installed by the end of 2017. The network includes monitoring stations established in 2014, 2015, and 2016 as part of the Counting Initiative. Details about each permanent monitoring location are presented in Chapter 3. Consistent with plans, MnDOT is archiving monitoring results from the index sites, developing performance indicators from the results, and providing guidance to local jurisdictions in interpretation and use of data in engineering applications.

2.3 SHORT-DURATION MONITORING SITES

The MnDOT bicycle and pedestrian monitoring plan calls for short-duration monitoring throughout the state by MnDOT staff or in collaboration with local and nonprofit partners. To develop methods and demonstrate the potential for short-duration counts to inform planning and engineering, the project team completed short-duration counts in 2014 and 2015 (See Chapter 4 for a summary of results).

The longer-term objective of short-duration monitoring is to provide greater understanding of variations in bicycle and pedestrian traffic volumes in different contexts and to identify different types of traffic patterns that can be used to establish "factor groups" for purposes of analysis and extrapolation. Factor groups are groups of sites with similar hourly or seasonal traffic patterns such as commuter patterns with morning and evening peaks on weekdays or multipurpose patterns with even traffic flows throughout weekends and weekdays.

As with the selection of permanent index sites, the goals are to monitor at locations that encompass a range of types of infrastructure and other geographic and land use characteristics. In addition, short-duration sites may be selected to provide other information such as traffic volumes before and after installation of new bicycle or pedestrian facilities.

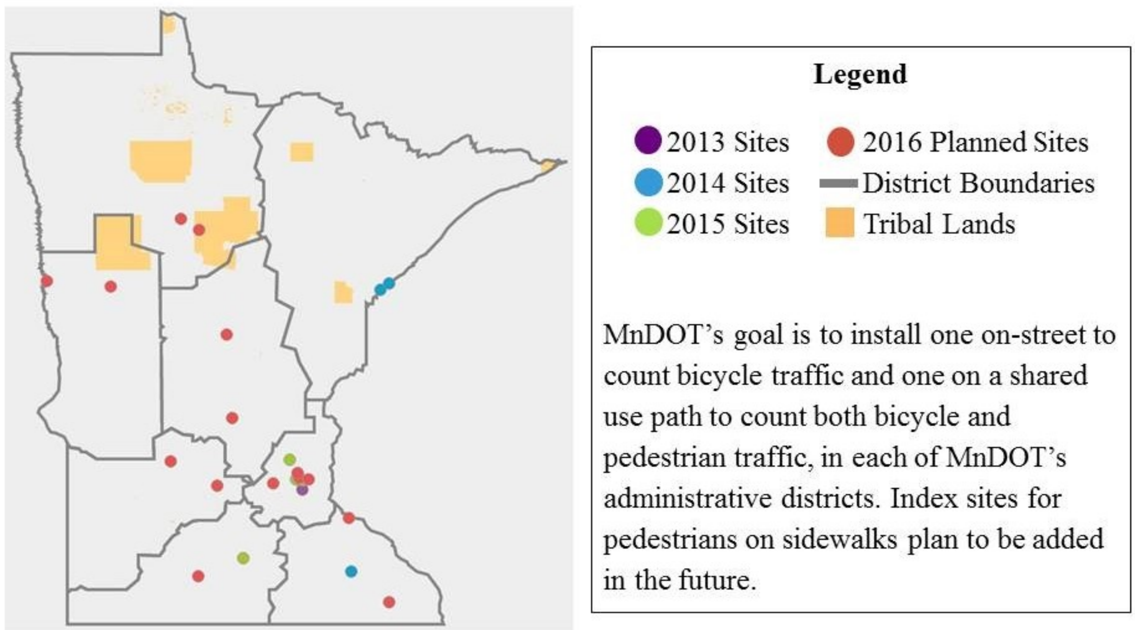


Figure 2-1 Map of Permanent Bicycle and Pedestrian Monitoring Locations

Short-duration sites generally will be continuously monitored for five to seven days between May and October, because research indicates that error in extrapolation to annual non-motorized traffic volumes is minimized with samples of this duration during periods when non-motorized traffic volumes are highest. This period is longer than short-duration monitoring for vehicles (i.e., 48 hours) because bicycle and pedestrian traffic varies more in response to weather and because non-motorized traffic volumes often are higher on weekends than weekdays. If resources and other circumstances permit, non-motorized monitoring may be integrated with vehicle monitoring (e.g., vehicle classification counts using pneumatic tubes could be adapted to produce counts of bicyclists). The scope of short-duration monitoring across Minnesota in the future will be determined by the availability of resources and partnerships established with local agencies in districts. MnDOT anticipates archiving results from the short-duration monitoring sites.

2.4 MONITORING EQUIPMENT LOAN PROGRAM

The project team recommended MnDOT establish a monitoring equipment loan program for cities, communities or other local groups that could conduct counts in order to maximize the number of short-duration counts taken in the state. The rationale for the loan program is multi-faceted: MnDOT resources available for monitoring are limited; most bicycle and pedestrian traffic occurs on local roads, sidewalks, and trails; local agencies need counts to inform project planning; and local agencies in some cases have interest in developing the expertise required for monitoring. In addition, the Bicycle System Plan identifies increasing local bicycling networks as a priority and this strategy is one way MnDOT can advance increased local connectivity. Consistent with the broad goal of making bicycle and pedestrian traffic monitoring routine practice in the state, the idea is that as transportation planners and engineers become familiar with bicycle and pedestrian counts and how they can be collected and used, they will be more likely to initiate monitoring.

The project team recommended, and MnDOT subsequently purchased, portable counters to be loaned, two per MnDOT district, for short-duration sampling. These counters, 16 in total, include eight pneumatic tube counters for counting cyclists on roadways or trails, and eight passive infrared counters for counting pedestrians and cyclists on sidewalks or trails. Members of the project team met with MnDOT staff and representatives of regional development commissions and planning agencies in each MnDOT district to identify local individuals and agencies to be responsible for the equipment and administering the loan program. The project team initiated training for individuals involved in the loan program in 2016. Details about the equipment and the training session are provided in Chapter 3.

2.5 TECHNICAL ASSISTANCE, COLLABORATION, AND ENCOURAGEMENT

Consistent with its motorized traffic monitoring program, MnDOT's bicycle and pedestrian traffic monitoring plans call for ongoing technical assistance, collaboration, and encouragement for district personnel and other state, local, and nonprofit transportation, planning, health, and recreation agencies. The types of activities envisioned as part of technical assistance and collaboration range from training in use of equipment and methods for data analysis and reporting, to joint identification and establishment of permanent monitoring stations. For example, in 2015 and 2016, the project team conducted bicycle and pedestrian monitoring training sessions in conjunction with MnDOT's annual training session for its local partners who collaborate in motorized traffic monitoring. Tools developed for training and specific training activities completed during this project in response to this part of the plan are described in other chapters of this report.

2.6 LONGER TERM PLANS FOR NON-MOTORIZED TRAFFIC MONITORING

The scope of the concept plan for bicycle and pedestrian monitoring was, as noted previously, revised and adapted as MnDOT allocated additional funds for equipment purchase, and the project team completed additional project tasks, developed new tools, gained experience in monitoring, and deepened relationships with state and local partners. MnDOT's plans will continue to evolve for these same reasons. The project team expects that in the future the number of permanent monitoring stations will increase, specifics of the loan program will change, and methods of collecting, analyzing, reporting, and archiving data will be refined. Consistent with the objective of institutionalizing bicycle and pedestrian traffic monitoring, the concept plan evolved into a working plan that provides direction for a set of ongoing programmatic activities. These activities are described in the following chapters.

CHAPTER 3: PLAN IMPLEMENTATION AND COUNTER OPERATION

The first steps towards implementation of MnDOT's plan for bicycle and pedestrian traffic monitoring were taken during the Implementation project in 2013 when the project team, with assistance from the consulting firm SRF, acquired and tested a number of automated bicycle and pedestrian counters and prepared the "Bicycle and Pedestrian Data Collection Manual – Draft" (Lindsey et al., 2015; Minge et al. 2015). Among other results of the Implementation project, MnDOT acquired, installed, and evaluated permanent automated counters at four locations and deployed and evaluated several types of portable, automated counters. The evaluations of these counters led to the decision to move forward with the Institutionalization project and informed decisions about the types of counters to be purchased for deployment throughout the state. Specifically, MnDOT decided to purchase Eco-Counter ™ counters for both permanent and short-duration monitoring. The reasons for selection of Eco-Counter ™ counters included their relative accuracy and reliability and their integrated, online systems for data analysis and reporting. Eco-Counter ™ was unique among vendors in its capacity to provide counters to match different settings (e.g., inductive loops for roadways; passive infrared devices for sidewalks), daily internet uploads of traffic counts for all counters for in-office viewing, and customized, integrated reporting for all permanent and portable counters in MnDOT's fleet, without the need for electrical power service to individual counters.

3.1 INSTALLATION OF PERMANENT BICYCLE AND PEDESTRIAN TRAFFIC MONITORING STATIONS

Table 3-1 lists MnDOT's current and planned locations for permanent bicycle and pedestrian traffic monitoring, the type of facility on which the devices were installed, the actual or anticipated date of installation, and the modes of traffic that are being monitored. Bicycle-selective inductive loops are being deployed on roadways (e.g., in bicycle lanes, on wide shoulders) and integrated inductive-loop/passive infrared systems are being deployed on multiuse trails or shared-use paths. The Eco-Counter ™ counters installed during the Implementation project at five permanent monitoring locations have become part of the statewide network. By the end of 2017, the network will include 25 permanent sites (Table 3-1). The West River Parkway trail monitoring location in Minneapolis was funded by the nonprofit Rails to Trails Conservancy (RTC) in collaboration with the Minneapolis Park and Recreation Board (MPRB). The RTC and MPRB agreed to include the site among those in the MnDOT network. This cooperative agreement is an example of how MnDOT's permanent monitoring network may grow in the future even without new direct investments by MnDOT. Monitoring results from the stations in place during 2014 and 2015 are presented in Chapter 4.

Table 3-1 Permanent Bicycle and Pedestrian Monitoring Stations in Minnesota

City	Facility Name	Facility Type	Bikes	Peds	Mixed	Year Installed
Eagan	Trunk Highway 13	Shoulder	x			2013
Minneapolis	Central Ave	Bike lane	x			2013
Duluth	Lake Walk Trail	Shared use path	x	x		2014
Duluth	Scenic Hwy 61	Shoulder	x			2014
Minneapolis	West River Parkway	Shared use path	x	x		2014
Rochester	Douglas Trail	Shared use path	x	x		2014
Brooklyn Park	Rush Creek Trail	Shared use path	x	x		2015
Mankato	Veterans Memorial Bridge	Shared use path			x	2015
Minneapolis	Park Avenue	Buffered bike lane	x			2015
St Paul	Summit Avenue	Bike lane	x			2015
Cass Lake	Ma-ga-zi Trail	Shared use path	x	x		TBD
Brainard	Paul Bunyon Trail	Shared use path	x	x		TBD

St Cloud	Beaver Island Trail	Shared use path	x	x		2016
Moorhead	New Diverging Diamond near TH75 and 24th Ave S	Diverging diamond interchange	x	x		TBD
Detroit Lakes	West Lake Road	Shoulder	x	x		TBD
Lanesboro	Root River Trail	Shared use path	x	x		TBD
Red Wing	New Trail adjacent to Levee Rd and the River	Shared use path	x	x		TBD
St James	Sidewalk	Sidewalk			x	TBD
Willmar	Lakeland Drive	Bike lane	x			TBD
Hutchinson	Luce Line Trail	Shared use path	x	x		TBD
Minneapolis	Franklin Ave Bridge	Separated shared use path	x			2016
Orono	Shadywood Road	Shoulder	x			2016
St Paul	Jackson Street	Separated bike lane and sidewalk	x	x		2016
Minneapolis	Central Ave (replacing NB counter)	Bike Lane	x			TBD
Bemidji	TBD	TBD	TBD	TBD	TBD	TBD

3.2 IMPLEMENTATION OF SHORT-DURATION BICYCLE AND PEDESTRIAN TRAFFIC MONITORING

In 2015, the project team used portable monitoring devices purchased during the Implementation project to conduct 58 counts of at least five days each at 33 locations across Minnesota. Counts were completed in Bemidji, Cass Lake, Fergus Falls, Mankato, Morris, and St. Paul. The devices used for these short duration counts included Metrocount pneumatic tubes for monitoring bicycles on roadways; Chambers radio beam counters for monitoring bicycles and pedestrians on shared use paths and sidewalks; and Eco-Counter Pyro (passive infrared) counters for monitoring mixed-mode (i.e., undifferentiated bicycle and pedestrian) traffic on shared use paths and sidewalks. MnDOT anticipates that in the future most short-duration counts will be completed with Eco-Counter pneumatic tubes and passive infrared devices so results can be more easily integrated into traffic count databases. However, the Metrocount and Chamber's counters will be made available to partners upon request. Results of short-duration monitoring are summarized in Chapter 5.

3.3 IMPLEMENTATION OF PORTABLE COUNTER LOAN PROGRAM

To implement the portable counter loan program, the project team prepared equipment kits for distribution statewide, identified partners responsible for managing the equipment loan program in each district, established procedures for loaning equipment, and conducted a training session for agency partners and other individuals interested in monitoring. Below is a list of the agencies that have assumed responsibility for managing the equipment loan program in each MnDOT district.

- District 1 - Arrowhead Regional Development Commission
- District 2 – MnDOT District Office
- District 3 – MnDOT District Office
- District 4 – West Central Initiative
- Metro District – MnDOT Office of Transit
- District 6 – MnDOT District Office
- District 7 – MnDOT District Office
- District 8 – MnDOT District Office

Figure 3-1 is the Terms of Use Agreement approved by MnDOT attorneys that will guide the portable equipment loan program. The Agreement includes a list of the monitoring equipment available for loan.

The project team held a training session in May 2016 for partners in the counter loan program and others that included a classroom session on monitoring and data analysis and a field session to practice installation of pneumatic tubes and infrared counters. Portable equipment kits were distributed to partners. Approximately 30 individuals attended the training session. Participants came from throughout the state and reflected the agencies hosting the portable counting equipment and within their region. Appendix C is a copy of the PowerPoint slides used in the training session. The slides address MnDOT's permanent monitoring program in addition to the short-duration monitoring program and the portable equipment loan program.

Terms of Use for Hosting MnDOT's Bicycle and Pedestrian Automated Counting Equipment

OWNER: Minnesota Department of Transportation (MnDOT)
395 John Ireland Blvd, St Paul, MN 55155
(651) 366-4197

MnDOT Representative:
Michael Petesch
Michael.Petesch@state.mn.us

HOST:

Terms & Conditions:

The HOST will store, manage, maintain and share the portable count equipment, manage regional data and procedures identified in the attached Eco-Visio document, Exhibit A. HOST will set up sites in Eco-Visio and inform MnDOT's Representative of any concerns or suggestions with equipment use; attend training provided by MnDOT on how to use and maintain portable equipment and provide technical assistance to parties who want to borrow the equipment.

1. **Portable Equipment Storage & Maintenance**: Before loaning the equipment kit out to another party, the HOST will clean, dry, neatly organize and store the equipment in its accompanying blue tote. This includes wiping off the counters, tubes and other associated equipment making sure to remove any insects, leaves, or other debris on or within the equipment. The HOST will plug in and charge the Android tablet to ensure that its battery is at least 50% full.

Equipment Kit Checklist:

Eco-***Pyro*** Sensor And Associated Parts	Eco-***Tube*** Sensor And Associated Parts
1 Pyro box	1 Eco-Tube counting system (steel box) including an Eco-Combo Logger and battery
An "Installation Guide," a "User Guide" and a "Quick Install Guide"	An "Installation Guide," a "User Guide" and a "Quick Install Guide"
1 back plate with 3 security screw at the base	2 "selective" tubes (thick ~30ft long tubes) for on-road installations
2 metal plates and screws for installation of back plate on a flat surface	2 "mini-tubes" (thin ~16ft long tubes) for counting on a trail / shared use path
3 extra security screws	2 "shock absorber" tubes (thick ~4ft long tubes) for counting on a trail / shared use path
1 socket wrench	A chain and padlock to secure the steel box to a post (e.g. lamppost, sign, tree, etc.)
1 Torx security allen wrench	Mini serflex clamps / figure-eight's to anchor the tubes to the counting surface
3 metal bands	Small fasteners / hose clamps to hold the tubes on the counter attachments
Magnet	Road nails & Magnet
ADDITIONAL TOOLS AND SUPPLIES IN THE KIT	
1 reflective vest, 1 hammer, 1 roll of Gorilla tape, 1 Android tablet/charger/instruction book	

2. **HOST'S RESPONSIBILITIES**
   a. **Loaning & Data Management:**
      - Maintain a calendar schedule that tracks the dates and location of the counters.
         - Email dates and locations to Michael Petesch at Michael.Petesch@state.mn.us or to his successor.
      - When loaning equipment, inform the acquiring party to aim for installations of 4-10 days including two FULL weekdays and two FULL weekends (7 consecutive days is ideal). For instance, install on Thursday and pick up on Tuesday in order to get complete traffic volumes for Friday through Monday.
      - The HOST should provide the borrowing party with and briefly go through with them the following documents:
         - InstallationSafety.docx
         - EquipmentKitContents.docx
         - EcoCounterTips&Tricks.docx
         - EcoLinkAndroidManual.pdf
      - Follow procedures identified in the attached Eco-Visio document, Exhibit A, and create new count locations in Eco-Visio for each new site counted in their region and transfer the data from the counter to Eco-Visio.

   b. **Technical Assistance & Updates:**
      - Provide technical assistance and copies of MnDOT's automated counting documents to parties who want to borrow the equipment and inform Michael Petesch at Michael.Petesch@state.mn.us or successor of any concerns or suggestions with equipment.
      - Staff members will attend future trainings provided by MnDOT on how to use and maintain portable equipment.

3. **Liabilities**: The OWNER does not assume liability for any damages resulting from the improper installation or use of the counting equipment. In no event shall OWNER be liable for any consequential, incidental, exemplary, or special damages whether in contract or tort, in any action connected with the equipment or services described in this document.

4. **Damage / No Return of Unit:** If any of the sensors or accompanying equipment is damaged or not returned to the HOST within five (5) days of the end of a scheduled loan, the HOST will inform the OWNER immediately.

Figure 3-1 Terms of Use Agreement for Equipment Loans

3.4 COUNTER INSTALLATION AND OPERATIONS

The project team followed standard traffic monitoring and engineering procedures outlined in FHWA's *Traffic Monitoring Guide* and elsewhere when establishing permanent monitoring locations and deploying equipment for short-duration monitoring. These procedures involved collaboration with local partners to determine monitoring objectives, completion of a site reconnaissance visit, preparation of plans for installation, installation or deployment of equipment, and in-field validation to confirm the counters were operating properly.

Permanent sites, as noted previously, were selected to reflect a range of types of facilities in a variety of settings (e.g., urban, suburban, small town) and because local partners had particular interests in learning about bicycle and/or pedestrian volumes at these locations or because installation meshed well with construction and implementation schedules. In addition to these criteria, locations for short-duration counts were chosen to provide data for pending construction projects or to assess pre-post conditions at project sites. The site reconnaissance visits were important for determining the existence of field conditions that might affect the operation of counters and the feasibility of monitoring.

As work to implement permanent counters proceeded, members of the project team within MnDOT's office of Traffic Data Analysis assumed responsibility for preparation of plans and designs and for oversight of installation. For example, Figures 3-2 and 3-3 illustrate plans for installation of an inductive loop counter on Summit Avenue in St. Paul, MN and for an integrated inductive loop / passive infrared counter on the Rush Creek Trail operated by the Three Rivers Park District in suburban Hennepin County. MnDOT is archiving plans for all permanent monitoring stations.

In-field validation of counters included manual counting of bicycles and/or pedestrians and comparison with totals registering on the automated counters for periods up to one hour. The objective of these in-field validation counts was to confirm that the counters were operating properly. Because traffic volumes vary substantially across locations, no specific thresholds were established for these counts.

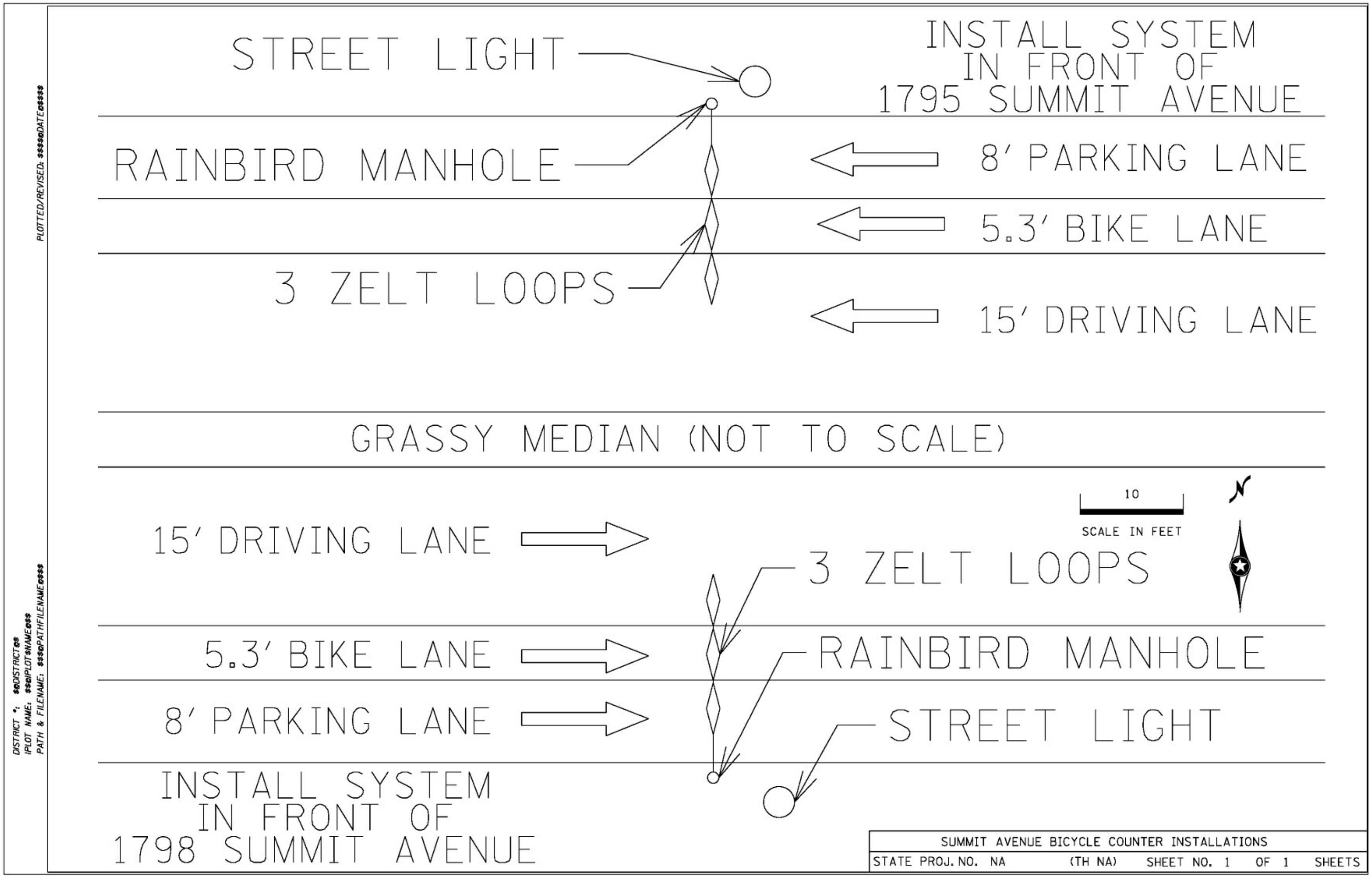


Figure 3-2 Site Plans for Summit Avenue Bicycle Traffic Monitoring Station (inductive loop counter)

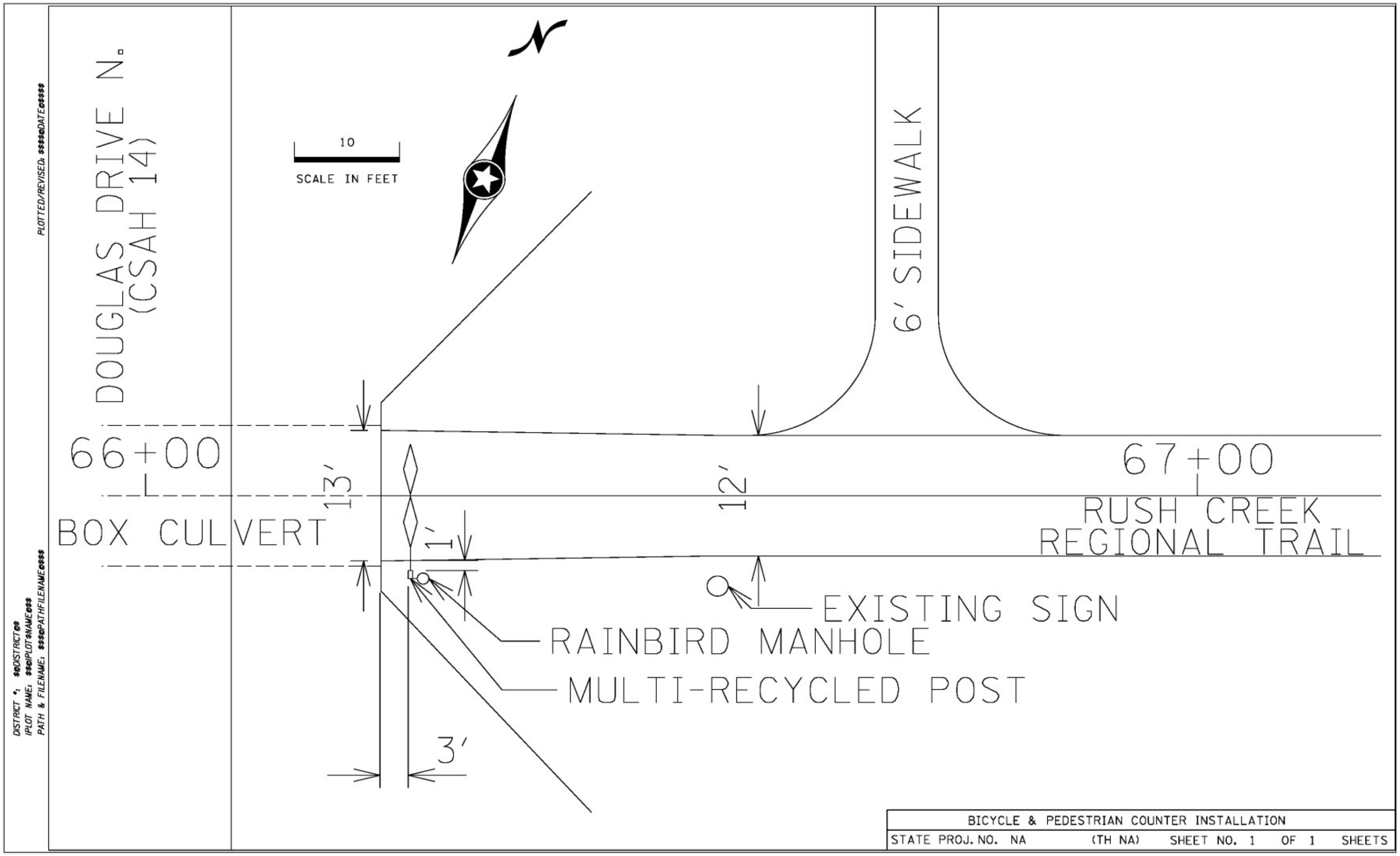


Figure 3-3 Site Plans for Rush Creek Trail Bicycle and Pedestrian Traffic Monitoring Station (inductive loop and passive infrared counter)

CHAPTER 4: BICYCLE AND PEDESTRIAN TRAFFIC DATA MANAGEMENT, ANALYSIS, AND REPORTING

MnDOT historically has maintained databases for managing, analyzing, reporting, and archiving motorized traffic counts. At the time the Institutionalization project was initiated, MnDOT was in the process of implementing a new data management system capable of supporting non-motorized traffic monitoring in addition to motorized traffic monitoring. One objective of this Institutionalization project was to develop procedures for integrating bicycle and pedestrian traffic counts into the new MnDOT traffic database. Early in the project period, however, implementation of the new MnDOT database was halted for administrative and financial reasons unrelated to this project. MnDOT then contracted with a different vendor to assist with implementation of a different database. This new database is called Jackalope and is supported by a vendor named High Desert Systems. Because it was not possible to integrate the bicycle and pedestrian counts collected during the project into the motorized traffic database, the project team developed a set of tools to manage, analyze, report, and archive bicycle and pedestrian traffic data until they can be integrated into the new Jackalope database in 2017.

4.1 DATA REQUIREMENTS FOR MANAGING BICYCLE AND PEDESTRIAN COUNTS

In collaboration with MnDOT staff from Transportation Data Analysis (TDA), MnDOT Information Technologies (MnIT), Transportation System Management (OTSM) and the Office of Transit, the project team first identified a list of essential information to capture for each non-motorized count (Table 4-1). This list is based on federal Traffic Monitoring Analysis System (TMAS) data submission requirements; each item represents a field in the TMAS database. The project team compiled each piece of information for all the bicycle and pedestrian traffic counts collected from permanent and short duration monitoring locations during this project. These data are being tracked in a master Excel © spreadsheet that is compatible with motor vehicle databases and can be integrated into mapping programs used by MnDOT. Fields in the spreadsheet also enable users to track deployment and maintenance of equipment and record notes from counts and locations. Appendix D is the MnDOT Bicycle and Pedestrian Count Master Spreadsheet that includes information required to integrate bicycle and pedestrian counts into MnDOT’s motorized traffic databases and FHWA’s TMAS system.

Table 4-1 Data Fields for Bicycle and Pedestrian Counts to Ensure Compatibility with FHWA TMAS Databases

Data Field	Notes / Explanation
Jurisdiction	Where the count was performed
Location Description	Detailed description pinpointing count location
FIPS and GNIS	Federal location identifiers
Latitude and Longitude	
Road Address	Useful for finding the location on site
Facility Type	Sidewalk, shared use path, buffered bike lane, shoulder, etc.
Road Classification	Useful for determining how many counter we have on different types of roads
Sensor Type	Vendor and equipment name
Mode Counted	Bikes, pedestrians, both combined, or both separately
Start date and time	
End date and time	
Responsible Agency	Who is / was responsible for the count

4.2 SPREADSHEET TEMPLATES FOR MANAGING BICYCLE AND PEDESTRIAN COUNTS

A challenge in developing standard methods and tools for managing and archiving bicycle and pedestrian counts is that, like counts of motorized vehicles, non-motorized counts may be taken manually or with a variety of types of automated sensors that record counts for different time periods and in different formats. As of 2016, bicycle and pedestrian counts had been taken in Minnesota using automated counters manufactured by at least six different vendors: Eco-Counter, Metrocount, Chambers, TrailMaster, TrafX, and Sensys. The project team developed Excel © spreadsheet templates for managing, analyzing, and archiving traffic counts completed manually and with automated sensors owned by MnDOT or used by partners in the state. Templates for the Chambers radio beam monitors, Metrocount pneumatic tubes counters, and TrailMaster active infrared monitors are available from the MnDOT Office of Transit. Figure 4-1 is a copy of a count summary for bicycle counts using the Metrocount pneumatic tubes. In addition to descriptive information about the monitoring location, the template summarizes average daily traffic volumes and a variety of other statistics. Appendix E is a copy of instructions for using the Metrocount Excel © template. The project team provided TrailMaster templates to the Arrowhead Regional Development Commission in Duluth and to the National Park Service in Minneapolis for testing and use. As of 2016, both agencies were continuing to use the templates to analyze data collected using TrailMaster counters.

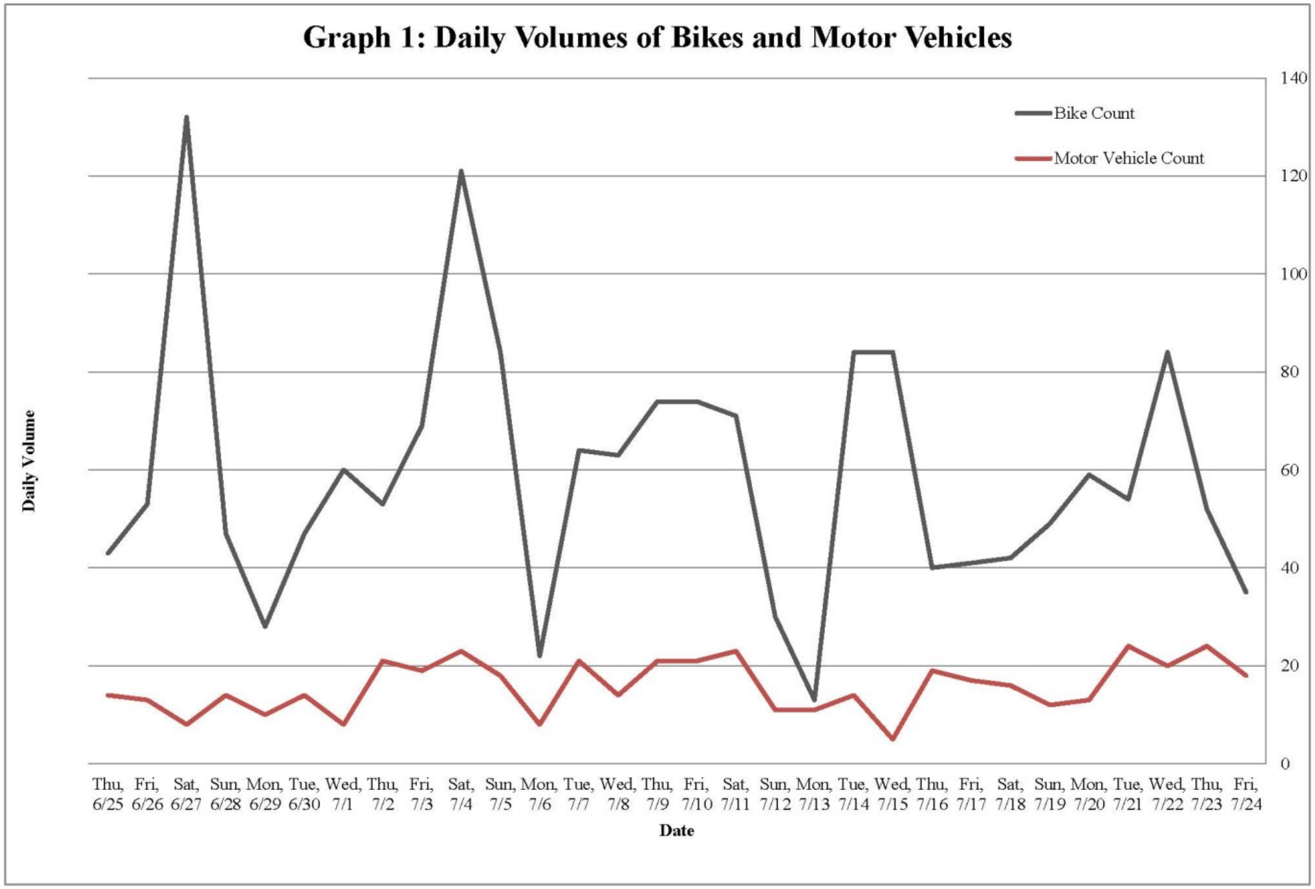
This summary report shows results from Rollins Creek near Githcee Gami Trail (GGT) for complete days (full 24-hour periods) counted between 6/24/15 and 7/25/15 using MetroCount MC5600 sensors. Using rubber road tubes, this sensor only classified bikse and motor vehicles even though it potentially detected pedestrians, roller bladers, bike trailers and or strollers too.

- Table 1 summarizes many useful descriptive factors including Total Traffic Volume and Daily Average Volume
- Graph 1 depicts the total daily volumes of people biking and driving for all complete days during the sample period
- Graph 2 compares the average daily volumes of people driving and biking at at Rollins Creek near the GGT as well as the average distribution of total non-motorized traffic for each day of the week. It shows that bike traffic is highest on Saturday making up 19% of total traffic at that location per week.
- Graph 3 shows the average hourly traffic volumes for people walking and biking during weekdays
- Graph 4 shows the volumes for non-motorized traffic during weekend days

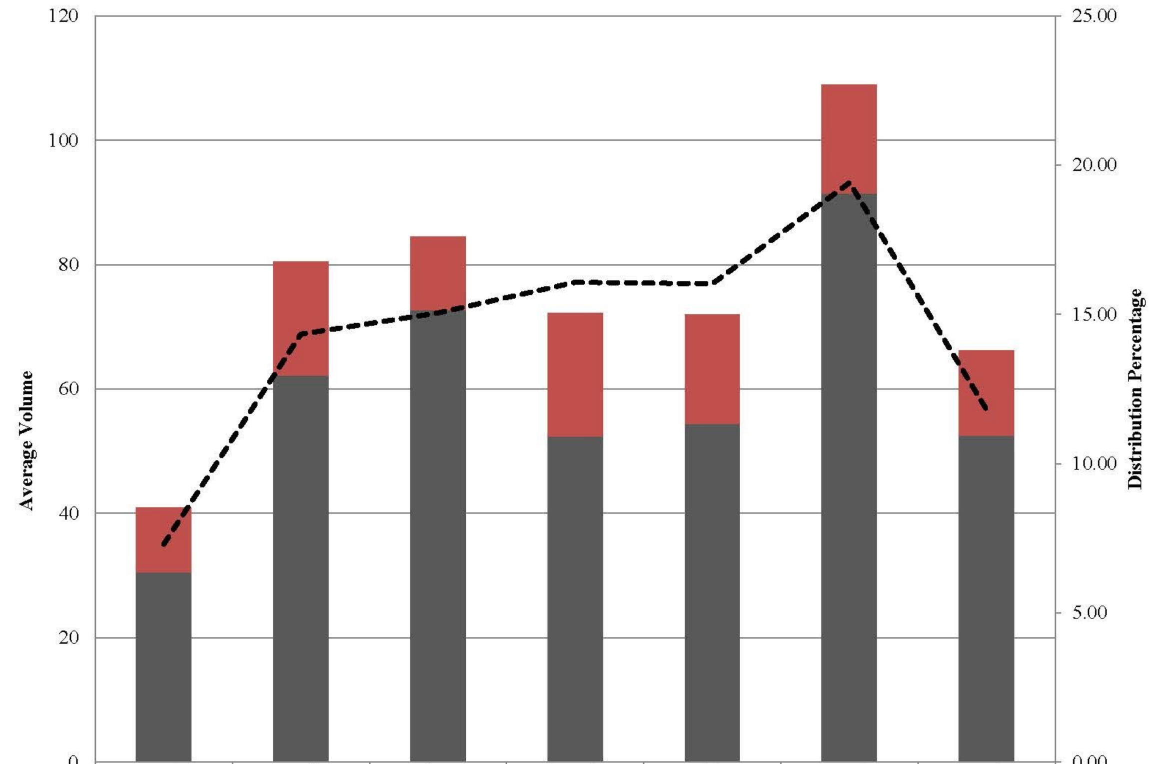
* The graphs and tables in this report may include extraordinary data as fluctuations caused by weather, holidays, and or other notable events such as organized races may not be addressed. Some recommended links for comparing this output to local weather are http://www.noaa.gov/ and http://weather.weatherbug.com/.

Table 1: Key Figures for Sample Period

	Bike Traffic		Motor Vehicle Traffic		Total Traffic	
First Complete Day of Data:					6/25/2015	
Last Complete Day of Data:					7/24/2015	
Number of Complete Days of Data:					30	
Number of Complete Weekdays:					22	
Number of Complete Weekend Days:					8	
Total Traffic Volume:	1772		474		2246	
Daily Average Volume:	59		16		75	
Weekday Daily Average Volume:	54		16		70	
Weekend Daily Average Volume:	72		16		88	
Ratio of Weekend vs. Weekday Traffic (WWI):	1.3		1.0		1.2	
Ratio of Morning (7-9am) to Midday (11am-1pm) Traffic (AMI):	0.3		0.2		0.3	
Weekday Maximum Average Hourly Traffic (Peak Hour):	10:00 AM	6	4:00 PM	2	10:00 AM	8
Weekend Maximum Average Hourly Traffic (Peak Hour):	11:00 AM	11	2:00 PM	2	11:00 AM	13
Day of Week with the Maximum Average Daily Traffic:	Saturday	92	Thursday	20	Saturday	109
Day of Sample with the Maximum Daily Traffic:	6/27/2015	132	7/21/2015	24	7/4/2015	144

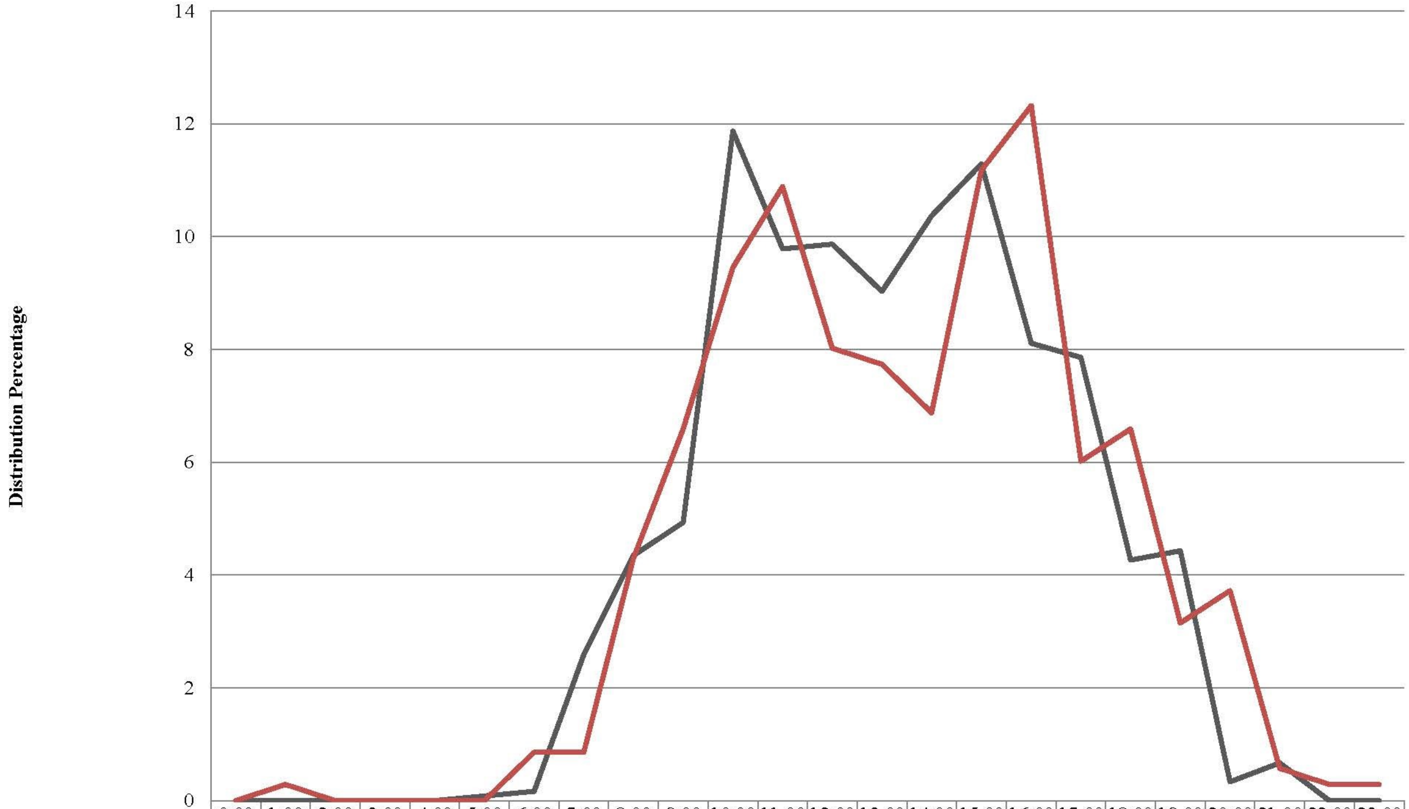

Graph 1: Daily Volumes of Bikes and Motor Vehicles
Bike Count
Motor Vehicle Count
Daily Volume
140
120
100
80
60
40
20
0
Thu, 6/25
Fri, 6/26
Sat, 6/27
Sun, 6/28
Mon, 6/29
Tue, 6/30
Wed, 7/1
Thu, 7/2
Fri, 7/3
Sat, 7/4
Sun, 7/5
Mon, 7/6
Tue, 7/7
Wed, 7/8
Thu, 7/9
Fri, 7/10
Sat, 7/11
Sun, 7/12
Mon, 7/13
Tue, 7/14
Wed, 7/15
Thu, 7/16
Fri, 7/17
Sat, 7/18
Sun, 7/19
Mon, 7/20
Tue, 7/21
Wed, 7/22
Thu, 7/23
Fri, 7/24
Date

Graph 2: Average Daily Traffic for Sample Period



	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Average Motor Vehicle Volume	11	18	12	20	18	18	14
Average Bike Volume	31	62	73	52	54	92	53
# of Days in Sample	4	4	4	5	5	4	4
Total Distribution over Sample (%)	7.30	14.34	15.05	16.07	16.03	19.41	11.80

Graph 3: Average Hourly Traffic Volumes During Weekdays



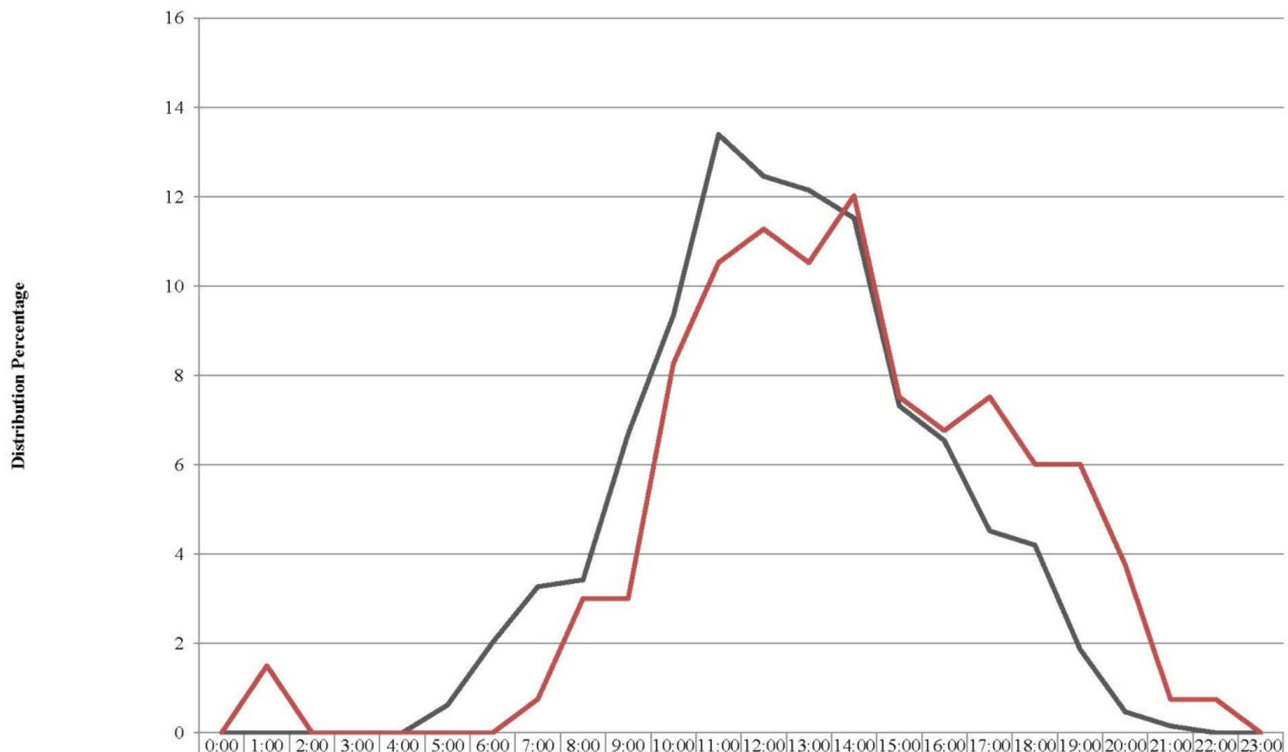
	0:00	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00
% Bikes	0.00	0.00	0.00	0.00	0.00	0.08	0.17	2.59	4.35	4.93	11.87	9.78	9.87	9.03	10.37	11.29	8.11	7.86	4.26	4.43	0.33	0.67	0.00	0.00
% Motor Vehicles	0.00	0.29	0.00	0.00	0.00	0.00	0.86	0.86	4.30	6.59	9.46	10.89	8.02	7.74	6.88	11.17	12.32	6.02	6.59	3.15	3.72	0.57	0.29	0.29
% Total Traffic	0.00	0.06	0.00	0.00	0.00	0.06	0.32	2.20	4.34	5.31	11.33	10.03	9.45	8.74	9.58	11.26	9.06	7.44	4.79	4.14	1.10	0.65	0.06	0.06

Rollins Creek near Gitchee Gami Trail
in Grand Marais, MN

ARDC, UMN

8/4/2015

Graph 4: Average Hourly Traffic Volumes During the Weekend



	0:00	1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00
% Bikes	0.00	0.00	0.00	0.00	0.00	0.62	2.02	3.27	3.43	6.70	9.35	13.40	12.46	12.15	11.53	7.32	6.54	4.52	4.21	1.87	0.47	0.16	0.00	0.00
% Motor Vehicles	0.00	1.50	0.00	0.00	0.00	0.00	0.00	0.75	3.01	3.01	8.27	10.53	11.28	10.53	12.03	7.52	6.77	7.52	6.02	6.02	3.76	0.75	0.75	0.00
% Total Traffic	0.00	0.26	0.00	0.00	0.00	0.52	1.68	2.84	3.35	6.06	9.16	12.90	12.26	11.87	11.61	7.35	6.58	5.03	4.52	2.58	1.03	0.26	0.13	0.00

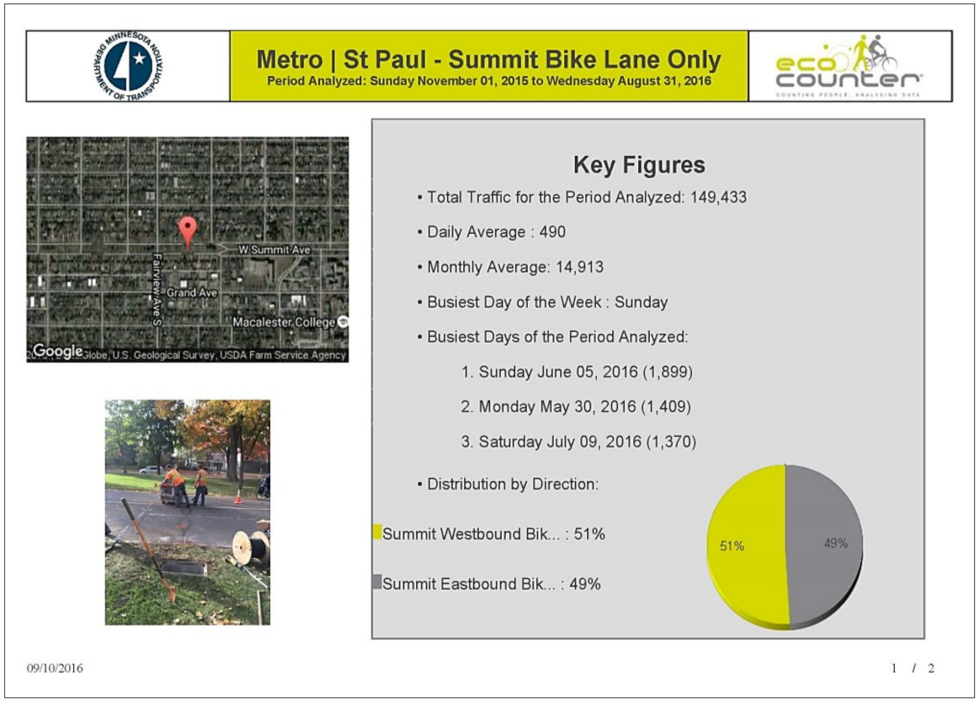
5

Figure 4-1 Spreadsheet Templates for Managing and Analyzing Count Data from Metrocount Pneumatic Tubes.

4.3 ECO-COUNTER AND ECO-VISIO DATA MANAGEMENT

MnDOT has purchased Eco-Counter counters for its permanent monitoring locations, short-duration monitoring, and equipment loan program. As noted previously, one of the reasons for selecting Eco-Counter as the principal vendor for bicycle and pedestrian counters was the capacity for remote data retrieval and the analytic capabilities of the accompanying software, Eco-Visio. MnDOT can access data from all its counters (both permanent and portable) through the same interface. Among other features, Eco-Visio allows users to analyze hourly, daily, weekly, monthly, or annual traffic patterns for any chosen time period. Figure 4-2 is a sample of an Eco-Counter standard report form for bicycle traffic on Summit Avenue in St. Paul.

The project team developed administrative procedures for use of the Eco-Visio data retrieval software. These procedures involve accessing data through an FTP service provided by the vendor that typically is provided on a 'per-domain' basis so it can include all of the counters in a user's domain for a single fee. The Eco-Visio web-based data management system allows users to choose the data format (XML, TXT or CSV) and the data to identify the systems (i.e., specify the counting site identification number). This integration procedure will enable MnDOT to secure all data in-house, thereby supporting larger analyses and making the creation of adjustment factors easier. These procedures also will enable MnDOT to integrate data from permanent and portable EcoCounter monitors into MnDOT traffic databases when they are operational in the future. To facilitate data-sharing, the project team created a read-only access option and is sharing the Eco-Visio site with staff in MnDOT and with external partners, including agencies collaborating in counting and consulting engineers and planners who need data for project-related work.


Metro | St Paul - Summit Bike Lane Only
Period Analyzed: Sunday November 01, 2015 to Wednesday August 31, 2016

Key Figures

- Total Traffic for the Period Analyzed: 149,433
- Daily Average : 490
- Monthly Average: 14,913
- Busiest Day of the Week : Sunday
- Busiest Days of the Period Analyzed:
  1. Sunday June 05, 2016 (1,899)
  2. Monday May 30, 2016 (1,409)
  3. Saturday July 09, 2016 (1,370)
- Distribution by Direction:

Summit Westbound Bik... : 51%

Summit Eastbound Bik... : 49%

09/10/2016 1 / 2

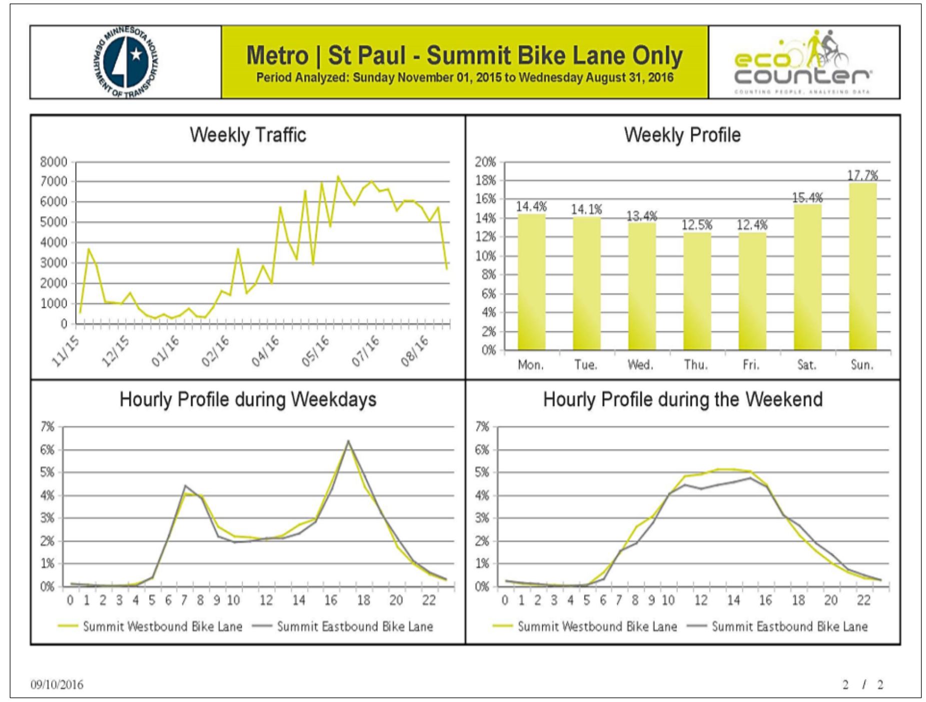


Figure 4-2 Eco-visio Standard Report for Bicycle Traffic on Summit Avenue in St. Paul

4.4 ONLINE, INTERACTIVE GIS MAP FOR ACCESSING BICYCLE AND PEDESTRIAN COUNTS

As an interim step towards integration of all bicycle and pedestrian counts with MnDOT's motorized vehicle database, the project team created an interactive map that displays all count locations and allows users to download count summaries from both the Excel © spreadsheet templates and the Eco-Visio reports. The link for the interactive map is: http://arcg.is/2da0kqs.

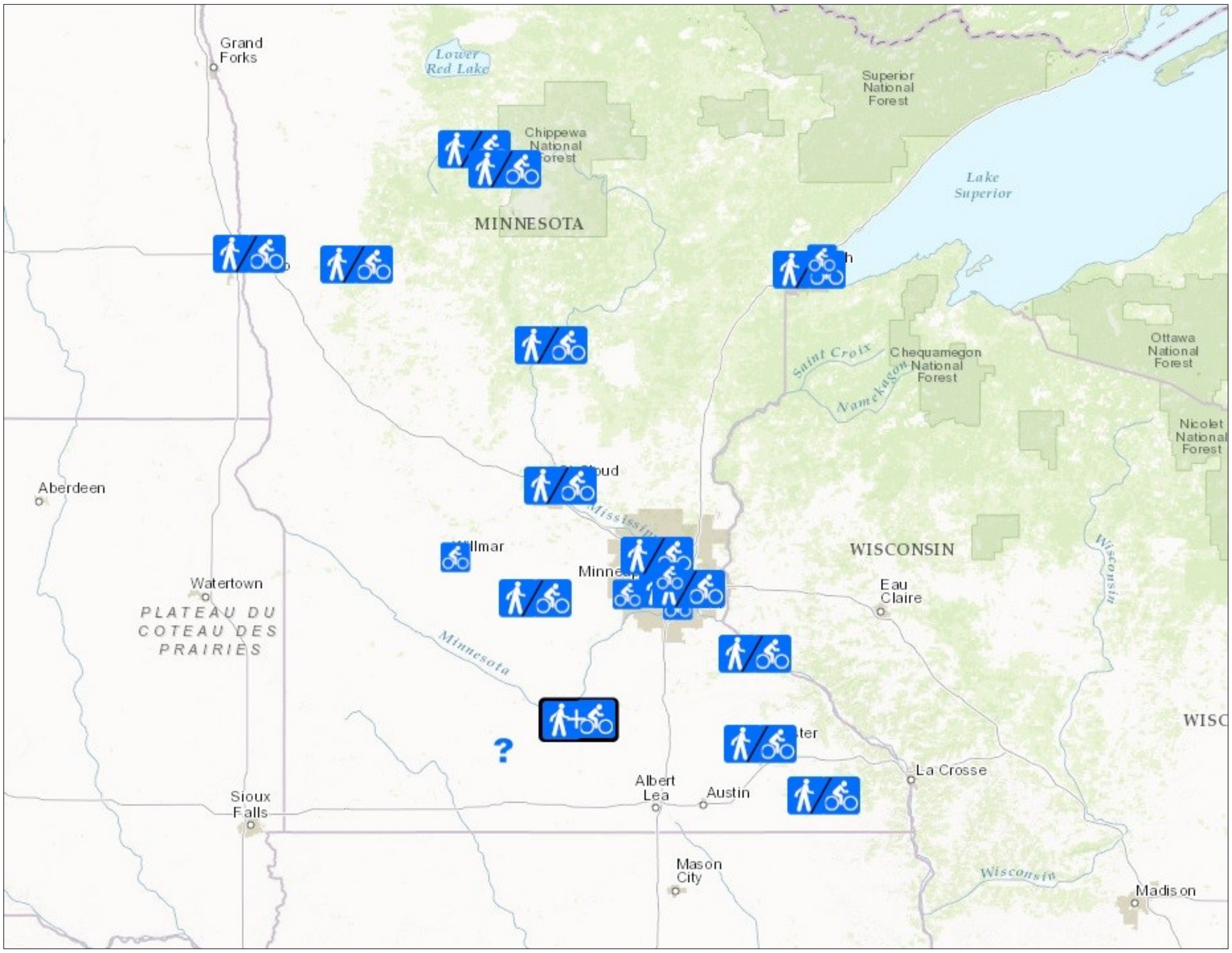


Figure 4-3 Screenshot of MnDOT Online, Interactive Map for Accessing Bicycle and Pedestrian Counts.

4.5 DATA ANALYSIS

Standard approaches to analysis of bicycle and pedestrian counts are described in the draft MnDOT Bicycle and Pedestrian Data Collection Manual (Minge et al. 2015) completed in 2015 as part of MnDOT's project, Implementing Bicycle and Pedestrian Traffic Counts and Data Collection (Lindsey et al. 2015). The revised final version of this manual is available on the MnDOT Research Services website: http://dotapp7.dot.state.mn.us/projectPages/pages/projectDetails.jsf?id=13849&type=CONTRACT. Key steps in data analysis include quality assurance/quality control (QA/QC), calculation of descriptive statistics used in transportation planning, engineering, and decision-making, and calculation of factor, or ratios, used to extrapolate short-duration samples into estimates of annual or summer average daily traffic. Because each of these topics are addressed in detail in the Data Collection Manual and in the Implementation project report, this report includes only new examples that complement and extend these sources.

4.5.1 Quality Assurance/Quality Control

Major guidance documents on bicycle and pedestrian data collection stress the importance of QA/QC (FHWA 2013, Minge et al. 2015, Turner et al. 2013). Adapting procedures used in QA/QC for motorized vehicle traffic data, Turner (2013) advises visual inspection of data, assessment of potential for outliers using a pre-specified cutoff criterion, assessment of zero counts, and use of professional engineering judgment to make final decisions about counts to include or censor from a dataset.

The project team recruited students in a practicum course to explore approaches to QA/QC. Following the course, one student refined methods and reanalyzed data, following Turner's recommended approach (Vorvick and Lindsey 2016). Table 4-2 lists six locations included in this example of procedures for QA/QC. The locations include three installations of inductive loops on roadways measuring bikes and three installations of integrated inductive loop and passive infrared devices at three locations on multiuse trails. Two sensors were installed at each roadway location to count bicycles traveling in opposite directions. Each location is one of MnDOT's permanent index monitoring sites.

Approximately one year of data was analyzed for each site. Across locations, average daily traffic (ADT) ranged from 19 to 972 for bikes, and 75 to 787 for pedestrians. The traffic flows are characterized by high seasonality; to account for this, the data were separated into winter (October - March) and summer (April – September) datasets for some analyses. Summer average daily bicyclists (ADB) were an average of 154% of ADB for the entire dataset. Winter ADB were an average of 23% of ADB for the entire dataset. Seasonality was less pronounced in the pedestrian traffic on trails. Summer and winter average daily pedestrians (ADP) averaged, respectively 136% and 47% of ADP for the dataset.

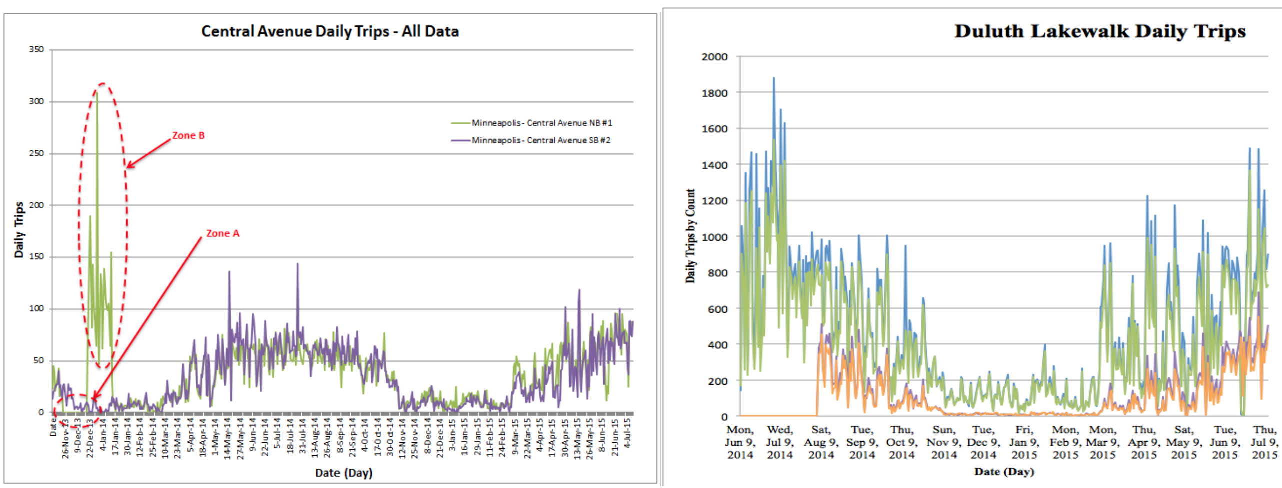
Table 4-2 Monitoring Sites and Sensors Included in QA/QC Example (Vorvick and Lindsey 2016)

Site	Location	Name	Description	Sensor	Type	Mode	Data Days	Raw ADT
1	NE Mpls	Central Ave NB	Shoulder - Bike Lane	1	ZELT inductive loops with manhole	Bike	366	43
		Central Ave SB	Shoulder - Bike Lane	2	ZELT inductive loops with manhole	Bike	367	37
2	Duluth Kitchi Gami Park	Scenic 61 EB	Hwy Shoulder	3	ZELT inductive loops with manhole	Bike	366	22
		Scenic 61 WB	Hwy Shoulder	4	ZELT inductive loops with manhole	Bike	366	19
3	Eagan	TH 13 NB	Hwy Shoulder	5	ZELT inductive loops with manhole	Bike	366	21
		TH 13 SB	Hwy Shoulder	6	ZELT inductive loops with manhole	Bike	366	20
4	Mpls W. River Parkway	W River Greenway	Park Trail	7	3-Loop Wooden Post MULTI	Bike	396	972
				8	PYRO Zoom	Ped	396	413
5	Rochester Cascade Lake Park	Macnamara Bridge	Park Trail	9	2-loop ZELT	Bike	367	129
				10	mid-range PYRO	Ped	367	75
6	Duluth Canal Park	Lakewalk Multi	Park Trail	11	2-loop ZELT	Bike	368	257
				12	mid-range PYRO	Ped	368	787

Visual inspection is a first step in QA/QC, though if there are many locations, it is time consuming and may not always be possible. Visual inspection can help confirm the date a counter was installed. For example, some devices (e.g., Eco-Counter) may be inadvertently active prior to installation, resulting in a long string of zero counts prior to the first days actual counts are recorded. Visual inspection can identify and censor these types of counts.

Figure 4-4 illustrates visual editing on daily data for two locations, Central Avenue in Minneapolis and the Lake Walk in Duluth, a shared-use path for both bicyclists and pedestrians (Vorvick and Lindsey 2016). Visual inspection identified suspiciously high data and runs or “zero days” in mid-season. Data from three (25%) of the 12 sensors at the six locations required suppression or editing. The days that required editing included both winter and summer days: 2 winter days for one sensor; 11 summer and 2 winter days for a second sensor, and 52 days for a third sensor. The maximum of 52 days is equivalent to 14% of the days in a year.

Figure 4-4 also summarizes the effects of data suppression on estimates of ADB and ADP. For the Central Avenue location, visual editing reduced the estimate of ADB about 10.5% from 43 to 38.5. Suppressing invalid counts on W. River Parkway multiuse trail slightly increased estimates of average daily traffic.



Summary Table

Location	Sensor	Mode	ADT	Direction	VE Day	VE Suppressed Days	VE ADT	VE % of Raw ADT
Central Avenue	**1**	**Bike**	**AADT**	**NB**	**315**	**52**	**38.5**	**89%**
West River Greenway	**7**	**Bike**	**AADT**	**Two-Way**	**394**	**2**	**977.1**	**101%**
	8	**Ped**	**AADT**	**Two-Way**	**383**	**13**	**426.8**	**103%**

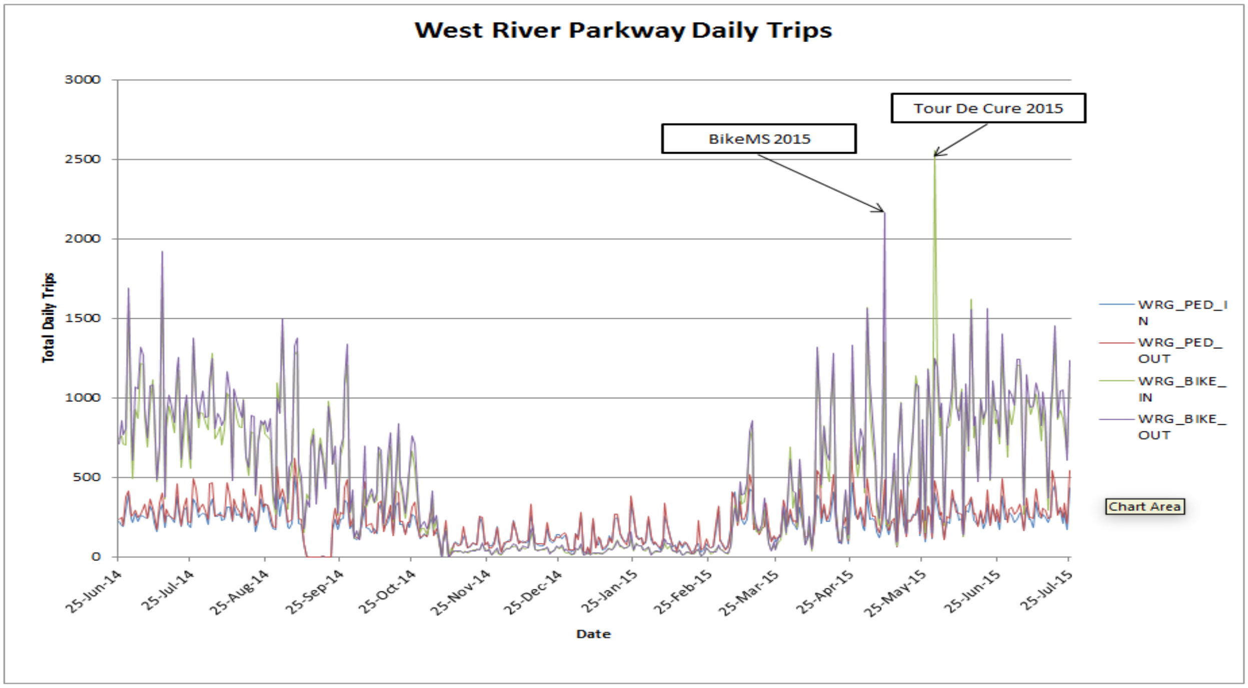
Figure 4-4 Examples of Invalid Daily Counts Identified with Visual Inspection

Following visual editing, a second common step in QA/QC involves censoring of counts with values above some pre-specified criterion that are believed to have a high probability of being invalid. For example, analysts may censor counts with values more than two or three standard deviations above the mean.

Figure 4-5 illustrates the effects of suppressing all values greater than two standard deviations above the mean on estimates of average daily traffic, both before and after visual editing. It is useful to explore both cases because visual editing first changes the dataset and therefore affects which values are suppressed as outliers. Because this step involves censoring high values, it reduces estimates of the average daily traffic. For these twelve sensors, this approach to controlling for outliers resulted in suppression of 146 days of counts, roughly 3% of days in the raw dataset. Across all sensors, ADB and ADP were reduced an average 6% and 9% from raw values, respectively. The effects of this approach are greater on estimates of winter ADB and ADP than on summer ADB and ADP. Specifically, if "outliers" are censored, summer and winter ADB drop 5% and 21% respectively; summer and winter ADP dropped 7% and 20%, respectively.

One limitation of this approach is that these "outliers" may actually be valid counts that, depending on the purpose of the analysis, should be retained. Web searches can identify events that match many of the identified spikes. For example, in Figure 4-5, two daily counts that appear to be outliers and would be censored if thresholds for censoring were followed blindly. These high counts occurred on days of special events, specifically, charity rides for multiple sclerosis and diabetes. Another limitation is that this approach may miss invalid counts below the threshold. For example, some of the high values recorded on Central Avenue through visual inspection were below the threshold of two standard deviations but actually invalid. These types of problems (i.e., censoring valid counts and retaining invalid counts) cannot be avoided completely if threshold criteria for censoring values are followed blindly.

A third step in QA/QC is to assess the validity of counts of zero, or no bicycle or pedestrian traffic. For motorized vehicles on roadways, daily counts of zero and long consecutive hours of zero counts are relatively rare, so it is a common practice to flag these types of zero counts for inspection and/or suppression. Daily counts and long strings of hourly counts of zero are more common for bicycle and pedestrian traffic, especially on facilities in rural areas in winter when volumes may be quite low. Particularly because of the high seasonality of bicycle and pedestrian traffic, the type of decision rules for counts of zero for motorized traffic cannot be applied to non-motorized traffic.

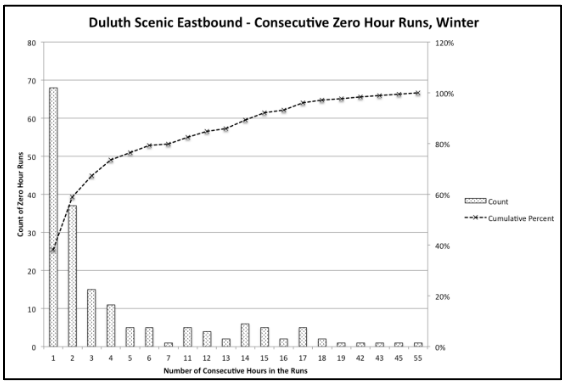


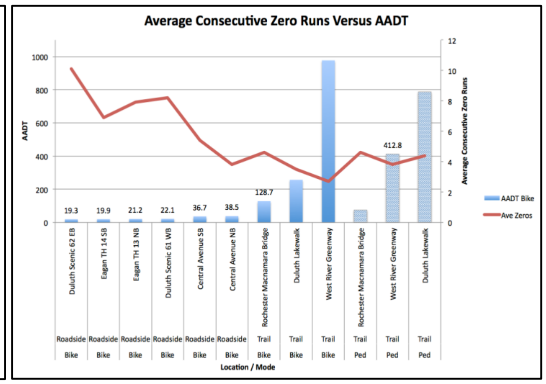
					2Sigma Spike Edit				Post VE 2Sigma Spike Edit				
Facility	Location	Sensor	Mode	Directio	2S Days	2S Suppressed Days	2S ADT	2S % of Raw ADT	VE2S Days	VE2S Suppressed Days	VE 2S ADT	VE2S % of VE ADT	
Roadside	Central Avenue	1	Bike	NB	346	20	41.2	96%	338	28	37.8	98%	98%
		2		SB	355	12	35.7	97%					97%
	Duluth Scenic 61	3	Bike	EB	353	13	20.0	90%					90%
		4		WB	355	11	17.4	90%					90%
	Eagan TH 13	5	Bike	NB	361	5	20.6	97%					97%
		6	Bike	SB	354	12	18.9	95%					95%
Multiuse Trail	West River Greenway	7	Bike	2-Way	385	16	909.4	94%	378	18	925.6	95%	95%
		8	Ped	2-Way	384	15	395.2	96%	366	30	405.6	95%	95%
	Rochester Macnamara Bridge	9	Bike	2-Way	359	8	122.4	95%					95%
		10	Ped	2-Way	356	11	63.2	84%					84%
	Duluth Lakewalk	11	Bike	2-Way	358	10	244.1	95%					95%
		12	Ped	2-Way	355	13	729.9	93%					93%

146			
Ave Total Bike vs Raw	94%	Ave Total Bike vs Raw	95%
Ave Total Ped vs Raw	91%	Ave Total Ped vs Raw	91%
Ave Summer Bike vs Raw	95%	Ave Summer Bike vs Raw	95%
Ave Winter Bike vs Raw	79%	Ave Winter Bike vs Raw	79%
Ave Summer Ped vs Raw	93%	Ave Summer Ped vs Raw	92%
Ave Winter Ped Vs Raw	80%	Ave Winter Ped Vs Raw	80%

Figure 4-5 Effects of Censoring Data Spikes Greater Than 2 Standard Deviations above the Mean (Vorvick and Lindsey 2016)

The challenges of assessing the validity of hourly counts of zero are illustrated in Figure 4-6 for sensors on Scenic Highway 61 outside Duluth MN. For this example, a run of zero hours is defined by the maximum number of consecutive hours with counts of zero (e.g., eight consecutive hours of zero is a run of eight hours). One-hour runs of zero counts occurred most frequently (n=68), but most zero hours occurred in longer runs. Four zero runs of greater than 40 hours occurred, including one run of 55 zero hours. Most of these long runs occurred in the winter when temperatures in northern Minnesota are very cold and snow may accumulate on road shoulders. Eco-Counter reports that inductive loops can record bicycles through at least four inches of snow. However, it is very difficult to know with certainty whether these runs of zeroes are valid or invalid. Retaining hourly or daily zeroes will lower estimates of average daily traffic, perhaps erroneously, while censoring them may artificially raise them. Hence, professional judgment is necessary when determining whether to suppress or censor hourly counts of zero.





					Consec Zero Hour Runs					
Facility	Location	Sensor	Mode	Direction	CZR Raw			CZR Post Visual Edit		
					Max	Ave		Max	Ave	
Roadside	**Central Avenue**	**1**	**Bike**	**NB**	**224**	**3.8**		**37**	**3.8**	
		2		**SB**	**54**	**5.4**				
	Duluth Scenic 61	**3**	**Bike**	**EB**	**193**	**8.2**				
		4		**WB**	**303**	**10.1**				
	Eagan TH 13	**5**	**Bike**	**NB**	**199**	**7.9**				
		6	**Bike**	**SB**	**199**	**6.9**				
Multiuse Trail	**West River Greenway**	**7**	**Bike**	**2-Way**	**14**	**2.7**		**14**	**2.7**	
		8	**Ped**	**2-Way**	**153**	**4.2**		**12**	**3.8**	
	Rochester Macnamara Bridge	**9**	**Bike**	**2-Way**	**63**	**4.6**				
		10	**Ped**	**2-Way**	**36**	**4.6**				
	Duluth Lakewalk	**11**	**Bike**	**2-Way**	**36**	**3.5**				
		12	**Ped**	**2-Way**	**24**	**4.4**				

Ave Annual Bike CZR	5.9		5.9	
Ave Annual Ped CZR	4.4		4.3	
Ave Summer Bike		60%		60%
Ave Winter Bike		131%		128%
Ave Summer Ped		82%		76%
Ave Winter Ped		95%		99%

Figure 4-6 Consecutive Zero Count Hourly Runs

Several observations can be drawn from this example. Visual editing is an appropriate and necessary step in assessing data quality. The blind or automated use of pre-specified thresholds for identifying and suppressing unusually high counts may result in censoring of both valid and invalid counts. Conversely, retention of these values may result in inclusion of invalid counts. Internet research into events that correspond to spikes in daily counts can be conducted, but takes time. Reviewing hourly runs of zero is useful but automated decision rules should not be applied blindly. For the six locations and 12 sensors analyzed in the preceding example, multiple long hourly runs of zero, including runs of zero lasting as long as a day or two, were common. However, daily zero values in the summer should be investigated as anomalous.

Consistent application of professional judgment will be necessary when conducting QA/QC. One pragmatic consideration is whether retention or exclusion of suspect counts materially affects estimates of ADT. The preceding analyses showed that in most cases, censoring high values greater than two standard deviations above the mean reduced estimates of ADT by only a few percent. A relevant question is whether censoring makes any difference for practice and would materially affect any decision an engineer or planner might make. Seven of the 12 sensors recorded volumes less than 100 bicyclists or pedestrians per day. For a site with an ADT of 100, even if censoring high values reduced estimates by 10%, it would change the estimate only to 90. Few decisions would hinge on a difference in ADT of 10. For higher volume sites, the question is not so simple and it is possible to imagine that automatic application of rules for censoring suspect outliers could potentially affect engineering or policy decisions. One strategy for addressing these issues is to standardize procedures to explore the effects of following different decision rules and make decisions based on the particulars of the situation. This type of contingent process, however, is more difficult to administer and sustain. MnDOT has staff with expertise in traffic monitoring, and as the staff gains additional experience in non-motorized traffic monitoring, these general procedures can be refined.

4.6 DESCRIPTIVE STATISTICS

As noted in MnDOT Bicycle and Pedestrian Data Collection Manual, transportation planners and engineers frequently use descriptive statistics such as average daily traffic (ADT), annual average daily traffic (AADT) and peak hour volume in planning and engineering (Minge et al. 2015). These types of measures often are calculated for particular days of the week in each month of the year, as averages for weekdays and weekends in each month of the year, or for seasons. The MnDOT Manual provides a general overview of these statistics.

The spreadsheet template developed by the project team for analyzing counts (Figure 4-1) and the Eco-Counter standard summary report in Eco-Visio (Figure 4-2) summarize many standard descriptive statistics useful in transportation planning and engineering. The spreadsheet template reports the sample period; numbers of complete weekdays and weekend days; total traffic volume, average daily traffic volume, and average weekday and weekend daily traffic; and weekday and weekend maximum average hourly traffic (peak hour). Eco-Visio presents essentially the same statistics in a slightly different format.

4.6.1 Factors for Data Analysis and Extrapolation of Short-duration Counts

As noted previously, the FHWA's Traffic Monitoring Guide (TMG) (2013) recommends use of ratios, or factors, derived from data collected at permanent monitoring sites for extrapolating short-duration counts into estimates of AADT. The standard approach to factoring short-duration motorized traffic counts involves use of day-of-week and month-of-year factors. When short-duration samples are less than one complete day, hourly factors also can be calculated and used in extrapolation and analyses. These hourly factors may be computed for each day of the week or for weekdays and weekend days generally. The FHWA's Traffic Monitoring Guide (2013) includes a step-by-step example from Minnesota that demonstrates how this standard approach can be used to extrapolate short-duration mixed-mode (i.e., undifferentiated bicycle and pedestrian) counts taken on a multiuse trail. The standard approach is not described in detail here because this example is available in the TMG.

Eco-Counter and Eco-Visio do not automatically report the ratios that are required to use the standard factoring approach, although users can compute the ratios directly within Eco-Visio using available commands. To facilitate computation of factors, the project team developed instructions for computing daily and monthly factors in Eco-Visio. These instructions are presented in Appendix F.

The project team assisted the nonprofit Parks and Trails Council of Minnesota in adapting the standard factoring method for two hour manual counts its volunteers completed on 25 state multiuse trails in 2015 (Parks and Trails Council of Minnesota 2016). The Council used hourly, day-of-week, and month-of-year factors to estimate annual average daily mixed-mode trail traffic for each trail. The factors used for extrapolation were derived from counts at permanent monitoring stations on trails in Minneapolis. Chapter 8 of this report, which summarizes technical assistance activities completed during the Institutionalization project, includes additional details on the methods used by the Parks and Trails Council, including sources of error in their application of the standard factoring methods. Perhaps the most significant limitation in their approach has do with the uncertainty associated with extrapolating very short (i.e., 1-2 hour) counts. Nordback et al. (2013) and Hankey et al. (2014) have shown that the margin of error associated with estimating AADT from two hour counts may be as high as 40%. The Parks and Trails Council noted this limitation in its estimates of annual trail traffic.

Previously, during the Implementation project that preceded and led to this study, the project team developed an alternative approach to factoring non-motorized counts called the day-of-year factoring approach (Hankey et al. 2014; Lindsey et al. 2015). This approach results in more accurate estimates of AADT from short-duration samples because it does a better job in capturing the effects of weather on bicycle and pedestrian traffic. The day-of-year approach is based on the assumption that within a specified geographic region where weather conditions are essentially the same, bicycle and pedestrian traffic varies similarly in response to weather. Thus, relative to an annual total, the traffic volumes at different sites on any given day account for similar proportions of total annual traffic, even if absolute volumes vary significantly. A similar approach was derived by a research group in Canada at about the same time (Nosal et al. 2014), and more recent research has confirmed that day-of-year factoring is superior to the standard approach for factoring non-motorized traffic counts (El Esawey 2014).

During this Institutionalization study, the project team worked with Hennepin County and the Arrowhead Regional Development Commission (ARDC) to adapt the day-of-year factoring approach for their new monitoring programs. Hennepin County launched a bicycle monitoring program in 2015 and completed 48-hour bicycle counts using pneumatic tubes at 31 on-road locations (Hennepin County 2016). The County then used day-of-year factors to estimate annual average daily bicyclists (AADB) from its short-duration counts. The County developed its factors from MnDOT's permanent monitoring station on Central Avenue in Minneapolis. To illustrate seasonal variation in traffic volumes, the County also used factors to estimate January and July ADB. Figure 4-7 is an excerpt from Hennepin County's count report that summarizes its application of the day-of-year factoring method.

ARDC is using day-of-year factors from two automated control sites to estimate summertime average daily mixed-mode trail traffic from short-duration counts at 21 locations on the Gitchi-Gami Trail (ARDC 2015). In the summer of 2015, the ARDC used active infrared monitors to count trail users at 23 locations along the Gitchi-Gami Trail adjacent to Lake Superior in Lake and Cook Counties (ARDC 2016). The ARDC established two control sites for continuous automated monitoring and completed 10 day counts at additional 21 locations. The ARDC then used day-of-year factors developed from their two control sites to extrapolate their short duration counts into estimates of summertime average daily traffic (SADT). The reason for focusing on SADT rather than AADT is that the Gitchi-Gami is not maintained (i.e., plowed) during winter months and trail managers are most interested in summertime use. The focus on SADT also is consistent with the Minnesota Statutory definition of the bicycling season. Figure 4-8 is an excerpt from ARDC's count report that summarizes its application of the day-of-year factoring method (ARDC 2016). Additional details on the ARDC monitoring program are summarized in Chapter 5 of this report.

4.6.2 Identification of Factor Groups

The *TMG* (FHWA 2013) documents various types of hourly and day-of-week traffic patterns at different locations and recommends that factor groups be established for purposes of developing extrapolation factors. For example, some locations are characterized by commuting traffic patterns, and others are characterized by multipurpose traffic patterns. Hourly and day-of-week factors derived from counts at these types of sites differ. To maximize accuracy in extrapolation, factors from permanent sites should be matched to counts from short-duration sites with the same patterns. The number and types of factor groups to establish is an active area of research (FHWA 2013, Miranda-Moreno et al. 2013; Nordback 2013). As noted in the Implementation Project report Lindsey et al. (2015) and Miranda-Moreno et al. (2013) identify four factor groups: utilitarian, mixed-utilitarian, mixed-recreational, and recreational. These groups are based on the ratio of weekend to weekday traffic and the ratio of a.m. traffic to noon-time traffic on weekdays. The idea is that utilitarian patterns have higher weekday than weekend traffic and that sites with commuting patterns have higher traffic on weekdays during a.m. peak hours than at noon-time. In the Implementation Project report Lindsey et al. (2015) renamed the patterns or factor groups created from these ratios as commuter, mixed-commuter, multipurpose, and multipurpose-mixed. The rationale was that the names more aptly described the hourly patterns that were observed on different days of the week.

In order to calculate AADB, staff used a permanent counting station at Central Ave and Lowry Ave in Minneapolis that collected bicycle volumes 365 days per year to **estimate how bicycle traffic on any given day compared to the average bicycle traffic from that entire year**. This serves as a control for weather and other unknown daily factors.

Steps to calculate AADB are as follows:

1. Obtain a chart that lists the hourly traffic at the Central Ave & Lowry Ave site for every hour of 2015.
2. Calculate bicycle volumes at the Central Ave site (southbound only because northbound broke) for the exact time period of each 48 hour count. For example, for site 303 EB, 123 bicyclists were counted between 11am on 9/14/15 and 11am on 9/16/15.
3. Divide that number by the total volume for the year at the Central Ave site. This will give you the percentage of annual traffic at this location that took place during each 48 hour sample period. At site 303 EB, that calculation is 123 / 13146 = .00917. In other words, 0.917% of annual traffic at the Central Ave location took place between 11am on 9/14/15 and 11am on 9/16/15.
4. Divide the 48 hour raw counts at each location by the percentage calculated in step 3 above. This will give you the estimated annual traffic at each location. For site 303 EB, this calculation is 389 / .00917 = 42429. In other words, the estimated annual bicycle traffic at site 303 EB is 42,429.
5. Divide the estimated annual traffic at each location by 365 to get annual average daily bicycle traffic (AADB). At site 303 EB, this is 42429 / 365 = 389.
6. For one-way sites or sites where both directions were counted at the same place at the same time (i.e. both directions are represented in the 48 hour raw count), you are finished. For sites where the 48 hour raw counts are listed separately for each direction because they were calculated at different times or in different places, simply add the AADB for the two directions. Note that if counts were collected in different times or places, you do need to calculate AADB independently for each direction – do not combine raw counts unless taken at the exact same time and place.

Steps to calculate monthly or seasonal average are as follows:

1. Obtain a chart that lists the hourly traffic at the Central Ave & Lowry Ave site for every hour of 2015.
2. Calculate bicycle volumes at the Central Ave site (southbound only because northbound broke) for the exact time period of each 48 hour count.
3. Divide that number by the total volume for the month or season of interest. This will give you the percentage of monthly/seasonal traffic at this location that took place during each 48 hour sample period.
4. Divide the 48 hour raw counts at each location by the percentage calculated in step 3 above. This will give you the estimated monthly/seasonal bicycle traffic at each location.
5. Divide the estimated monthly/seasonal traffic at each location by the number of days in that time period of interest to get the average daily bicycle traffic for that time period.
6. For one-way sites or sites where both directions were counted at the same place at the same time, you are finished. For sites where the 48 hour raw counts are listed separately for each direction because they were calculated at different times or in different places, simply add the AADB for the two directions. Note that if counts were collected in different times or places, you do need to calculate AADB independently for each direction – do not combine raw counts unless taken at the exact same time and place.

Figure 4-7 Hennepin County Day-of-Year Factoring Method for Estimating AADB (Hennepin County 2016)

… To derive SADT, ARDC calculated the percent of summer traffic that occurred at the control site, divided the count at each sample site by the percent of summer traffic at the control site to derive the estimated summer traffic at each site, and divided the estimated summer traffic at each site by the total number of collection days at each site to derive the average daily traffic count for the summer. This calculation can be represented with the following string of equations, where N_C is adjusted trail user counts at the control site throughout summer, N_s is adjusted trail user counts at a sample site throughout summer, n_c is adjusted trail user counts at the control site during sample dates, n_s is adjusted trail user counts at a sample site during sample dates, P_{nc} is the percentage of summer traffic at the control site during the sample dates, and $SADT_s$ is the SADT at a sample site:

$$\frac{n_c}{N_c} = P_{nc}$$

$$\frac{n_s}{P_{nc}} = N_s$$

Figure 4-8 ARDC Day-of-Year Factoring Method for Estimating Summertime Average Daily Traffic (SADT; ARDC 2016)

The project team designed the spreadsheet template for summarizing counts to report two statistics for establishing these factor groups (Figure 4-1):

- Ratio of weekend to weekday average daily traffic volumes (WWI)
- Ratio of morning (7-9am) to midday (11am-1pm) weekday traffic volumes (AMI)

WWI ratios greater than 1 indicate a site is characterized by multipurpose or recreational traffic patterns, while WWI ratios less than one indicate that a site is characterized by commuting patterns. Conversely, AMI ratios greater than 1 indicate that a site is characterized by commuter traffic patterns, while AMI values less than 1 indicate a site is characterized by multipurpose traffic patterns. Sites with WWI < 1 and AMI > 1 have commuter patterns and can be grouped to create factors for short-duration monitoring sites believed to have commuter patterns. Sites with WWI > 1 and AMI < 1 have multipurpose or recreational traffic and can be grouped to create factors for short-duration monitoring sites believed to meet both criteria and have multipurpose patterns. Sites that do not fall into these categories have mixed traffic patterns. Researchers have not determined whether the extrapolation factors based on further differentiation of mixed patterns affects accuracy of extrapolations.

Although MnDOT has a goal of establishing different factor groups and is establishing permanent index monitoring sites at locations believed to have different traffic patterns, the permanent stations have not been operating long enough to determine which patterns exist. The *TMG* recommends that multiple monitoring stations be established for each factor group. As MnDOT obtains results and gains experience in development of extrapolation factors, additional permanent sites likely will be needed to match patterns that are observed.

4.7 SUMMARIES OF BICYCLE AND PEDESTRIAN COUNTS IN MINNESOTA

During the Institutionalization Project, MnDOT made a programmatic decision to focus data management activities on automated rather than manual bicycle and pedestrian counts. The main reasons for this decision were that this approach would facilitate integration with standard procedures for motorized vehicle traffic data management and provide more data and tools for local governments interested in bicycle and pedestrian traffic. As part of the transition to the focus on automated monitoring, the project team summarized manual bicycle and pedestrian counts taken by MnDOT partners between 2012 and 2014. To illustrate how counts from MnDOT's network of permanent index sites and its automated, short duration counts can be summarized, the project team prepared a short annual count report designed to serve as a template for future reports.

4.7.1 Manual Counts of Bicyclists and Pedestrians

In 2012, the Minnesota Department of Transportation (MnDOT) sponsored the Methodologies study, the first of the three projects to support and encourage bicycle and pedestrian monitoring by local and regional agencies in Minnesota. The objectives of the Methodologies study were to develop standard procedures for monitoring volumes of people walking and biking in Minnesota communities and increase use of non-motorized traffic data in transportation policy-making, planning, and project implementation.

Between 2012 and 2014, manual count data summaries from 55 Minnesota cities were submitted to MnDOT in different formats, and different methods were used to analyze each year of data. Appendix G is a list of these counts.

Local jurisdictions selected locations for counting bicyclists and pedestrians in response to local needs and interests. Many local organizations counted in relations to projects undertaken as part of the Minnesota Department of Health's State Health Improvement Program. Others counted in relation to capital projects to improve bicycle and pedestrian infrastructure.

Table 4-3 is a summary of manual count locations conducted in Minnesota between 2012 and 2014. The numbers of participating cities (43), count locations (133) and total hours counted (848) were highest during the first count season in 2012. Counting efforts were the lowest in 2013 when cities participated in two separate counts, one in the spring and another in the fall. The fall of 2014 saw a resurgence of counting with 24 cities counting an average of 22 hours, the highest average across all count periods.

Table 4-3 Summary of Manual Count Locations Conducted in Minnesota between 2012 and 2014

	Fall 2012	Spring 2013	Fall 2013	Fall 2014
Number of Cities	43	11	12	24
Number of Total Locations	133	27	32	83
Average Locations per City	3	2	3	3
Total Hours per City	848	171	146	520
Average Hours per City	20	16	12	22

Table 4-4 provides summary statistics for the manual counts conducting in Minnesota between 2012 and 2014. While the numbers of cities and count locations vary greatly across the count periods, and comparisons are difficult to make over time, two trends do appear. First, the number of pedestrians for all count periods is equal to or higher than the volume of people biking. Secondly, the mean hourly counts are under 20 for both bikes and pedestrians for all four count periods. Counts taken in the spring of 2013 had the highest average mean of hourly bike counts, whereas the fall 2012 count period had the highest average mean number of pedestrians. These changing volumes of people biking and walking illustrate the limitations of manual counting. Specifically, manual counts are

- Labor and time intensive – It takes organizers time to choose sites, mobilize staff and volunteers, training staff and volunteers, collect paper forms, enter data into spreadsheets, analyze data, and produce graphics and reports to relay the information. As a result, this level of resource intensity may lead to one-off counts and limited trend data.

- Limited in scope – One manual count typically captures two hours of data on one day per year so an average or "normal" daily traffic (ADT) cannot be established and used for comparison to each additional hour or day of data collected

- Weather dependent – Unlike with motor vehicles, weather is a major determinant of non-motorized volumes. Ideally, manual counts are performed on warm, dry, windless, low humidity days when volumes of people walking and biking are the highest. Even a predicted chance of precipitation or inclement weather can influence volumes.

Table 4-4 Summary Statistics for Manual Counts, 2012-2014

	Average Count Statistics			
	Fall 2012	Spring 2013	Fall 2013	Fall 2014
Number of Count Locations	133	27	32	83
Mean Hourly Bike Count	7	14	5	7
Median Hourly Bike Count	4	10	4	5
Maximum Hourly Bike Count	104	71	32	59
Mean Hourly Pedestrian Count	19	16	14	18
Median Hourly Pedestrian Count	8	10	6	8
Maximum Hourly Pedestrian	322	132	381	482

4.8 TEMPLATE FOR AUTOMATED BICYCLE AND PEDESTRIAN COUNTS ANNUAL REPORT

An important task of the Institutionalization project was to develop a template for an annual report that summarizes the scope and outcomes of bicycle and pedestrian monitoring in Minnesota. Figure 4-9 is the template for this new MnDOT annual programmatic report.

The key features include a map of permanent index sites and summaries of annual average daily traffic volumes, short duration monitoring results, and activities undertaken by local partners engaged in monitoring. As noted in the report, bicycle and pedestrian traffic volumes vary considerably across sites. No conclusions about trends can be drawn because data are not available for multiple years for all sites.

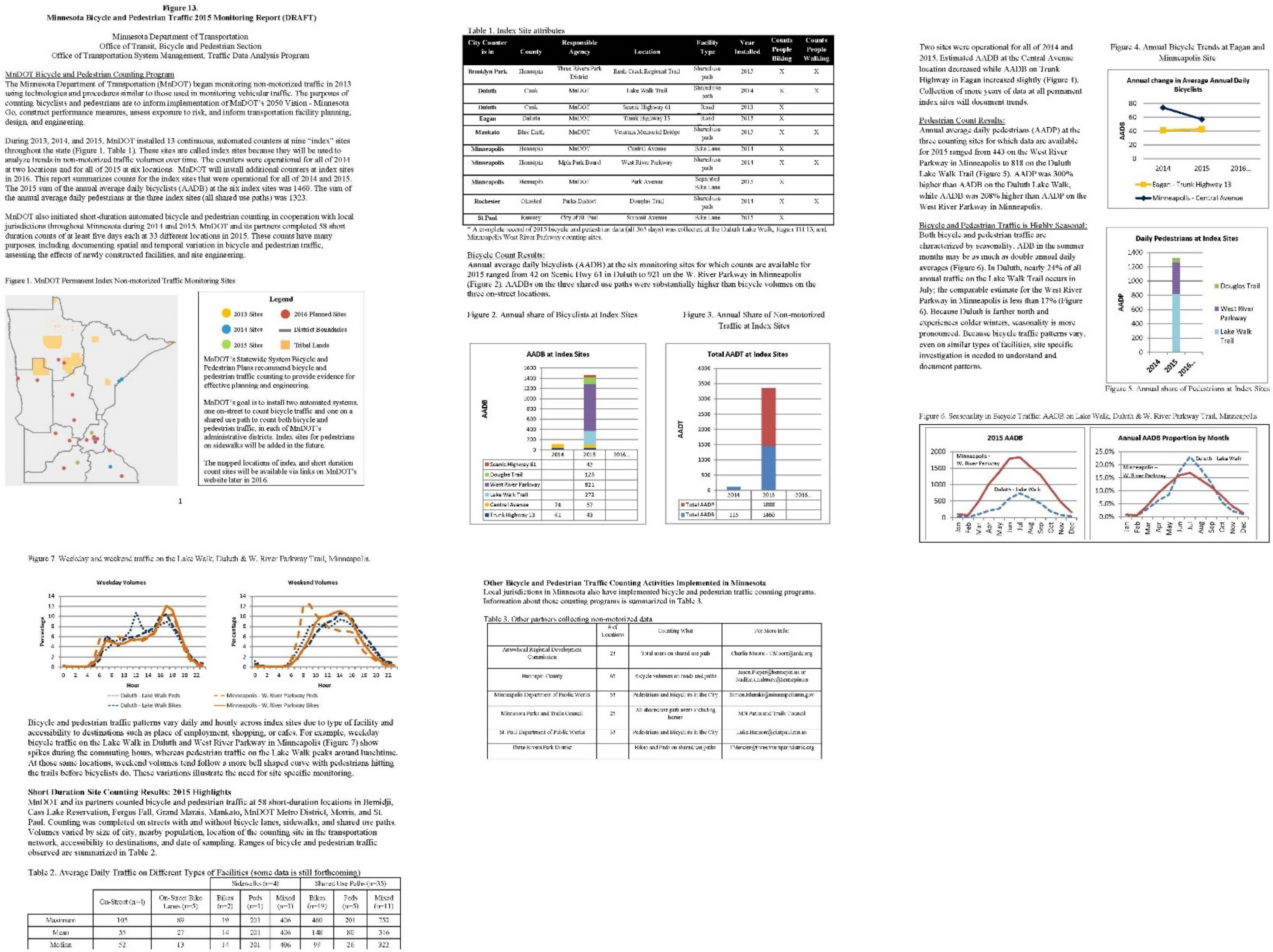


Figure 13.
Minnesota Bicycle and Pedestrian Traffic 2015 Monitoring Report (DRAFT)

Minnesota Department of Transportation
Office of Transit, Bicycle and Pedestrian Section
Office of Transportation System Management, Traffic Data Analysis Program

MnDOT Bicycle and Pedestrian Counting Program
The Minnesota Department of Transportation (MnDOT) began monitoring non-motorized traffic in 2013 using technologies and procedures similar to those used in monitoring vehicular traffic. The purposes of counting bicyclists and pedestrians are to inform implementation of MnDOT's 2050 Vision - Minnesota Go, construct performance measures, assess exposure to risk, and inform transportation facility planning, design, and engineering.

During 2013, 2014, and 2015, MnDOT installed 13 continuous, automated counters at nine "index" sites throughout the state (Figure 1, Table 1). These sites are called index sites because they will be used to analyze trends in non-motorized traffic volumes over time. The counters were operational for all of 2014 at two locations and for all of 2015 at six locations. MnDOT will install additional counters at index sites in 2016. This report summarizes counts for the index sites that were operational for all of 2014 and 2015. The 2015 sum of the annual average daily bicyclists (AADB) at the six index sites was 1460. The sum of the annual average daily pedestrians at the three index sites (all shared use paths) was 1323.

MnDOT also initiated short-duration automated bicycle and pedestrian counting in cooperation with local jurisdictions throughout Minnesota during 2014 and 2015. MnDOT and its partners completed 58 short duration counts of at least five days each at 33 different locations in 2015. These counts have many purposes, including documenting spatial and temporal variation in bicycle and pedestrian traffic, assessing the effects of newly constructed facilities, and site engineering.

Figure 1. MnDOT Permanent Index Non-motorized Traffic Monitoring Sites

MnDOT's Statewide System Bicycle and Pedestrian Plans recommend bicycle and pedestrian traffic counting to provide evidence for effective planning and engineering.

MnDOT's goal is to install two automated systems, one on-street to count bicycle traffic and one on a shared use path to count both bicycle and pedestrian traffic, in each of MnDOT's administrative districts. Index sites for pedestrians on sidewalks will be added in the future.

The mapped locations of index and short duration count sites will be available via links on MnDOT's website later in 2016.

1

Table 1. Index Site attributes

City Counter is in	County	Responsible Agency	Location	Facility Type	Year Installed	Counts People Biking	Counts People Walking
Brooklyn Park	Hennepin	Three Rivers Park District	Rush Creek Regional Trail	Shared use path	2015	X	X
Duluth	Cook	MnDOT	Lake Walk Trail	Shared use path	2014	X	X
Duluth	Cook	MnDOT	Scenic Highway 61	Road	2013	X	
Eagan	Dakota	MnDOT	Trunk Highway 13	Road	2013	X	
Mankato	Blue Earth	MnDOT	Veterans Memorial Bridge	Shared use path	2015	X	X
Minneapolis	Hennepin	MnDOT	Central Avenue	Bike Lane	2014	X	
Minneapolis	Hennepin	Mpls Park Board	West River Parkway	Shared use path	2014	X	X
Minneapolis	Hennepin	MnDOT	Park Avenue	Separated Bike Lane	2015	X	
Rochester	Olmsted	Parks District	Douglas Trail	Shared use path	2014	X	X
St Paul	Ramsey	City of St. Paul	Summit Avenue	Bike Lane	2015	X	

* A complete record of 2015 bicycle and pedestrian data (all 365 days) was collected at the Duluth Lake Walk, Eagan TH 13, and Minneapolis West River Parkway counting sites.

Bicycle Count Results:
Annual average daily bicyclists (AADB) at the six monitoring sites for which counts are available for 2015 ranged from 42 on Scenic Hwy 61 in Duluth to 921 on the W. River Parkway in Minneapolis (Figure 2). AADBs on the three shared use paths were substantially higher than bicycle volumes on the three on-street locations.

Figure 2. Annual share of Bicyclists at Index Sites

	2014	2015	2016...
Scenic Highway 61		42	
Douglas Trail		125	
West River Parkway		921	
Lake Walk Trail		272	
Central Avenue	74	57	
Trunk Highway 13	41	43	

Figure 3. Annual Share of Non-motorized Traffic at Index Sites

	2014	2015	2016...
Total AADP		1888	
Total AADB	115	1460	

Two sites were operational for all of 2014 and 2015. Estimated AADB at the Central Avenue location decreased while AADB on Trunk Highway in Eagan increased slightly (Figure 4). Collection of more years of data at all permanent index sites will document trends.

Figure 4. Annual Bicycle Trends at Eagan and Minneapolis Site

Pedestrian Count Results:
Annual average daily pedestrians (AADP) at the three counting sites for which data are available for 2015 ranged from 443 on the West River Parkway in Minneapolis to 818 on the Duluth Lake Walk Trail (Figure 5). AADP was 300% higher than AADB on the Duluth Lake Walk, while AADB was 208% higher than AADP on the West River Parkway in Minneapolis.

Figure 5. Annual share of Pedestrians at Index Sites

Bicycle and Pedestrian Traffic is Highly Seasonal:
Both bicycle and pedestrian traffic are characterized by seasonality. ADB in the summer months may be as much as double annual daily averages (Figure 6). In Duluth, nearly 24% of all annual traffic on the Lake Walk Trail occurs in July; the comparable estimate for the West River Parkway in Minneapolis is less than 17% (Figure 6). Because Duluth is farther north and experiences colder winters, seasonality is more pronounced. Because bicycle traffic patterns vary, even on similar types of facilities, site specific investigation is needed to understand and document patterns.

Figure 6. Seasonality in Bicycle Traffic: AADB on Lake Walk, Duluth & W. River Parkway Trail, Minneapolis

Figure 7. Weekday and weekend traffic on the Lake Walk, Duluth & W. River Parkway Trail, Minneapolis.

Bicycle and pedestrian traffic patterns vary daily and hourly across index sites due to type of facility and accessibility to destinations such as place of employment, shopping, or cafes. For example, weekday bicycle traffic on the Lake Walk in Duluth and West River Parkway in Minneapolis (Figure 7) show spikes during the commuting hours, whereas pedestrian traffic on the Lake Walk peaks around lunchtime. At those same locations, weekend volumes tend follow a more bell shaped curve with pedestrians hitting the trails before bicyclists do. These variations illustrate the need for site specific monitoring.

Short Duration Site Counting Results: 2015 Highlights
MnDOT and its partners counted bicycle and pedestrian traffic at 58 short-duration locations in Bemidji, Cass Lake Reservation, Fergus Fall, Grand Marais, Mankato, MnDOT Metro District, Morris, and St. Paul. Counting was completed on streets with and without bicycle lanes, sidewalks, and shared use paths. Volumes varied by size of city, nearby population, location of the counting site in the transportation network, accessibility to destinations, and date of sampling. Ranges of bicycle and pedestrian traffic observed are summarized in Table 2.

Table 2. Average Daily Traffic on Different Types of Facilities (some data is still forthcoming)

			Sidewalks (n=4)			Shared Use Paths (n=35)		
	On-Street (n=4)	On-Street Bike Lanes (n=5)	Bikes (n=2)	Peds (n=1)	Mixed (n=1)	Bikes (n=19)	Peds (n=5)	Mixed (n=11)
Maximum	105	89	19	201	406	460	201	752
Mean	55	27	14	201	406	148	80	316
Median	52	13	14	201	406	99	26	322

Other Bicycle and Pedestrian Traffic Counting Activities Implemented in Minnesota
Local jurisdictions in Minnesota also have implemented bicycle and pedestrian traffic counting programs. Information about these counting programs is summarized in Table 3.

Table 3. Other partners collecting non-motorized data

	# of Locations	Counting What	For More Info:
Arrowhead Regional Development Commission	23	Total users on shared use path	Charlie Moore - CMoore@ardc.org
Hennepin County	65	Bicycle volumes on roads and paths	Jason.Pieper@hennepin.us or Nadine.Chalmers@hennepin.us
Minneapolis Department of Public Works	53	Pedestrians and Bicyclists in the City	Simon.Blenski@minneapolismn.gov
Minnesota Parks and Trails Council	25	All shared use path users including horses	MN Parks and Trails Council
St. Paul Department of Public Works	33	Pedestrians and Bicyclists in the City	Luke.Hanson@ci.stpaul.mn.us
Three Rivers Park District		Bikes and Peds on shared use paths	TMercier@threeriversparkdistric.org

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Figure 4-9 Template for Automated Bicycle and Pedestrian Counts Annual Report

CHAPTER 5: TECHNICAL ASSISTANCE FOR PARTNERS IN COUNTING INITIATIVE

The project team provided technical assistance and support for partners in the Counting Initiative as part of its effort to institutionalize bicycle and pedestrian monitoring throughout the state. The support ranged from development of monitoring plans to analyses of data to review of technical reports. On several occasions, the principal investigator recruited students or student teams to prepare plans or undertake analyses for partners.

In-depth support was provided to six organizations interested in development and implementation of bicycle and pedestrian traffic monitoring programs: The Arrowhead Regional Development Commission; Hennepin County, Minnesota Department of Natural Resources, National Park Service, the nonprofit Parks and Trails Council of Minnesota, and the Sawtooth Mountain Clinic. The project team also advised other organizations about monitoring strategies.

5.1 ARROWHEAD REGIONAL DEVELOPMENT COMMISSION (ARDC)

The ARDC is a regional planning organization based in Duluth that provides planning services for seven counties in Northeast Minnesota: Aitkin, Carlton, Cook, Itasca, Koochiching, Lake, and St. Louis. In the summer of 2015, the project team helped ARDC design, fund, and implement a program to monitor mixed-mode (i.e., undifferentiated bicycle and pedestrian) traffic on the Gitchee Gami Trail (GGT) along Lake Superior in Lake and Cook Counties. The team reviewed an ARDC grant proposal, loaned the ARDC equipment, trained staff in operation of infrared monitors and analyses of monitoring results, and reviewed draft and final ARDC reports. The project also received labor and other in-kind support from the Sawtooth Mountain Clinic in Grand Marais. An interactive map of the counting locations and data collected can be found at this link: http://arcg.is/1Uc0XAI.

The GGT currently includes 29 miles of paved trail in six unconnected sections; when completed, the GGT will be 86 miles long (ARDC, 2015). Monitoring was initiated to enable trail stakeholders and partners to plan and manage the trail more effectively and to provide information for future expansion. The monitoring design involved adaptation of FHWA (2013) procedures and included two reference or control sites and 21 short-duration monitoring locations approximately 1 to 2 miles apart (Figure 5-1). Because the GGT is not plowed and receives very limited use in winter, ARDC chose to estimate summertime average daily trail traffic (SADTT) rather than AADTT. This example illustrates how monitoring programs can be customized to meet needs and that in some situations, seasonal counts may be sufficient to meet needs of decision-makers.

Monitoring was completed between May 23 and September 8, 2015 in order to capture Memorial Day and Labor Day traffic; short-duration counts were taken for a minimum of 10 days. All monitoring was done with active infrared monitors, and all counts were adjusted for occlusion. Short-duration counts were extrapolated using a “day-of-summer” approach based on the day-of-year approach (Hankey et al., 2014, Figure 4-7). SADTT estimates ranged from 36 to 201 across segments (Figure 5.1). ARDC planners are using monitoring results to support grant applications and to prioritize segments for funding. The ARDC received additional support and repeated the monitoring program in 2016.

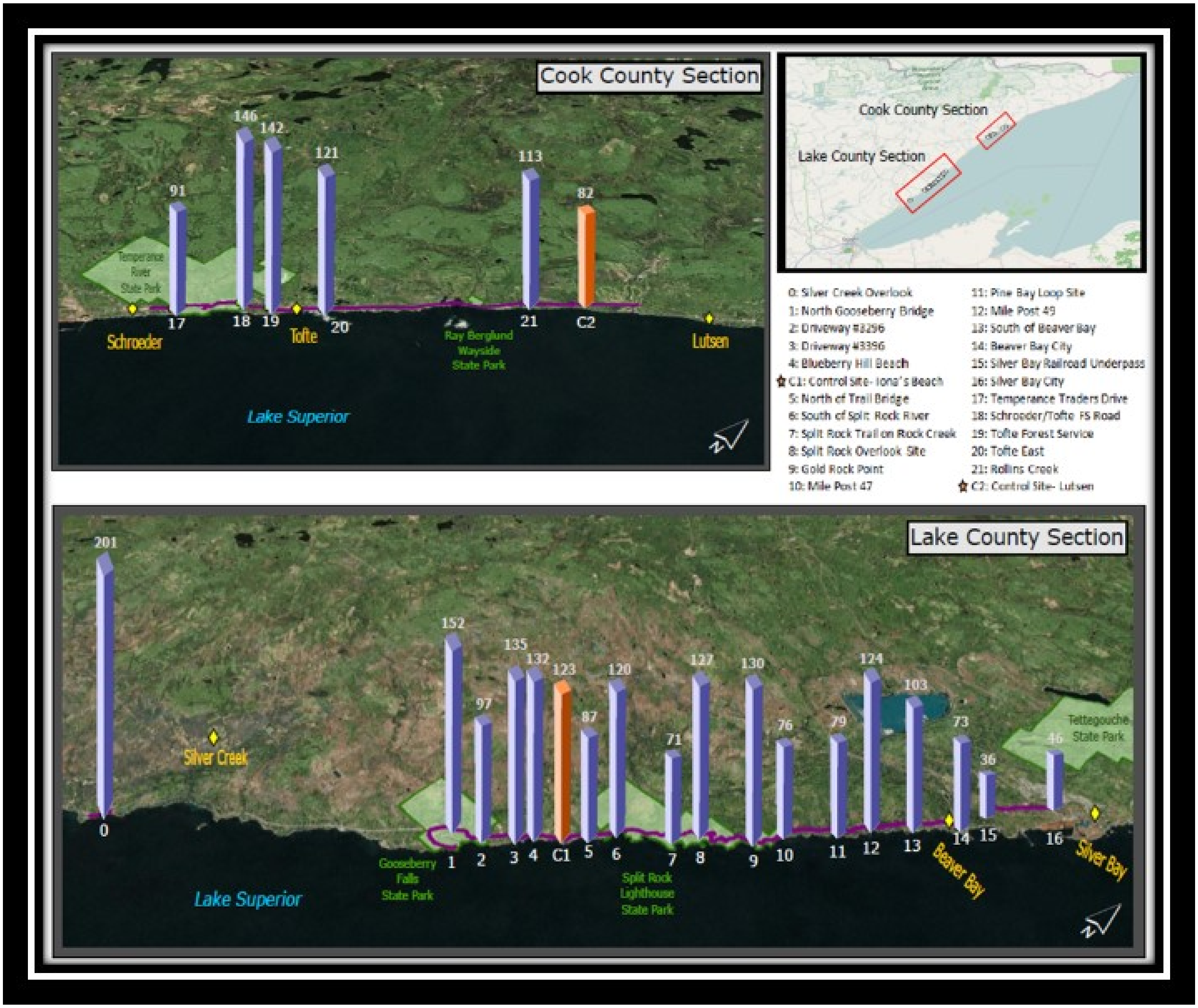


Figure 5-1 Gitchi-Gami State Trail: Monitoring Locations and 2015 Summer Average Daily Traffic

5.2 HENNEPIN COUNTY DEPARTMENT OF PUBLIC WORKS (DPW)

Hennepin County DPW has been an active participant in the Counting Initiative since its inception and previously collaborated with MnDOT and the project team on several activities. As part of the Methodologies Project, Hennepin County DPW collaborated in testing the performance of pneumatic tubes in counting bicycles in mixed traffic flows (Lindsey et al. 2015; Brosnan et al. 2015). In 2014, a team of University of Minnesota students in a capstone class prepared a master plan for monitoring bicycle traffic in Hennepin County (Chalmers et al. 2014). The plan establishes a goal of completing short-duration counts at 60 locations in the county, with 30 sites monitored each year in succeeding years.

Hennepin County launched its bicycle traffic monitoring program in 2015, completing short duration, 48-hour counts at approximately 30 locations (Hennepin County 2016). The project team helped Hennepin County staff develop procedures to analyze monitoring results and use factors to estimate annual average daily bicyclists (AADB) and July and January average daily bicyclists (ADB) from short-duration samples (Table 5-1, Figure 4-8). Across these locations, July ADB ranged from a low of 9 to a high of 711. These values reflect the diverse land use of Hennepin County, which includes the largest city in the State, suburban communities, and more remote exurban and rural areas. The project team also reviewed draft and final Hennepin County reports that summarize bicycle monitoring results.

Table 5-1 Average Annual Daily Bicyclists (AADB) for all 2015 Bicycle Count Locations (Hennepin County 2016)

Station ID	Local name	Intersection	AADB	Jan ADB	July ADB
303	Lake Street West	E of Dupont	190*	38	371
401	Eden Prairie Road	S of Boys School Rd / N of Ferris Ln	14	3	27
402	Eden Prairie Road	N of Berger Drive	68	14	132
501	Franklin Avenue East	E of 27th St S	321	65	627
502	Franklin Avenue East	E of Elliot Ave / E of Chicago	180	36	352
504	Minnetonka Boulevard	W of Oregon Ave S	23	5	45
505	Minnetonka Boulevard	E of Steele St / E of Fairchild	38	8	74
1701	France Avenue	N of 47 St	47	9	91
1902	Shadywood Road	S of Crabapple Ln	65	13	127
2101	West 50th Street	E of James Ave S / W of Newton Ave S	47	10	92
2202	Lyndale Avenue	N of 36th St	69*	14	135
3202	Penn Avenue S	N of 91st St	28**	6	55
3301	Park Avenue South	S of 27th St	363	73	710
3302	Park Ave South	S of 37th St	261	53	511
3501	Portland Avenue South	S of 40th St	198	40	387
3502	Portland Avenue South	S of 28th	364	73	711
3503	Portland Avenue South	N of 74th St	66	13	129
3901	Valley View Road	W of Anagram Drive	17	3	33
4201	42nd Street	W of 22nd	73	15	143
4601	46th Street West	E of Pleasant	55	11	107
4602	46th Street West	E of 17th Ave	21	4	42
4802	26th Avenue South	S of Midtown Greenway	99	20	193
5201	Nicollet Avenue	N of 90th St	13	3	24
5202	Nicollet Avenue	N of 76th St	21	4	41
6001	Baker Road	N of Excelsior Ave	36	7	70
9201	County Road 92 North	N of Trista Ln	5	1	9
11001	Commerce Road	N of Grandview Blvd / Sherwood Dr	22	4	43
15101	North Arm Drive	N of Cherry Ave	10	2	19
15201	Cedar Avenue South	N of Nokomis Pkwy	8	2	16

15203	Cedar Avenue South	S of E 40th St	20	4	38
15801	Vernon Avenue South	E of Vernon Ln	29	6	56

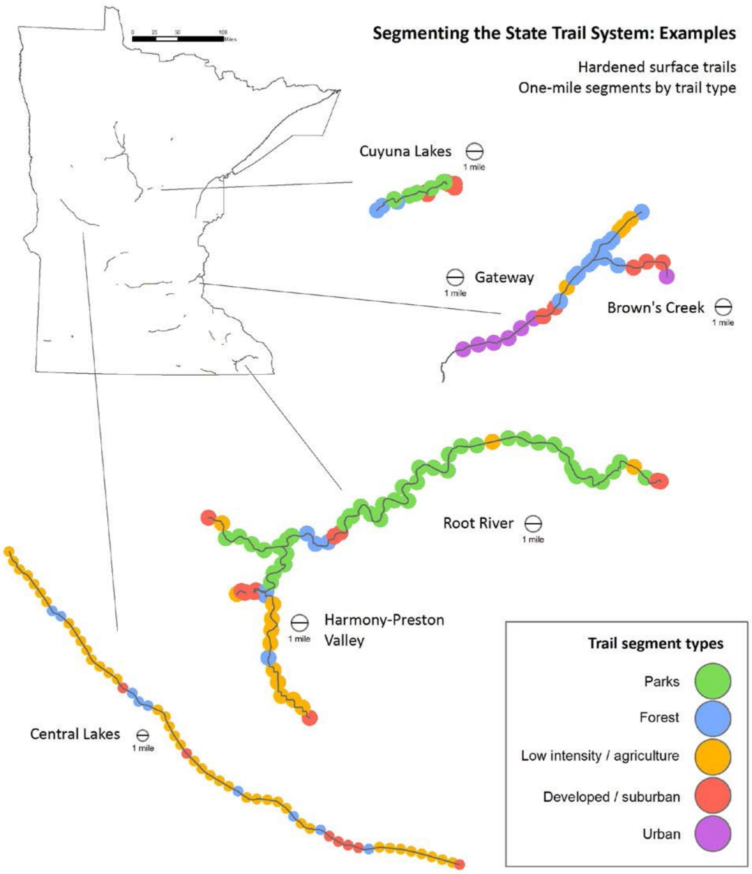
5.3 MINNESOTA DEPARTMENT OF NATURAL RESOURCES (MDNR)

As the state's principal agency for management of natural resources, the MDNR oversees and maintains state forests, parks, and trails. The MDNR recreational trail network includes 677 miles of trails that have paved or hardened surfaces. The project team recruited a student in a capstone course to assess strategies for monitoring bicycle and pedestrian traffic on MDNR trails (Holmes et al. 2016). The study reviewed previous studies by MDNR to estimate trail use, conducted a field experiment, identified alternative strategies for monitoring, and recommended an approach for monitoring consistent with the procedures in the FHWA Traffic Monitoring Guide and MnDOT's Bicycle and Pedestrian Data Collection Manual.

As part of the study, the capstone team identified seven key design elements of a monitoring strategy: comprehensiveness, frequency, segmenting, length of count, technology, extrapolation method, and data management (Holmes et al., 2016). To illustrate options for segmenting the trail network for monitoring, the capstone team created a land use typology that included five classifications potentially associated with traffic volumes and patterns: parks, forest, low-intensity/agriculture, suburban, and urban (Figure 5-2). The team illustrated how segments could be established using these classifications and other factors such as access points (Figure 5-2) but did not make final recommendations. The team noted that decisions about segments involve tradeoffs with other considerations, including funding available, accuracy of estimates, and monitoring frequency.

MDNR is evaluating options for monitoring and will make decisions about implementation in the future based on resource availability. As noted previously, some of MnDOT's permanent monitoring stations are being placed on MDNR trails. In addition, MDNR is exploring options for monitoring in collaboration with the Greater Minnesota Regional Parks and Trails Commission, a state agency with responsibility for making recommendations to the legislature for funding projects outside the seven-county Twin Cities Metropolitan Area.

a. MDNR Trail Typology on Five Trails.



b. Example of potential segments along a trail.

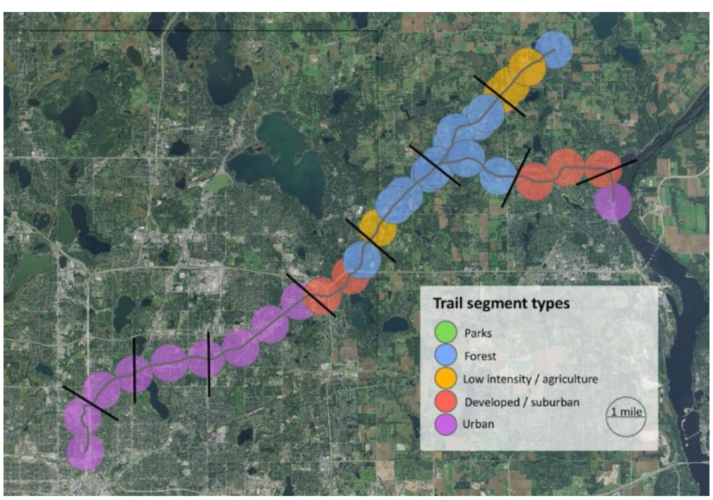


Figure 5-2 MDNR Trail Typology and Example of Potential Segmentation

5.4 NATIONAL PARK SERVICE (NPS), MISSISSIPPI NATIONAL RIVER AND RECREATION AREA (MNRRA)

The NPS manages the MNRRA along the Mississippi River throughout the Twin Cities Metropolitan Areas. The NPS has undertaken a number of two-hour (peak) bicycle and pedestrian counts at various locations in the MNRRA. As part of its efforts to assess demand for bicycling and walking in the MNRRA, the NPS contacted the project team about assistance for monitoring use of trails near its Coldwater Springs facility near Minnehaha Falls.

The project team loaned MNRRA staff infrared monitors and advised staff in collection and analysis of traffic counts on trails near its Coldwater Springs facility in Minneapolis. This assistance included guidance on the use of the MnDOT spreadsheet template for analyzing counts. The NPS implemented counting in summer 2016 at two locations and is using the MnDOT template for analyses. Results have been submitted to regional managers who have authorized investment in new counters for the NPS Cold Springs monitoring.

5.5 PARKS AND TRAILS COUNCIL OF MINNESOTA (COUNCIL)

The Council is a nonprofit advocacy organization interested in development and maintenance of the parks and trails system in Minnesota, including the trail network maintained by the MDNR. The project team helped the nonprofit Council design a program to manually count trail traffic on paved Minnesota State Trails. The assistance included development of procedures to estimate annual traffic from the field observations and review of draft and final reports.

The Council had three objectives in its study (Parks and Trails Council of Minnesota, 2016):

1. *Provide an order-of-magnitude estimate of trail use;*
2. *Mobilize local volunteers in counting; and*
3. *Highlight the need for expanded counting on trails.*

The monitoring strategy involved dividing the trails into 15 to 25 mile segments, recruiting volunteers, and counting for a minimum of 10 hours on each segment, including peak-hours on weekdays and weekends. The Council chose locations based on three factors: expected patterns of use, accessibility, and volunteer safety. Most locations were near a city, trail head, park, or junction. The final plan included 35 segments, but only 25 ultimately were counted because volunteers could not be recruited for some segments. The Council followed MnDOT guidelines for manual counting and adapted procedures outlined by the FHWA (2013) and Hankey et al. (2014) to extrapolate counts to non-winter ADTT. Non-winter ADTT was estimated because most trails are not plowed and receive little use in winter. The extrapolation procedures involved six steps (Parks and Trails Council of Minnesota, 2016, p. 14):

1. *Estimate average weekday (or weekend) traffic using hour-long field counts;*
2. *Estimate monthly average daily traffic using average weekday (or weekend) traffic;*
3. *Estimate annual average daily traffic using monthly average daily traffic;*

4. *Estimate annual traffic using annual average daily traffic;*
5. *Estimate non-winter use by subtracting November-March use; and*
6. *Estimate margin of error.*

All factors used to extrapolate counts were obtained from analyses of year-round trail traffic on other multiuse trails in Minnesota.

The Council noted four important limitations of the approach (Parks and Trails Council of Minnesota, 2016, p. 16): “small sample sizes, use of nonlocal adjustment factors for extrapolation, assumptions of daily traffic patterns, and the level of uncertainty associated with our estimates.” To communicate these limitations, the Council described the estimates as “order-of-magnitude” and, based on studies of extrapolation error (Nordback et al., 2013; Hankey et al., 2014), characterized the range of error as 40% either side of the estimate. The Council is using results to support its advocacy efforts and is exploring the feasibility of using portable monitoring equipment from MnDOT for automated monitoring.

5.6 SAWTOOTH MOUNTAIN CLINIC (GRAND MARAIS)

The Sawtooth Mountain Clinic is a Federally Qualified Community Health Center that, in collaboration with the Minnesota Department of Health’s (MDH) Statewide Health Improvement Partnership (SHIP) and Blue Cross and Blue Shield of Minnesota, has established a series of projects to support active living. Among other efforts, the Clinic established Moving Matters, a cross-sector partnership to create safe and accessible infrastructure and environments for biking and walking in Grand Marais and elsewhere. The Moving Matters program is using evidence, community visioning, and health impact assessment (HIA) to encourage investment in new infrastructure (Webb and Wharton 2015).

The project team advised staff of the Clinic on strategies for monitoring bicycle and pedestrian traffic in Grand Marias. With assistance from the University of Minnesota, the Clinic completed counts, including counts of pedestrians and bicyclists crossing State Highway 61 and traveling on the Grand Marais sections of the Gitchee Gami Trail. The monitoring results then were incorporated results in the HIA and shared with local residents in community meetings. The HIA, data, and community vision led MnDOT to reprioritize regional highway projects and allocate $500,000 for a bike and pedestrian infrastructure project in Grand Marais in 2019.

5.7 OTHER ASSISTANCE

The project team provided assistance to other organizations in addition to those cited above. These organizations included the Greater Minnesota Regional Parks and Trails Commission (GMRPTC), the Minneapolis Park and Recreation Board (MPRB), the Minneapolis Department of Public Works (DPW), and the Three Rivers Park District. The GMRPTC is responsible for making recommendations to the legislature for use of Legacy parks and trails funds for projects outside the seven-county Twin Cities Metropolitan Area. The project team discussed strategies for measuring use of trails in greater Minnesota with the director of the GMRPTC and others in the summer and fall of 2016. The project team advised the MPRB, the Minneapolis DPW, and the Three Rivers Park District on an array of issues involving trail traffic monitoring, including use of trail traffic counts to assess need for traffic controls at roadway intersections.

Additional case studies, uses of the data and examples of collaboration can be found in the MnDOT Bicycle and Pedestrian Data Collection Manual.

CHAPTER 6: DOT PLANS AND POLICIES THAT SUPPORT BICYCLE AND PEDESTRIAN TRAFFIC MONITORING

The project team worked with MnDOT in the Offices of Transit and Traffic Data Analysis on several related MnDOT policy and programmatic initiatives to ensure that these initiatives supported bicycle and pedestrian traffic monitoring. Among other contributions, the team:

- Provided input about traffic monitoring to MnDOT Statewide Bicycle System Plan and Minnesota Walks;
- Provided information about use of bicycle infrastructure for the MnDOT Study, "Assessing the Economic Impact and Health Effects of Bicycling in Minnesota.";
- Prepared a grant proposal to FHWA for a pilot project to collect data for submission to the FHWA TMAS system;
- Engaged other MnDOT units and other state and local agencies.

6.1 MINNESOTA STATEWIDE BICYCLE SYSTEM PLAN

The project team worked with the Office of Transit to incorporate commitments to bicycling traffic monitoring in the Statewide Bicycle System Plan. Chapters 5 and 6: Increasing Ridership and Measuring Success – which underscore MnDOT's Role in Encouragement, Education, Enforcement, and Evaluation of Bicycling including bicycling traffic monitoring in measuring progress towards the states multimodal vision. Strategy 15 is to "Create a statewide bicycle traffic monitoring program to count and estimate bicycle traffic volumes at selected locations throughout the state" (MnDOT 2016, p.v). In support of this strategy, the Plan states that "Maintaining counts on an on-going basis is critical to the reliability of this data and MnDOT's ability to measure change in rates of bicycling at different locations" (ibid).

Chapter 6 Measuring Success includes additional commitments to monitoring, establishing "average daily traffic volumes at permanent index monitoring sites statewide" as a performance measure (MnDOT 2016, p.53). The MnDOT Plan notes that "this measure will illustrate demand on infrastructure at specific locations" (ibid).

6.2 MINNESOTA WALKS

The project team also advised the Office of Transit on issues related to pedestrian traffic monitoring during preparation of Minnesota Walks, which provides a framework to safe, convenient and desirable walking and rolling for all partners at the local, regional and state levels. Minnesota Walks includes a performance measure, "Annual average daily pedestrian (AADP) traffic volumes at MnDOT permanent index monitoring sites on shared-use paths." (MnDOT 2016, p.39):

> *Although data from these* [index] *sites will not be representative of pedestrian traffic on all sidewalks or paths in Minnesota, these data provide useful examples of pedestrian traffic volumes and patterns on shared use paths and how patterns and volumes change over time.*

6.3 MINNESOTA BICYCLING ECONOMIC IMPACT STUDY

The project team provided summaries of bicycle traffic counts and other information about use of bicycling infrastructure for the MnDOT project, “Assessing the Economic Impact and Health Benefits of Bicycling in Minnesota”. These data were used to illustrate the range of bicycle traffic volumes on roads and trails across Minnesota. Among other activities, the principal investigator served on the study’s Technical Advisory Panel and met with health researchers responsible for quantifying the health benefits of bicycling. The purpose of these discussions was to assess methods for estimating levels of bicycling in the state.

6.4 FEDERAL HIGHWAY ADMINISTRATION GRANT PROPOSAL

The FHWA contacted the project team in March 2016 to learn about MnDOT’s bicycle and pedestrian traffic monitoring program and to discuss opportunities for agencies in Minnesota to submit bicycle and pedestrian traffic data to the FHWA’s Traffic Monitoring and Analysis (TMAS) system. Following discussions with MnDOT staff and the project team, the FHWA invited MnDOT to submit a proposal for a $30,000 pilot project to collect data from local agencies and submit the data to TMAS, with the longer-term goal of institutionalizing procedures within MnDOT for collection and archiving of local counts. The project team prepared the initial draft of the proposal, which subsequently was funded (Appendix H). Funds are being used to support staff responsible for collecting and submitting local traffic monitoring data to FHWA.

6.5 OUTREACH TO MNDOT ADMINISTRATIVE UNITS AND OTHER AGENCIES

The project team engaged in a variety of activities to increase understanding of the value and benefits of bicycle and pedestrian monitoring. Among these, the project team:

- Collaborated with MnDOT staff in training sessions with the Minnesota Department of Health and others in 2015 and 2016;
- Met with various MnDOT administrative units, including Transportation System Management and the Central District Operations Group, to describe the Institutionalization project and discuss how bicycle and pedestrian counts can inform agency activities.

Staff from these units confirmed that access to bicycle and pedestrian traffic counts would inform projects to increase traffic safety and prioritize investments in bicycle and pedestrian infrastructure. They also noted that non-motorized traffic data can inform activities and programs such as MDH’s State Health Improvement Program (SHIP) and MnDOT’s Complete Streets and Toward Zero Deaths programs.

The project team also collaborated with the MnDOT project manager and other MnDOT staff to develop conference and workshop presentations. These included presentations at the Winter Cycling Congress in Minneapolis in February 2016, multiple presentations at the North American Travel Monitoring Exposition and Conference (NATMEC) in Miami, Florida in May 2016, a presentation to the Metropolitan

Commission, and presentations at seminars and workshops sponsored by the Center for Transportation Studies at the University of Minnesota, and demonstrations at the Minnesota State Fair.

CHAPTER 7: OBSERVATIONS, CONCLUSIONS, AND LESSONS LEARNED

MnDOT launched the Minnesota Bicycle and Pedestrian Counting Initiative in 2011 to encourage non-motorized traffic monitoring by local, regional, and state governments and nonprofit organizations. This project, Institutionalizing the Use of State and Local Pedestrian and Bicycle Traffic Counts, was the third of three research and implementation projects funded by MnDOT to support the Initiative. The principal goals of this project were to support ongoing efforts to institutionalize bicycle and pedestrian traffic monitoring in Minnesota and provide advice on use of bicycle and pedestrian traffic data in projects, studies, and plans.

To institutionalize an activity in an organization or network of organizations means to establish it as a routine practice or cultural norm. Institutionalizing a new technical activity such as bicycle and pedestrian monitoring throughout an entire state where many different state, regional, and local agencies share responsibility for management of transportation systems necessarily involves collaboration with many different people in those agencies. Institutionalizing new technical activities therefore requires time, particularly in the absence of new funding and opportunities for training.

MnDOT has made important progress in institutionalizing bicycle and pedestrian monitoring in Minnesota. Key accomplishments include:

- A statewide bicycle and pedestrian traffic monitoring network with more than 20 permanent monitoring locations, including at least two stations in each of MnDOT's eight administrative districts;
- A new district-based portable equipment loan program to support local jurisdictions interested in bicycle and pedestrian traffic monitoring;
- Minnesota's first Bicycle and Pedestrian Annual Traffic Monitoring Report;
- A new MnDOT website for reporting annual and short-duration counts that enables local engineers to download data for analysis;
- A new Bicycle and Pedestrian Data Collection Manual that local jurisdictions and consultants can use to guide installation of monitoring equipment and implementation of monitoring programs;
- New annual training programs for bicycle and pedestrian monitoring held in collaboration with motorized traffic monitoring training programs led by MnDOT Traffic Data Analysis; and
- Provisions in the Statewide Bicycle and Pedestrian System Plans that call for bicycle and pedestrian traffic monitoring and creation of performance measures based on counts.

In addition to these accomplishments within MnDOT, the Initiative has supported local efforts to implement monitoring, including an automated bicycle traffic monitoring program implemented in Hennepin County, an automated trail traffic monitoring program implemented on the Gitchi-Gami Trail by the Arrowhead Regional Planning Commission and plans to monitor traffic on state trails.

Other administrative and programmatic changes have occurred that are helping to make bicycle and pedestrian monitoring a routine practice in Minnesota. The MnDOT Office of Transit has hired a data coordinator and program administrator for bicycle and pedestrian monitoring activities, thereby helping to ensure monitoring will continue. The Office of Traffic Data Analysis, which manages the state's efforts to monitor motorized traffic, has assumed principal responsibility for design and installation of new, permanent bicycle and pedestrian traffic monitoring stations. The Office of Transportation System Management is integrating web-based reporting of bicycle and pedestrian counts into the set of data and mapping services it provides to MnDOT, local jurisdictions and engineering professionals in the state. MnDOT district employees have assumed responsibility for loaning portable monitoring equipment. Local jurisdictions as diverse as Minneapolis, Mankato, and Grand Marais have used bicycle and pedestrian counts to change traffic controls and improve roadway treatments and designs. These changes represent significant progress, but years will be required to institutionalize monitoring throughout the entire state.

A number of insights can be drawn from this progress and help guide future efforts:

- The bicycle and pedestrian traffic monitoring programs implemented in Minnesota are based on general monitoring principles outlined in the FHWA's *Traffic Monitoring Guide*, but have been adapted to meet organizational needs, contextual considerations, and resource constraints. Thus, the bicycle and pedestrian data can be used in tandem with motorized vehicle counts for planning and engineering.
- Monitoring systems will continue to evolve. As MnDOT and other agencies such as Hennepin County gain experience, innovations will enable refinement and improvement of programs. Familiarity with equipment, data analyses, and uses of the data will likely lead to more comprehensive, efficient monitoring programs.
- New tools that use GIS and statistical analysis for analyses of monitoring data are being developed. These tools have the potential to inform local transportation planning and engineering.
- Collaboration in the design and implementation of monitoring networks is essential. MnDOT's program would not have been possible without the collaboration of professionals from both public and nonprofit organizations working together to produce evidence to improve planning and management of bicycle and pedestrian infrastructure. As an indicator of the level of collaboration achieved in this initiative, the project team received the Center for Transportation Studies Research Partnership Award during the second phase of the study, and the efforts were documented in this video: https://mntransportationresearch.org/2014/04/24/bicycle-and-pedestrian-counting-project-wins-cts-partnership-award/. Systematic outreach to organizations with shared interests and pooling of resources can help increase the likelihood that comprehensive monitoring will be initiated.

Despite the progress illustrated by these results, significant challenges remain. No monitoring has yet occurred in most communities throughout Minnesota. This fact means that transportation planners and engineers often lack the evidence base needed to achieve the goals of policies such as Complete Streets and strengthen management of multimodal systems. Although more jurisdictions are experimenting with counting, ongoing funding for sustaining these programs has yet to be confirmed. In addition, the success of the new counter loan program has yet to be determined. It is not yet clear that local jurisdictions will take advantage of the opportunities provided by the loan program. Given these types of resource constraints and uncertainties, continued efforts to share progress and innovations in bicycle and pedestrian traffic monitoring are warranted.

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APPENDIX A
SUMMARY OF PROJECT ACTIVITIES BY TASK

THE MINNESOTA BICYCLE AND PEDESTRIAN COUNTING INITIATIVE: INSTITUTIONALIZING BICYCLE AND PEDESTRIAN TRAFFIC MONITORING WAS THE THIRD OF THREE PROJECTS FUNDED BY MNDOT TO DEVELOP, IMPLEMENT, AND INSTITUTIONALIZE BICYCLE AND PEDESTRIAN MONITORING IN MINNESOTA. THIS PROJECT INCLUDED 10 INTERRELATED, SUBSTANTIVE TASKS, EACH OF WHICH INVOLVED COLLABORATION WITH MNDOT STAFF FROM THE OFFICES OF TRANSIT, TRAFFIC DATA ANALYSIS, AND RESEARCH SERVICES. THE FOCUS OF EACH TASK WAS ON DEVELOPMENT OF METHODS, PROCEDURES, OR REPORTS THAT MNDOT AND ITS PARTNERS CAN USE TO IMPLEMENT AUTOMATED MONITORING OF BICYCLE AND PEDESTRIAN. SOME TASKS INVOLVED PROVIDING INPUT TO RELATED MNDOT PROJECTS, REPORTS, OR ACTIVITIES. TASKS WERE OVERLAPPING AND BECAUSE THEY INVOLVED WORK TO DEVELOP NEW PROCEDURES THAT WERE INTERDEPENDENT, WERE NOT NECESSARILY COMPLETED CONSECUTIVELY OR CHRONOLOGICALLY. THE PURPOSE OF SUMMARIZING WORK BY TASK, AS DISTINCT FROM PRESENTING PROJECT OUTCOMES IN THE BODY OF THIS REPORT, IS TO DOCUMENT EFFORTS FOR OTHER PRACTITIONERS INTERESTED IN THE COLLABORATIVE EFFORTS TO ESTABLISH AND IMPLEMENT NEW PROCEDURES.

THE TEN PROJECT TASKS WERE:

1. Continue Non-motorized Traffic Data Collection and Management.
2. Develop Procedures for Loaning Portable Automated Traffic Monitors.
3. Update Guidance for Non-motorized Traffic Data Collection.
4. Archive Historic Manual Bicycle and Pedestrian Counts.
5. Prepare Template for Reporting Bicycle and Pedestrian Counts.
6. Develop Template for MnDOT Annual Bicycle and Pedestrian Count Report.
7. Develop Statewide Bicycle Traffic Monitoring Plan.
8. Collaborate on Non-motorized Traffic Projects.
9. Develop Statewide Pedestrian Traffic Monitoring Plan.
10. Organize Bicycle and Pedestrian Traffic Monitoring Task Force.

<u>Task 1 Continue Non-motorized Traffic Data Collection and Management</u>

The project management team (the University of Minnesota, MnDOT Office of Transit, MnDOT Traffic Data Analysis, MnDOT Research Services):

- Installed four permanent automated bicycle and/or pedestrian monitoring devices in collaboration with the cities of Minneapolis and St. Paul and with the Three Rivers Park District.

- Completed 58 short duration automated counts at 33 locations across MN, including locations in Bemidji, Cass Lake, Fergus Falls, Mankato, Morris, and St. Paul.
- Assisted the Arrowhead Regional Development Commission, Hennepin County, the Minnesota Parks and Trails Council, and the Sawtooth Mountain Clinic (Grand Marais), implement bicycle and pedestrian count programs or campaigns.
- Developed spreadsheet templates for tracking, analyzing, summarizing, and archiving automated short duration counts that can be used until MnDOT completes implementation of a new traffic monitoring database that includes both vehicular and non-motorized traffic monitoring data.
- Helped secure funding for additional permanent counters to be installed in each MnDOT administrative district in 2016 and 2017.

Task 2 Develop Procedures for Loaning Portable Automated Monitoring Devices

The project management team:

- Helped secure funding for MnDOT purchase of 16 portable monitoring devices to be distributed to and used by MnDOT districts or loaned to local partners for short duration monitoring. The devices include eight pneumatic tubes for counting bicycles on roads or shared-use paths and eight passive infrared monitors for counting pedestrians on sidewalks or mixed-mode (bicycles and pedestrians) on shared-use paths.
- Prepared kits for short duration monitoring that include instructions, equipment lists, tablets for field work, and other information useful for monitoring.
- Developed procedures for loaning equipment to local public agencies and nonprofit organizations interested in monitoring bicycle and/or pedestrian traffic.
- Conducted demonstrations and training sessions in 2015 and 2016 on use of automated short duration monitoring devices.
- Provided technical support to partners and collaborators in use of equipment and analytic tools, including EcoVisio and the MnDOT count template (see Task 5).

Task 3 Update Guidance for Non-motorized Traffic Data Collection

The project management team updated and revised the "MnDOT Bicycle and Pedestrian Data Collection Manual (2015 Draft)" (http://www.dot.state.mn.us/research/TS/2015/201533.pdf). The revisions included new information about use of automated monitoring devices, analyses of traffic counts, factoring of short duration counts, and collaboration with MnDOT in monitoring. These guidance materials were summarized at training sessions in October 2015 and May 2016 attended by participants from throughout Minnesota, including representatives of municipalities, MnDOT District offices, counties, park districts, and regional development commissions.

Task 4 Archive Historic Manual Bicycle and Pedestrian Counts

The research team worked with MnDOT to summarize manual bicycle and pedestrian counts completed between 2012 and 2014 during the Methodologies and Implementation projects in a brief technical memorandum. This memorandum identifies the communities where counts were taken and identifies the location of counts.

The project team also designed a summary worksheet to track both manual and automated counts. This summary worksheet includes data fields for information about count locations, deployment and maintenance of equipment, notes from counts and locations, and adjustment factors. Tabs in this worksheet enable MnDOT to track agency involvement and permanent index sites. The worksheet also includes fields required to display monitoring locations on an interactive map built using ArcGIS Desktop and Online. The data summaries from this worksheet, including traffic patterns and statistical data, are being linked to the interactive map and will be available to be downloaded by users.

<u>Task 5 Prepare Template for Reporting Bicycle and Pedestrian Counts</u>

The project management team developed templates and a set of procedures for managing, archiving, and reporting automated and manual bicycle and pedestrian counts from devices produced by different vendors. For its permanent automated count program and for its counter loan program, MnDOT purchased several types of inductive loop, infrared, and pneumatic tube monitors from Eco-Counter. Eco-Counter provides an online data management tool (Eco-visio) that enables viewing, analysis, and reporting of traffic data. Eco-visio reports summarize data in formats relevant to most applications in bicycle and pedestrian planning and engineering. Eco-visio also supports data exports for more detailed data analyses, including exports to other data management systems. MnDOT will use Eco-Visio as an archive but also will export data from Eco-visio to its traffic monitoring databases when procedures for integrated bicycle and pedestrian counts with motorized vehicle counts have been created.

For counts from automated monitors manufactured by other vendors or counts taken manually, the team produced spreadsheet templates (Excel ©) that MnDOT and its partners can use to summarize and report results. Templates were developed for Chambers radio beam monitors, MetroCount pneumatic tube counters, TrailMaster active infrared monitors, and manual counts. These templates summarize (where relevant) annual, monthly, daily, and hourly traffic volumes and patterns in a consistent format. The templates were shared with and tested by the Arrowhead Regional Development Commission and Hennepin County to support local monitoring initiatives. They will be made available to other organizations engaged in monitoring upon request.

<u>Task 6 Develop Template for MnDOT Annual Bicycle and Pedestrian Count Report</u>

The project management team prepared the "Minnesota Bicycle and Pedestrian Traffic 2015 Monitoring Report." This report was designed as a template that can be replicated annually and supplemented in future years as more monitoring data become available. Features of the report include estimates for annual average daily bicycle and pedestrian traffic at permanent, index monitoring sites, summaries of monitoring results at short-duration monitoring sites, and an overview of monitoring activities by other local and regional organizations.

Task 7 Develop Statewide Bicycle Traffic Monitoring Plan

The project management team developed a statewide non-motorized traffic monitoring plan**.** The plan calls for implementation of a:

- Statewide network of permanent, automated bicycle and pedestrian monitoring sites called index sites to provide information about traffic patterns and trends over time, and
- Collaborative approach to short duration monitoring that includes distribution of portable monitoring equipment in each MnDOT District that can be used by District staff or loaned to public agencies and nonprofit organizations to conduct counts.

The plan calls for minimum of 16 to 20 permanent index sites, including two or more locations in each of MnDOT's eight Districts. The index sites will include a minimum of eight sites on roads and eight sites on shared use paths (i.e., one road site and one trail site in each District). Five sites were installed in 2014 during the Implementation project and, as noted in the discussion of Task 1, three additional sites were installed in 2015. Planning also had been completed to install additional sites through 2017, bringing the total to 25.

Short duration monitoring will be done by MnDOT staff or by local public agencies or nonprofit organizations in collaboration with MnDOT districts. In 2015, the project management team collaborated with organizations to conduct 58 short-duration counts of bicycle and pedestrian traffic at 33 locations. The number of counts and locations to be monitored in 2016 will depend on the interests of the hosts and the number of local agencies that borrow portable equipment made available by MnDOT.

Task 8 Collaborate on Non-Motorized Traffic Projects

The project management team collaborated with MnDOT staff in the Offices of Transit and Traffic Data Analysis on several MnDOT policy and programmatic initiatives. Among other contributions, the team provided input to MnDOT staff responsible for the MnDOT Statewide Bicycle System Plan and the State Pedestrian System Plan. Both plans include recommendations for traffic monitoring and both identify the need for performance indicators based on traffic monitoring results. The team provided information about use of bicycle infrastructure to the staff responsible for the MnDOT study to estimate the economic impact of the bicycling industry in Minnesota and worked with many state, regional, and local agencies to conduct or plan counts. These agencies included the Arrowhead Regional Development Commission (ARDC), Hennepin County Department of Public Works, Minnesota Parks and Trails Council, Minnesota Department of Natural Resources (MDNR), Sawtooth Mountain Clinic (Grand Marais), National Park Service, Mississippi National River and Recreation Area (MNRRA), and the Greater Minnesota Parks and Trails Commission (GMRPTC).

Task 9 Develop Statewide Pedestrian Traffic Monitoring Plan

As noted under Task 7, the project management team developed a statewide non-motorized traffic monitoring plan that calls for implementation of a statewide network of permanent, automated bicycle and pedestrian monitoring sites and a collaborative approach to short duration monitoring. This plan envisions counting of pedestrians at sites on sidewalks in addition to shared-use paths or trails. Implementation of pedestrian counting during the project period was limited because local partners tended to prioritize monitoring of bicycle traffic and monitoring on shared-use paths. With the exception of efforts to count pedestrians on shared-use paths, no permanent pedestrian monitoring locations were established in 2015. One site will be installed in St. Paul in 2016. Because of the need to develop additional methods and opportunities for monitoring pedestrians, especially in rural areas, MnDOT has allocated funding for a separate study.

Task 10 Organize Bicycle and Pedestrian Traffic Monitoring Task Force

The project management team organized a Task Force to serve in an advisory capacity to the Counting Initiative and as the Technical Advisory Panel (TAP) for the project. The Task Force included approximately 25 members, including representatives of regional planning agencies, municipalities, nonprofit organizations, and private consulting firms. The Task Force met in April and October 2015 and in 2016. Among other activities, the Task Force provided suggestions for MnDOT efforts to support local bicycle and pedestrian traffic monitoring. The TAP was provided the opportunity to review and comment on this final report.

APPENDIX B

CONCEPT PLAN FOR BICYCLE AND PEDESTRIAN TRAFFIC MONITORING IN MINNESOTA

Institutionalizing Bicycle and Pedestrian Monitoring in Minnesota

Concept Plan for Bicycle and Pedestrian Monitoring

February 12, 2015

Overview

The Minnesota Department of Transportation (MnDOT) is developing plans for statewide bicycle and pedestrian monitoring at a limited number of locations throughout Minnesota. The purpose of monitoring is to generate information about bicycle and pedestrian traffic volumes and patterns that can be used to inform state, regional, and local planning and engineering initiatives and to assess important transportation policies and programs such as Complete Streets and Toward Zero Deaths. The approach will be based on well-established principles of vehicular traffic monitoring and designed to be integrated with vehicular monitoring programs over the long term. The approach involves establishment of permanent, continuous monitoring stations at a limited number of locations throughout the state along with a larger number of short-duration monitoring locations. The purposes of the permanent monitoring stations are to track trends in traffic over time, to provide insight into exposure to risk for safety analyses, to identify patterns in traffic that can be used to interpret and extrapolate short-duration counts into annual traffic estimates, and to develop performance indicators to track progress relative to MnDOT goals and objectives. The purposes of short-duration monitoring are to document variations in traffic volumes on different types of roads, to provide broad geographic coverage across the state, and to assist with evaluation of transportation investments and innovative safety treatments. Because of resource limitations, the plan does not propose comprehensive monitoring for the entire state. Instead, the plan proposes a limited number of permanent "index" sites and a greater number of short-duration monitoring sites that can inform transportation planning and engineering in each district or region of Minnesota.

Permanent Index Monitoring Sites

MnDOT proposes to establish a network of 30 to 40 permanent index monitoring sites throughout the state, with a minimum of four locations in each of MnDOT's eight administrative districts. The goals for location of the index sites are to include a range of types of bicycle and pedestrian infrastructure (e.g., arterials or collectors with and without bicycle lanes, local streets, county roads, and multi-use trails) in a range of settings (e.g., urban, suburban, rural) that are near different types of land uses that may generate different traffic patterns (e.g., commercial, mixed-use, universities.

The index sites will be selected in consultation with MnDOT district staff and representatives of local, regional, and state agencies in each district. MnDOT will assist with and coordinate development of the network of index sites, but may not install or maintain all sites. Implementation of the network will depend on partnerships established with local agencies. To facilitate maintenance, there may be advantages to locating index sites in communities where MnDOT district offices are located. Figure 1 illustrates a possible distribution of sites. The network will include permanent monitoring sites established in 2014 in Duluth (Lake Front Trail; Scenic 61 shoulder), Eagan (Trunk Highway 13 shoulder), and Minneapolis (Central Avenue bike lane; W. River Parkway Trail). MnDOT anticipates archiving monitoring results from the index sites, developing performance indicators from the results, and providing guidance to local jurisdictions in interpretation and use of data in engineering applications such application of signal warrants.

Short-duration Monitoring Sites

MnDOT proposes to undertake short-duration monitoring at a number of locations in districts throughout the state in 2014 to provide greater understanding of variations in bicycle and pedestrian traffic volumes in different contexts and to identify different types of traffic patterns that can be used to establish “factor groups” for purposes of analysis and extrapolation. Factor groups are groups of sites with similar hourly or seasonal traffic patterns such as commuter patterns with morning and evening peaks on weekdays or multipurpose patterns with even traffic flows throughout weekends and weekdays.

As with the selection of permanent index sites, the goals are to monitor at locations that encompass a range of types of infrastructure and other geographic and land use characteristics. In addition, short-duration sites may be selected to provide other information such traffic volumes before and after installation of new bicycle or pedestrian facilities. All short-duration sites will be selected in consultation with local and regional agencies and MnDOT district staff.

Short-duration sites generally will be continuously monitored for five to seven days between May and October because research indicates that error in extrapolation to annual traffic volumes is minimized with samples of this duration during periods when traffic volumes are highest. This period is longer than short-duration monitoring for vehicles (i.e., 48 hours) because bicycle and pedestrian traffic varies more in response to weather. If resources and other circumstances permit, non-motorized monitoring may be integrated with vehicle monitoring (e.g., vehicle classification counts using pneumatic tubes could be adapted to produce counts of bicyclists). The scope of short-duration monitoring across Minnesota during 2014 will be determined by the availability of resources and partnerships established with local agencies in districts. MnDOT anticipates archiving results from the short-duration monitoring sites.

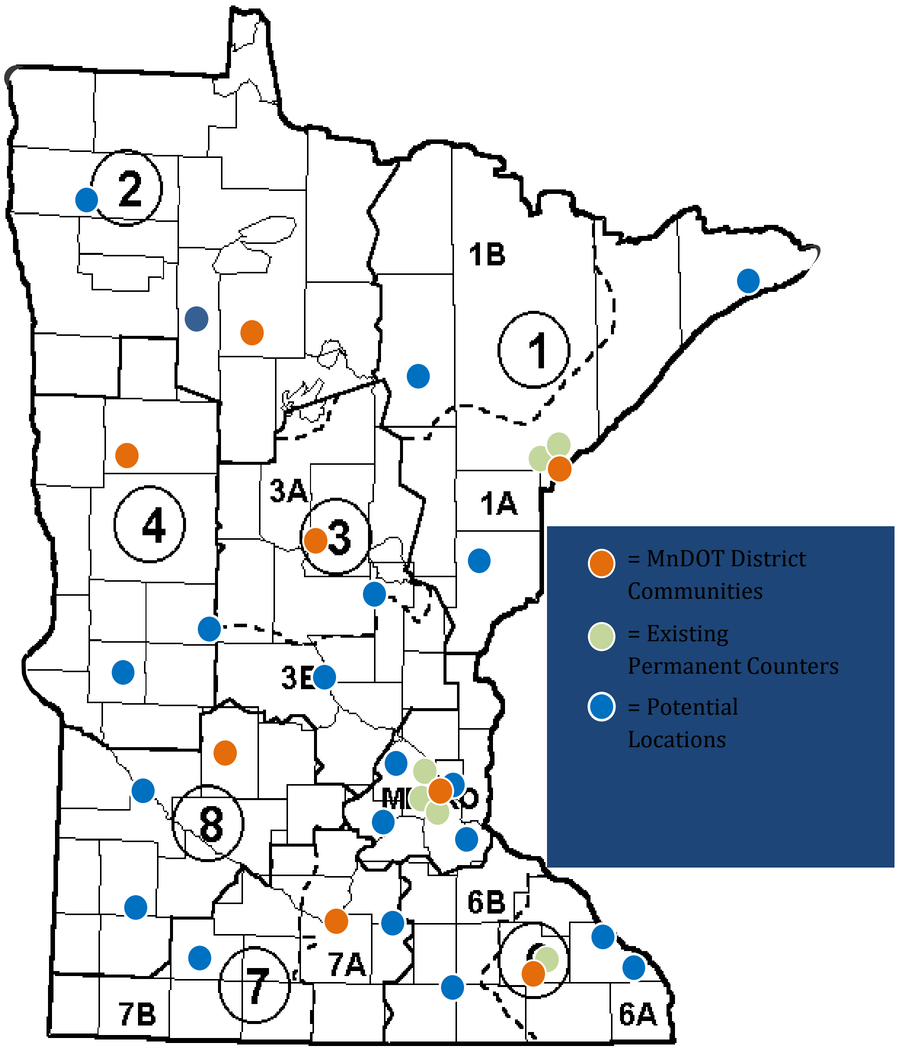
Implementation of Bicycle and Pedestrian Monitoring

Implementation of index site monitoring network will begin in the summer of 2014 and continue through 2016, depending on the availability of resources. MnDOT estimates that the capital and operations and maintenance costs over the initial five-year period (2014-18) will be approximately $560,000. This estimate assumes 32 monitoring sites (4 sites per district; two on-road sites, one multi-use trail, and one sidewalk or pedestrian facility). MnDOT presently has not identified funding sources for installation of permanent sites. To address funding needs for permanent index sites, MnDOT is seeking both internal funding and partnerships with other agencies to establish networks. For example, it may be feasible to integrate installation of monitoring equipment into new capital improvement projects and to incorporate the costs of equipment into project costs. MnDOT has a number of portable monitoring devices (i.e., infrared counters, radio beam counters, pneumatic tubes) and support for staff to undertake short-duration monitoring in summer 2014.

MnDOT personnel, with support from the University of Minnesota, will be meeting with local agencies and MnDOT district staff throughout the state in the spring and summer of 2014 to discuss the monitoring plan and explore opportunities for collaboration. These meetings will include discussions of potential locations for both permanent index sites and short-duration monitoring.

Contact for more information: Lisa Austin, MnDOT. Lisa.Austin@state.mn.us (651-366-4193)

Figure 1. Illustration of potential network of permanent, index monitoring sites.



APPENDIX C

MNDOT POWERPOINT (2016): TRAINING FOR BICYCLE AND PEDESTRIAN TRAFFIC MONITORING

The Minnesota Bicycle and Pedestrian Counting Initiative

Bicycle & Pedestrian Data Collection in Minnesota

Michael Petesch – UMN Humphrey School of Public Affairs
Greg Lindsey – UMN Humphrey School of Public Affairs
Lisa Austin – MnDOT
Amber Dallman – MnDOT

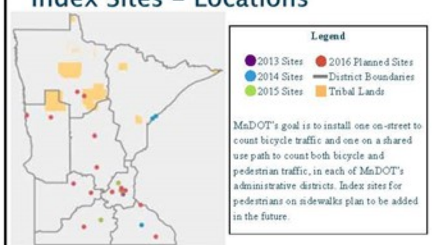
We all have a stake in A↔B

Training Objectives

- Overview of Minnesota's Bicycle and Pedestrian Counting Initiative (Permanent and Short Duration)
- Counting case studies – Arrowhead Regional Development Commission & Hennepin County
- Equipment overview & installation – site design to data collection
- Data access and analysis

Permanent "Index" Sites

Index Sites – Locations

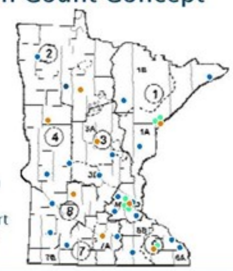


Index Sites – Purpose

- Statewide snapshot
- Adjustment factors
- How you can help
  - Know where they are in your district and check on them a couple times a year or when you're nearby
  - Inspect for vandalism, overgrown vegetation, insects in the sensors, or maybe change a battery or another piece of equipment
  - Validation – A couple days after install and periodically afterwards perform manual count in-person or with video

Short Duration Portable Counters

Short Duration Count Concept



MnDOT CO providing
- Portable equipment in each district
- Data collection support for districts and local jurisdictions

Short Duration Count Purposes

- Provide broad geographic coverage
- Measure variation in volume over time
- Inform project planning
  - Before & After Counts
  - Evaluate traffic control warrants
- Evaluate investments and innovative safety treatments
- Apply adjustment factors to estimate ADBT, ADPT

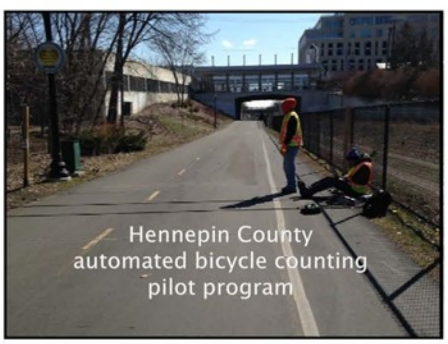
Short Duration Site Selection

- Facility types – streets, trails, sidewalks
- Facility area – rural, urban, suburban
- Trip generators – business parks, schools, churches, coffee shops, bars & restaurants
- Land uses – residential, commercial, green space

Short Duration Count Considerations

Good count considerations:
- Areas with high volumes of free flowing traffic
- 5-9 days w/ mix of weekdays & weekends
- Before and after construction projects
- Address equity when identifying sites, underserved areas and community needs for data
- Assure safety of personnel and equipment

Avoid:
- Areas where people loiter (i.e. benches, intersections, maps, lookouts, crosswalks, etc.)
- Events (i.e. fairs, races, farmers markets, etc.). Try to capture typical traffic flows
- Motor vehicles, waving branches & grasses, slope & curves




MetroCount pneumatic tube counters
48 hour weekday counts


Minnetonka Blvd,
Minnetonka


Franklin Ave, E of Chicago
Minneapolis


Nicollet Ave at 90th St,
Bloomington
AADB = 24
Nicollet Ave at 76th St,
Richfield
AADB = 41

Equipment costs

- Metrocount counters – $4,640 for 4 counters
- Hose – $430 annually
- Nails, drill, other misc field tools – $500 start up, $200 annually

Arrowhead Regional Development Commission

Charlie Moore

Short Duration Equipment

- Kit contents
  - 2 counters (1 Tube & 1 Pyro Counter)
  - List of site considerations, tips and tricks
  - Setup instruction booklets
  - Android tablet
  - Tools and equipment

Short Duration Counting Contacts

Location	Point Person(s)	Agency	Email	Location
D-1	Charlie Moore	ARDC	cmoore@ardc.org	Duluth
D-2	Darren Laesch	MnDOT	darren.laesch@state.mn.us	Bemidji
D-3	Jon Mason	MnDOT	jon.mason@state.mn.us	Baxter
D-4	Andrew Besold	WCI	andrew@wcif.org	Fergus Falls
D-6	Tracy Schnell	MnDOT	tracy.schnell@state.mn.us	Rochester
D-7	Ronda Allis	MnDOT	ronda.allis@state.mn.us	Mankato
D-8	Lindsey Knutson	MnDOT	lindsey.knustson@state.mn.us	Willmar
METRO	Amber Dallman	Bike/Ped	amber.dallman@state.mn.us	St. Paul

Field Work Time. Head Outside.

Field Work – Outside

- View & demonstrate counter setups
- Q&A
- Form small groups and install both counter types
- Review Eco-Link software and use to connect tablets and counters

Partner Up & Find a Computer.

Computer Work – Inside

- Program management
  - Custom Eco-Visio logins for each district
- New statewide login
- Custom names for each counter
- How to create new counters
- Creating data reports

Portable Counting Program Management

Local Login Info

1. Go to Eco-Visio at: https://www.eco-visio.net
2. Then enter your districts' login info:

District	User Name	Password
D1	d1counts	ardcduluth
D2	d2counts	mndotbemidji
D3	d3counts	apostcloud
D4	d4counts	wcifergusfalls
D6	d6counts	mndotrochester
D7	d7counts	mndotmankato
D8	d8counts	mndotwillmar
METRO	metrocounts	metrostpaul

Creating a "New Counter"

EcoCounter Management

- Counter Names
  - District number (D1, D2, etc)
  - Facility name (Douglas Trail, etc)
  - Direction from nearest cross street or trail miles
    - D2 | Cass Lake - 69th Ave NW north of 162nd St NW
    - Metro | St Paul - Jackson Ave north of 5th St
    - D7 | Marshall - West Main St northwest of N 1st St
- New Count Site "Description"
  - Comment
    - Spell out the borrowing organization's name
    - Provide cross streets info or where it is attached what it is attached to
    - Modify "In" and "Out" directions (i.e. In = NB or NEB)
    - List counter serial number
  - GPS coordinates (Lat / Long)
  - Set up / Install date
  - Assign tags by dragging and dropping

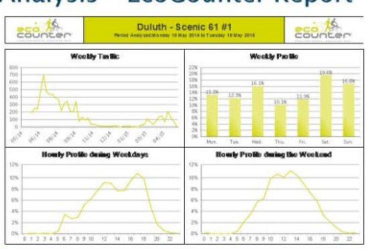
Eco-Visio Data Reports

Statewide View Only Login

UN: mndot

PW: countingmn

Analysis - EcoCounter Report



Equipment Checkout & Mgmt

- Review agreements
- Handout equipment
- Developing
  - Count Schedule - 5 to 9 day periods
  - Equipment Checklist
  - Sign-out agreements with loaning organization

Next steps

- Work with partners to identify locations and implement monitoring network
- Encourage partners to deploy the equipment
- Provide technical assistance as needed
  - Volunteer secondary contacts?
- Update count manual and other documents
- Hold additional trainings & webinars

APPENDIX D

MNDOT BICYCLE AND PEDESTRIAN COUNT MASTER SPREADSHEET (TMAS FORMAT)

Duration	City	Facility Location	Location Type	Facility Type	Responsible Agency	On/Off Road	Counting Type	Site Status
Permanent	Eagan	Trunk Highway 13	Suburban	Shoulder	MnDOT	On-Road	Bikes	Active Site
Permanent	Minneapolis	Central Ave	Urban	Bike Lane	MnDOT	On-Road	Bikes	Active Site
Permanent	Duluth	Lake Walk Trail	Urban	Shared Use Path	MnDOT	Off-Road	Both Differentiated	Active Site
Permanent	Duluth	Scenic Hwy 61	Rural	Shoulder	MnDOT	On-Road	Bikes	Active Site
Permanent	Minneapolis	West River Parkway	Urban	Shared Use Path	Minneapolis Park Board	Off-Road	Both Differentiated	Active Site
Permanent	Rochester	Douglas Trail	Suburban	Shared Use Path	Rochester Parks District	Off-Road	Both Differentiated	Active Site
Permanent	Brooklyn Park	Rush Creek Trail	Suburban	Shared Use Path	Three Rivers Park District	Off-Road	Both Differentiated	Active Site
Permanent	Mankato	Veterans Memorial Bridge	Urban	Shared Use Path	MnDOT	Off-Road	Both Combined	Active Site
Permanent	Minneapolis	Park Avenue	Urban	Buffered Bike Lane	MnDOT	On-Road	Bikes	Active Site
Permanent	St Paul	Summit Avenue	Urban	Bike Lane	City of St Paul	On-Road	Bikes	Active Site
Permanent	Bemidji	Pending	Urban	Pending	City of Bemidji	Off-Road	Both Differentiated	Planning Stage
Permanent	Cass Lake	Migizi Trail	Rural	Shared Use Path	Leech Lake Band	Off-Road	Both Differentiated	Active Site
Permanent	Brainerd	Paul Bunyan Trail	Urban	Shared Use Path	DNR	Off-Road	Both Differentiated	Planning Stage
Permanent	St Cloud	Beaver Island Trail	Suburban	Shared Use Path	City of St Cloud	Off-Road	Both Differentiated	Active Site
Permanent	Moorehead	New Trail under TH 75	Suburban	Shared Use Path	MnDOT	Off-Road	Both Differentiated	Planning Stage
Permanent	Detroit Lakes	West Lake Road	Suburban	Shoulder	City of Detroit Lakes	Off-Road	Both Differentiated	Planning Stage
Permanent	Lanesboro	Root River Trail	Urban	Shared Use Path	DNR	Off-Road	Both Differentiated	Planning Stage
Permanent	Red Wing	Red Wing Riverfront Trail	Urban	Shared Use Path	City of Redwing	Off-Road	Both Differentiated	Planning Stage
Permanent	St James	Pending	Pending	Pending	Pending	Pending	Pending	Planning Stage
Permanent	Willmar	Lakeland Drive	Suburban	Bike Lane	City of Willmar	On-Road	Bikes	Planning Stage
Permanent	Hutchinson	Luce Line Trail	Urban	Shared Use Path	City of Hutchinson	Off-Road	Both Differentiated	Planning Stage
Permanent	Minneapolis	Franklin Ave Bridge	Urban	Buffered Bike Lane and Sidewalk	Hennepin County	On-Road	Bikes	Active Site
Permanent	Orono	Shadywood Road	Suburban	Bike Lane	Hennepin County	On-Road	Bikes	Active Site
Permanent	St Paul	Jackson Street	Urban	Buffered Bike Lane and Sidewalk	City of St Paul	On-Road	Both Differentiated	Active Site
Permanent	Minneapolis	Central Ave	Urban	Bike Lane	MnDOT	On-Road	Bikes	Planning Stage
Short Duration	Mankato	Veterans Memorial Bridge	Urban	Road Shoulder	MnDOT D7	On-Road	Bikes	Removed
Short Duration	Mankato	Northstar Bridge	Urban	Shared use path	MnDOT CO	Off-Road	Both Differentiated	Removed
Short Duration	Mankato	South Broad Street	Urban	Bike Lane	MnDOT CO	On-Road	Bikes	Removed
Short Duration	Mankato	Stadium Road	Urban	Sidewalk	MnDOT CO	Off-Road	Both Combined	Removed
Short Duration	Mankato	Glenwood Avenue	Urban	Shared Use Path	MnDOT CO	Off-Road	Both Differentiated	Removed
Short Duration	Mankato	Red Jacket Trail	Urban	Shared Use Path	MnDOT CO	Off-Road	Bikes	Removed
Short Duration	Mankato	Stadium Road & Heron Dr	Urban	Shared Use Path	MnDOT CO	Off-Road	Both Combined	Removed
Short Duration	St Paul	Cold Spring Trail along Hwy 55	Urban	Shared Use Path	MnDOT CO	Off-Road	Bikes	Removed
Short Duration	St Paul	Hwy 5 Bridge	Urban	Shared Use Path	MnDOT CO	Off-Road	Both Combined	Removed
Short Duration	St Paul	Steep hill by Fort Snelling	Urban	Shared Use Path	MnDOT CO	Off-Road	Bikes	Removed
Short Duration	St Paul	Hwy 55 Bridge	Urban	Shared Use Path	MnDOT CO	Off-Road	Both Combined	Removed
Short Duration	St Paul	Hwy 35E Bridge	Urban	Shared Use Path	MnDOT CO	Off-Road	Both Combined	Removed
Short Duration	St Paul	Ford Parkway Bridge	Urban	Shared Use Path	MnDOT CO	Off-Road	Both Combined	Removed
Short Duration	St Paul	Trail Adjacent to Shepard Rd	Urban	Shared Use Path	MnDOT CO	Off-Road	Both Combined	Removed
Short Duration	Morris	Pomme de Terre Trail	Urban	Shared Use Path	UMN Morris Student	Off-Road	Bikes	Removed
Short Duration	Fergus Falls	East of Lincoln and Court St. intersection	Urban	Sharrows	West Central Initiative and City of Fergus Falls	On-Road	Bikes	Removed
Short Duration	Fergus Falls	West of Lincoln and Mill intersection	Urban	Sharrows	West Central Initiative and City of Fergus Falls	On-Road	Bikes	Removed
Short Duration	Fergus Falls	Sidewalk in front of the Kaddatz Hotel / Gallery	Urban	Sidewalk	West Central Initiative and City of Fergus Falls	Off-Road	Bikes	Removed
Short Duration	St Paul	Smith Ave Bridge	Urban	Shoulder and Sidewalk	MnDOT Metro and MnDOT CO	Both	Bikes	Removed
Short Duration	Bemidji	Midway Drive S Trail	Urban	Shared Use Path	City of Bemidji and MnDOT CO	Off-Road	Both Combined	Removed
Short Duration	Bemidji	Paul Bunyan Dr SE Trail	Urban	Shared Use Path	City of Bemidji and MnDOT CO	Off-Road	Both Combined	Removed
Short Duration	Bemidji	Beltrami and 3rd St in downtown	Urban	Sidewalk	City of Bemidji and MnDOT CO	Off-Road	Both Combined	Removed
Short Duration	Bemidji	Indian Trail entrance adjacent to Lake Blvd NE	Urban	Shared Use Path	City of Bemidji and MnDOT CO	Off-Road	Both Combined	Removed
Short Duration	Bemidji	Lake Blvd NE and adjacent Indian Trail	Urban	Bike Lane	City of Bemidji and MnDOT CO	On-Road	Bikes	Removed
Short Duration	Cass Lake	Heartland State Trail adjacent to Cass Lake High School	Rural	Shared Use Path	MnDOT CO and Leech Lake Band	Off-Road	Bikes	Removed
Short Duration	Cass Lake	Trail adjacent 69th Ave NW near Leech Lake Tribal College	Rural	Shared Use Path	MnDOT CO and Leech Lake Band	Off-Road	Both Combined	Removed
Short Duration	Cass Lake	Heartland State Trail adjacent to Cass Lake High School	Rural	Shared Use Path	MnDOT CO and Leech Lake Band	Off-Road	Both Combined	Removed
Short Duration	St Paul	Grotto St Bridge over I-94	Urban	Shared Use Path	MnDOT Metro and MnDOT CO	Off-Road	Both Combined	Removed
Short Duration	St Paul	Mackubin St Bridge over I-94	Urban	Shared Use Path	MnDOT Metro and MnDOT CO	Off-Road	Both Combined	Removed
Short Duration	St Paul	Griggs St Bridge over I-94	Urban	Shared Use Path	MnDOT Metro and MnDOT CO	Off-Road	Both Combined	Removed
Short Duration	Bemidji	1st St W of Gould	Urban	Shoulder	University of Minnesota	On-Road	Bikes	Removed
Short Duration	Bemidji	Claussen	Urban	Shoulder	University of Minnesota	On-Road	Bikes	Removed
Short Duration	Bemidji	Trail along Hwy 197	Urban	Shared Use Path	University of Minnesota	Off-Road	Both Differentiated	Removed
Short Duration	Bagley	Bagley City Park	Urban	Shoulder	University of Minnesota	On-Road	Bikes	Removed
Short Duration	Grand Marais	Wisconsin Ave	Urban	Shoulder and Sidewalk	University of Minnesota	Both	Both Differentiated	Removed
Short Duration	Grand Marais	Gun Flint Trail	Urban	Shoulder	University of Minnesota	On-Road	Bikes	Removed
Short Duration	Grand Marais	County Hwy 7	Rural	Shoulder	University of Minnesota	On-Road	Bikes	Removed
Short Duration	Grand Marais	Rt 61 E of 7 Old Shore Rd (MnDOT 1100)	Rural	Shoulder	University of Minnesota	On-Road	Bikes	Removed

Short Duration	Grand Marais	Rt 61 E of Quilt Shop (MnDOT 1098)	Rural	Shoulder	University of Minnesota	On-Road	Bikes	Removed
Short Duration	Eagan	TH 13 and Co Rd 26	Suburban	Shoulder	University of Minnesota	On-Road	Bikes	Removed
Short Duration	Brooklyn Center	Shingle Creek Pkwy W of CSAH 10	Suburban	Shared Use Path	Hennepin County	Off-Road	Both Differentiated	Removed
Short Duration	Corcoran	CSAH 19 S of Larsen Rd	Rural	Shared Use Path	Hennepin County	Off-Road	Bikes	Removed
Short Duration	Corcoran	CSAH 30 E of CSAH 19	Rural	Bike Lane	Hennepin County	On-Road	Bikes	Removed
Short Duration	Minneapolis	Central Ave N of Lowry	Urban	Bike Lane	Hennepin County	On-Road	Bikes	Removed
Short Duration	Minneapolis	15th Ave SE N of CSAH 36	Urban	Bike Lane	Hennepin County	On-Road	Bikes	Removed
Short Duration	Minneapolis	CSAH 152 at 12th Ave S	Urban	Shoulder	Hennepin County	On-Road	Bikes	Removed
Short Duration	Minneapolis	CSAH 152 E of 3rd Ave S	Urban	Shoulder	Hennepin County	On-Road	Bikes	Removed
Short Duration	Minneapolis	CSAH 152 S of Dowling Ave N	Urban	Bike Lane	Hennepin County	On-Road	Bikes	Removed
Short Duration	Minneapolis	CSAH 153 E of Lyndale Ave	Urban	Bike Lane	Hennepin County	On-Road	Bikes	Removed
Short Duration	Minneapolis	CSAH 27 N of CSAH 52	Urban	Shared Use Path	Hennepin County	Off-Road	Bikes	Removed
Short Duration	Minneapolis	CSAH 33 S of 3rd Ave S	Urban	Buffered Bike Lane	Hennepin County	On-Road	Bikes	Removed
Short Duration	Minneapolis	CSAH 35 S of 3rd Ave S	Urban	Buffered Bike Lane	Hennepin County	On-Road	Bikes	Removed
Short Duration	Minneapolis	CSAH 35 S of E 28th St	Urban	Buffered Bike Lane	Hennepin County	On-Road	Bikes	Removed
Short Duration	Minneapolis	CSAH 35 S of E 55th St	Urban	Bike Lane	Hennepin County	On-Road	Bikes	Removed
Short Duration	Minneapolis	CSAH 36 at 10th Ave SE	Urban	Bike Lane	Hennepin County	On-Road	Bikes	Removed
Short Duration	Minneapolis	CSAH 36 E of 15th Ave SE	Urban	Bike Lane	Hennepin County	On-Road	Bikes	Removed
Short Duration	Minneapolis	CSAH 40 E of Xerxes Ave N	Urban	Bike Lane	Hennepin County	On-Road	Bikes	Removed
Short Duration	Minneapolis	CSAH 66 E of TH 65	Urban	Shoulder	Hennepin County	On-Road	Bikes	Removed
Short Duration	Minneapolis	Trail on E side of Lake Harriet	Urban	Shared Use Path	University of Minnesota	Off-Road	Both Differentiated	Removed
Short Duration	Minneapolis	Midtown Greenway E of CSAH 152	Urban	Shared Use Path	University of Minnesota	Off-Road	Bikes	Removed
Short Duration	Minneapolis	Midtown Greenway W of Hennepin Ave	Urban	Shared Use Path	University of Minnesota	Off-Road	Bikes	Removed
Short Duration	Minneapolis	Trail along West River Parkway South of Lake St	Urban	Shared Use Path	University of Minnesota	Off-Road	Bikes	Removed
Short Duration	Minnetonka	CSAH 5 W of Honeywood Ln at Hopkins Crossroad	Suburban	Shared Use Path	Hennepin County	Off-Road	Both Differentiated	Removed
Short Duration	Minnetonka	CSAH 3 W of CSAH 61	Suburban	Bike Lane	Hennepin County	On-Road	Bikes	Removed
Short Duration	Richfield	CSAH 53 W of CSAH 52	Suburban	Shoulder	Hennepin County	On-Road	Bikes	Removed
Short Duration	Robbinsdale	CSAH 8 S of Lakeland Ave N	Suburban	Shoulder	Hennepin County	On-Road	Bikes	Removed
Short Duration	Rochester	Silver Lake shared use bridge	Urban	Shared Use Path	University of Minnesota	Off-Road	Both Differentiated	Removed
Short Duration	St. Paul	Gateway Trail at Bruce Vento Trail	Suburban	Shared Use Path	University of Minnesota	Off-Road	Both Differentiated	Removed
Short Duration	Lake Elmo	Manning Ave N north of I-94	Rural	Shared Use Path	University of Minnesota	Off-Road	Both Differentiated	Removed

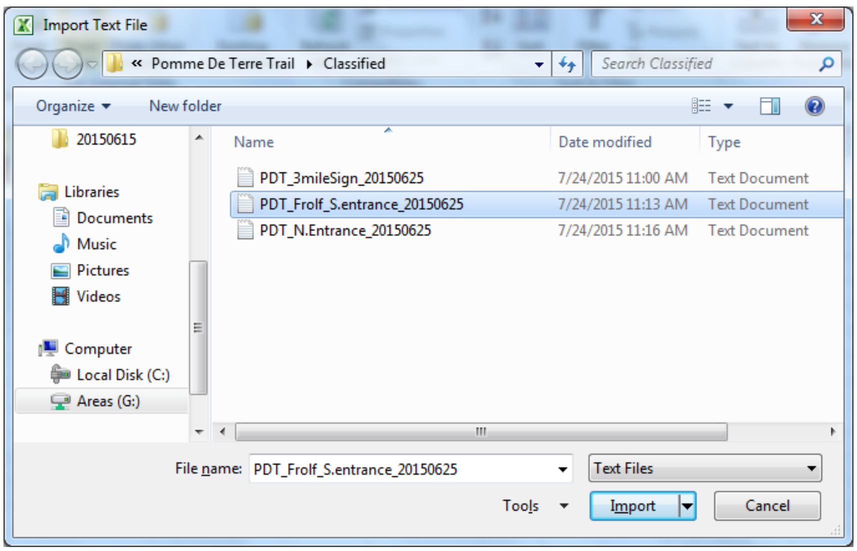
APPENDIX E
OPERATING INSTRUCTIONS FOR THE EXCEL SUMMARY SPREADSHEET METROCOUNT TEMPLATE

(Contact MnDOT Office of Transit for Templates for Manual Counts or Counts taken with Chambers or TrailMaster Counters**)**

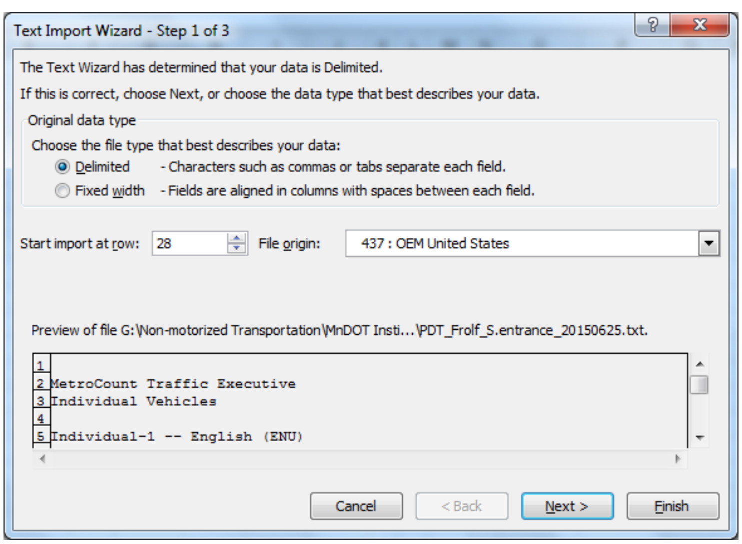
Operating Instructions for the MetroCount Summary Template

Michael Petesch (Michael.Petesch@state.mn.us; 11/10/15)

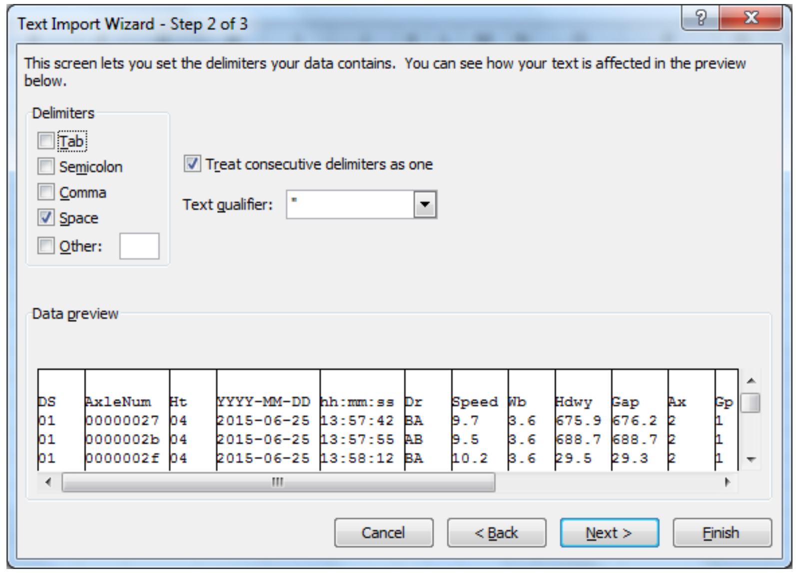
1. Open the Count Template Excel file
2. Navigate to “Raw Data” worksheet by clicking on the “Raw Data” tab at the bottom the Excel window
3. Click in Cell A2 **JUST BELOW** the **red cell** in the upper left corner
4. Click on "Data" tab in the top menu
5. Click on "From Text"
6. Select the .txt file with raw MetroCount date



7. Choose “Delimited” and start import at row “28”



8. Choose delimit by space (make sure that the cell in the second column of row 28 is labeled "AxleNum" with no space. If there is a space, open up the .txt file, delete the space, re-save the .txt file and redo steps 1-5 as stated above). Click “Next.”



9. Click on "Finish." The data will import and fill the worksheet

10. Click on the other worksheet tabs at the bottom the Excel window and visually verify that data cells have been automatically populated

<u>**OPTIONAL:** “15 Minutes” worksheet (aggregates data into 15 minute bins):</u>

Manually enter the row number of the last valid cell (the last count on the last day of the collection) in column F into the formulas in N5, N104 and N203. Then drag each cell right to column P and fill down through each table which are stacked vertically on top of each other:

- Total Hourly Distribution (for full, valid days)
- Weekday Hourly Distribution (for full, valid days)
- Weekend Hourly Distribution (for full, valid days)

Here are some visuals for manually finishing the 15 Minutes worksheet:

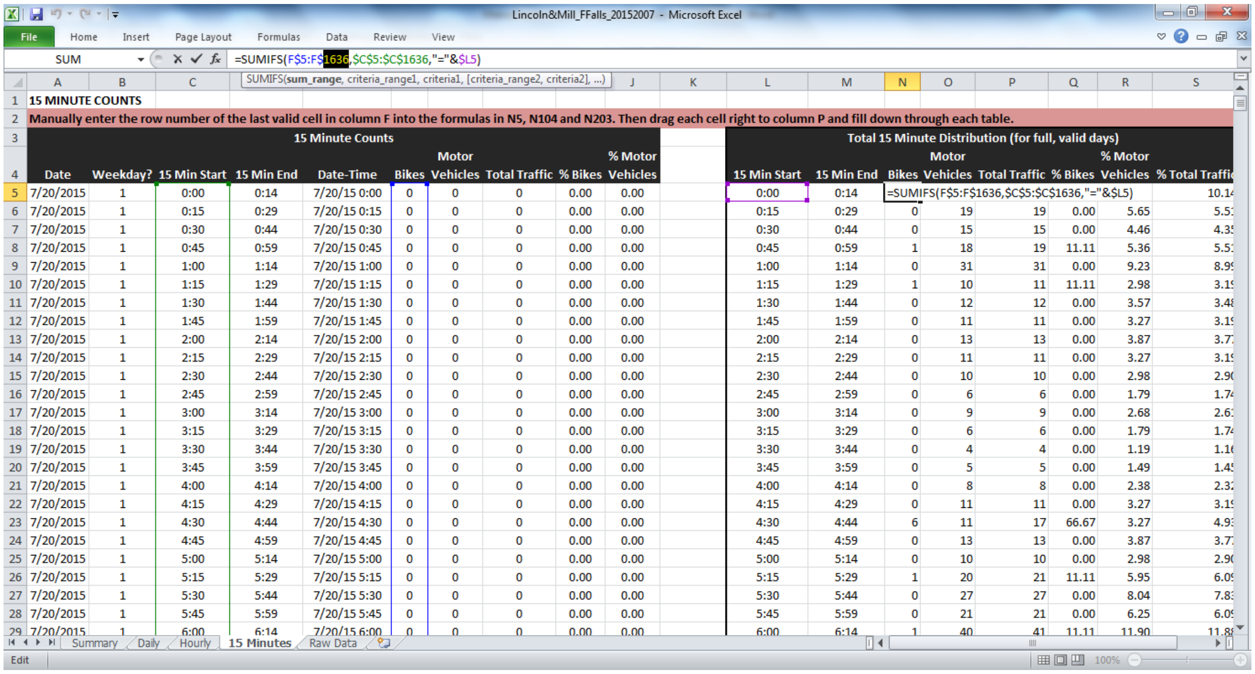
1. Find the last row of the last complete day of data (the second to last day of data because the last day is a partial day). This is the “last valid row” number:

Lincoln&Mill_FFalls_20152007 - Microsoft Excel

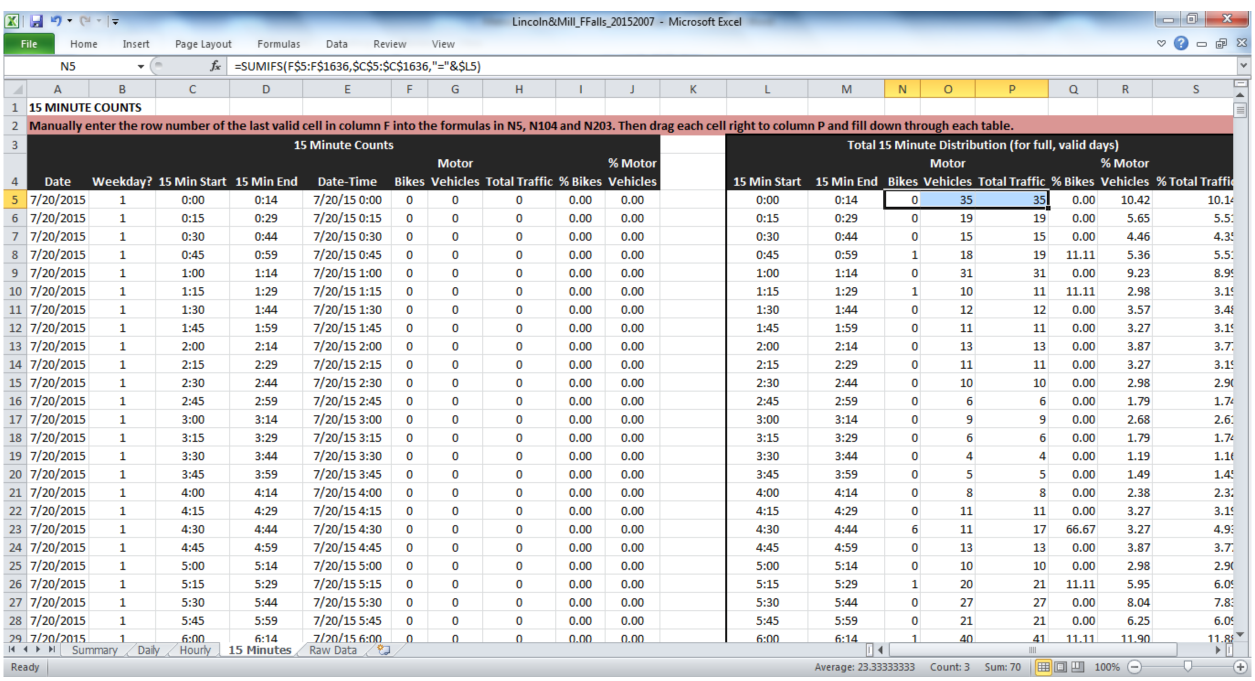
J1636 =100*IF(H1636>0,G1636/H1636,0)

	A	B	C	D	E	F	G	H	I	J
1621	8/5/2015	1	20:00	20:14	8/5/15 20:00	0	21	21	0.00	100.00
1622	8/5/2015	1	20:15	20:29	8/5/15 20:15	0	14	14	0.00	100.00
1623	8/5/2015	1	20:30	20:44	8/5/15 20:30	1	18	19	5.26	94.74
1624	8/5/2015	1	20:45	20:59	8/5/15 20:45	0	9	9	0.00	100.00
1625	8/5/2015	1	21:00	21:14	8/5/15 21:00	1	15	16	6.25	93.75
1626	8/5/2015	1	21:15	21:29	8/5/15 21:15	0	14	14	0.00	100.00
1627	8/5/2015	1	21:30	21:44	8/5/15 21:30	1	9	10	10.00	90.00
1628	8/5/2015	1	21:45	21:59	8/5/15 21:45	0	3	3	0.00	100.00
1629	8/5/2015	1	22:00	22:14	8/5/15 22:00	0	5	5	0.00	100.00
1630	8/5/2015	1	22:15	22:29	8/5/15 22:15	0	6	6	0.00	100.00
1631	8/5/2015	1	22:30	22:44	8/5/15 22:30	0	6	6	0.00	100.00
1632	8/5/2015	1	22:45	22:59	8/5/15 22:45	0	0	0	0.00	0.00
1633	8/5/2015	1	23:00	23:14	8/5/15 23:00	0	1	1	0.00	100.00
1634	8/5/2015	1	23:15	23:29	8/5/15 23:15	0	2	2	0.00	100.00
1635	8/5/2015	1	23:30	23:44	8/5/15 23:30	0	4	4	0.00	100.00
1636	8/5/2015	1	23:45	23:59	8/5/15 23:45	0	2	2	0.00	100.00
1637	8/6/2015	1	0:00	0:14	8/6/15 0:00	0	2	2	0.00	100.00
1638	8/6/2015	1	0:15	0:29	8/6/15 0:15	0	3	3	0.00	100.00
1639	8/6/2015	1	0:30	0:44	8/6/15 0:30	0	0	0	0.00	0.00
1640	8/6/2015	1	0:45	0:59	8/6/15 0:45	0	1	1	0.00	100.00
1641	8/6/2015	1	1:00	1:14	8/6/15 1:00	0	0	0	0.00	0.00
1642	8/6/2015	1	1:15	1:29	8/6/15 1:15	0	0	0	0.00	0.00
1643	8/6/2015	1	1:30	1:44	8/6/15 1:30	0	0	0	0.00	0.00
1644	8/6/2015	1	1:45	1:59	8/6/15 1:45	1	1	2	50.00	50.00

2. Replace the height of the range with the “last valid row” number in cell N5:



3. Then drag the formula from T5 across to column V and fill down through the table.



4. Repeat steps 2 and 3 for cells T32 and T59 starting with replacing the height of the ranges with the “last valid row” of data.

EXAMPLE: The highlighted "2000s" are stand ins ad should be replaced with the number of the last valid row: =SUMIFS(F$5:F$**2000**,$C$5:C**2000**,"="&$L5)

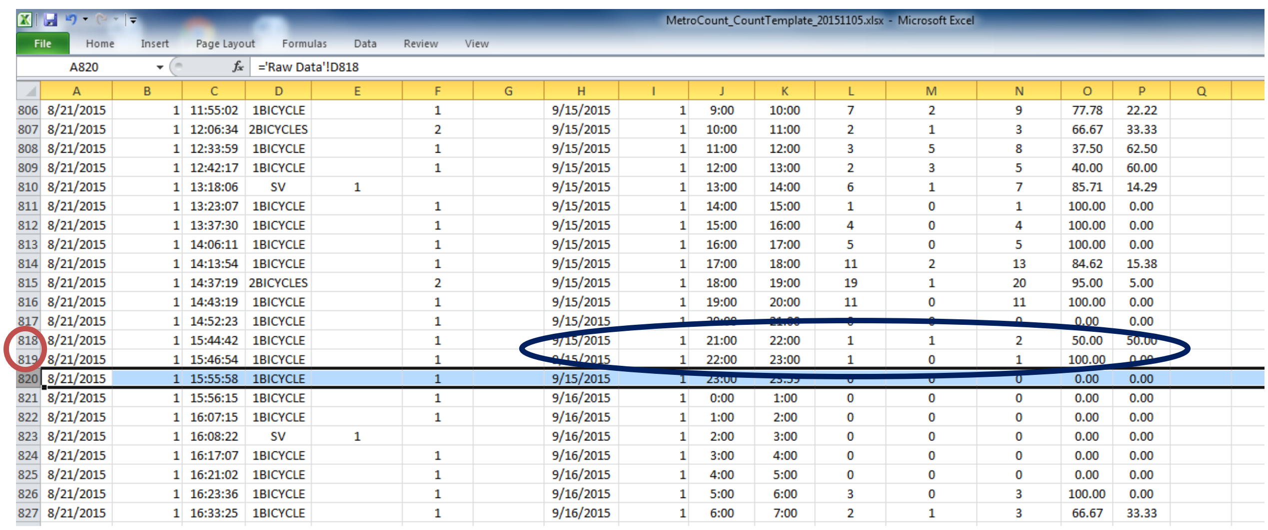
“Hourly” worksheet (aggregates data into hourly bins):

Manually enter the row number of the last valid cell (the last count on the last day of the collection) in column D into the formulas in T5, T32 and T59. Then drag each cell right to column V and fill down through each table which are stacked vertically on top of each other:

- Total Hourly Distribution (for full, valid days)
- Weekday Hourly Distribution (for full, valid days)
- Weekend Hourly Distribution (for full, valid days)

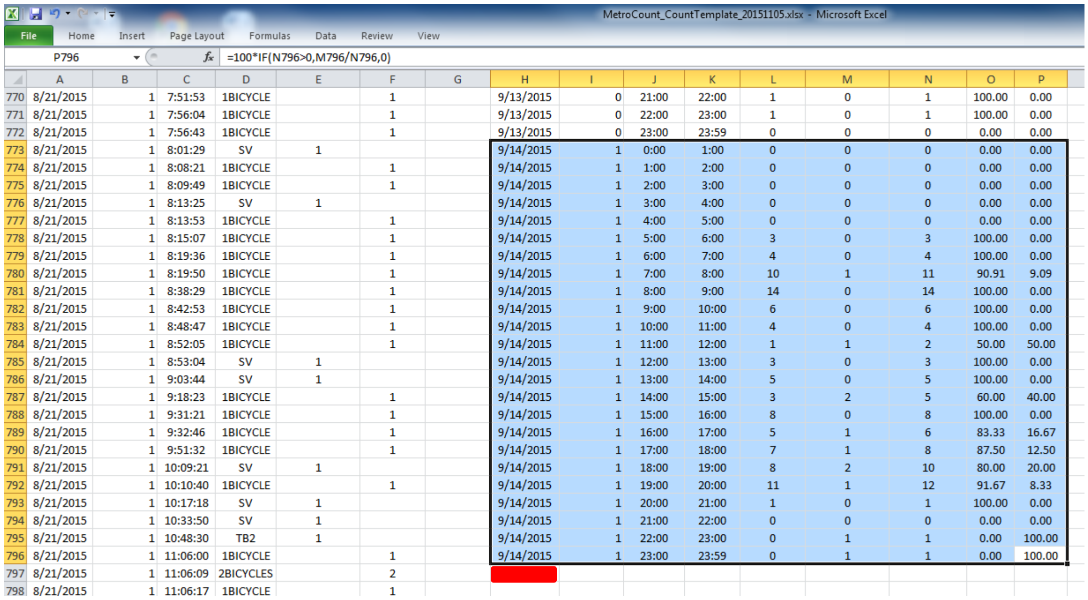
Here are some visuals for manually finishing the Hourly worksheet:

1. Find the midnight row of the last complete day of data (the big oval which shows the second to last day of data because the last day (pickup day) is a partial day). This is the “last valid row” number (little circle):

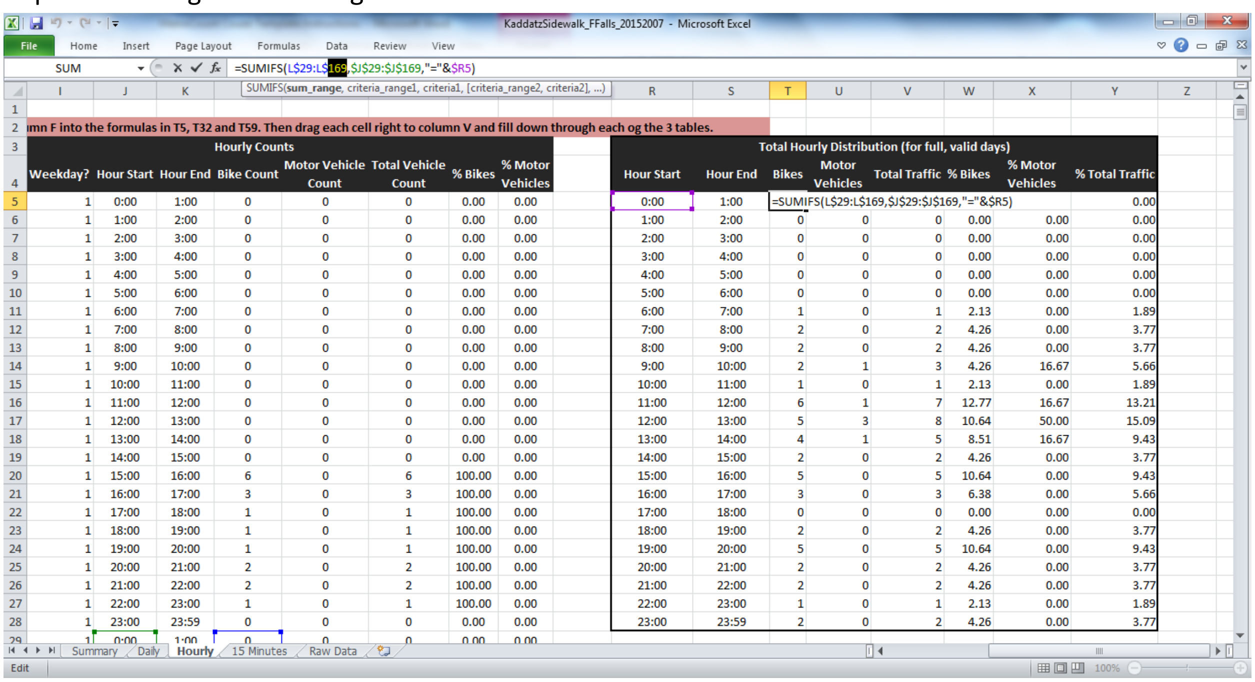


	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
806	8/21/2015	1	11:55:02	1BICYCLE		1		9/15/2015	1	9:00	10:00	7	2	9	77.78	22.22	
807	8/21/2015	1	12:06:34	2BICYCLES		2		9/15/2015	1	10:00	11:00	2	1	3	66.67	33.33	
808	8/21/2015	1	12:33:59	1BICYCLE		1		9/15/2015	1	11:00	12:00	3	5	8	37.50	62.50	
809	8/21/2015	1	12:42:17	1BICYCLE		1		9/15/2015	1	12:00	13:00	2	3	5	40.00	60.00	
810	8/21/2015	1	13:18:06	SV	1			9/15/2015	1	13:00	14:00	6	1	7	85.71	14.29	
811	8/21/2015	1	13:23:07	1BICYCLE		1		9/15/2015	1	14:00	15:00	1	0	1	100.00	0.00	
812	8/21/2015	1	13:37:30	1BICYCLE		1		9/15/2015	1	15:00	16:00	4	0	4	100.00	0.00	
813	8/21/2015	1	14:06:11	1BICYCLE		1		9/15/2015	1	16:00	17:00	5	0	5	100.00	0.00	
814	8/21/2015	1	14:13:54	1BICYCLE		1		9/15/2015	1	17:00	18:00	11	2	13	84.62	15.38	
815	8/21/2015	1	14:37:19	2BICYCLES		2		9/15/2015	1	18:00	19:00	19	1	20	95.00	5.00	
816	8/21/2015	1	14:43:19	1BICYCLE		1		9/15/2015	1	19:00	20:00	11	0	11	100.00	0.00	
817	8/21/2015	1	14:52:23	1BICYCLE		1		9/15/2015	1	20:00	21:00	0	0	0	0.00	0.00	
818	8/21/2015	1	15:44:42	1BICYCLE		1		9/15/2015	1	21:00	22:00	1	1	2	50.00	50.00	
819	8/21/2015	1	15:46:54	1BICYCLE		1		9/15/2015	1	22:00	23:00	1	0	1	100.00	0.00	
820	8/21/2015	1	15:55:58	1BICYCLE		1		9/15/2015	1	23:00	23:59	0	0	0	0.00	0.00	
821	8/21/2015	1	15:56:15	1BICYCLE		1		9/16/2015	1	0:00	1:00	0	0	0	0.00	0.00	
822	8/21/2015	1	16:07:15	1BICYCLE		1		9/16/2015	1	1:00	2:00	0	0	0	0.00	0.00	
823	8/21/2015	1	16:08:22	SV	1			9/16/2015	1	2:00	3:00	0	0	0	0.00	0.00	
824	8/21/2015	1	16:17:07	1BICYCLE		1		9/16/2015	1	3:00	4:00	0	0	0	0.00	0.00	
825	8/21/2015	1	16:21:02	1BICYCLE		1		9/16/2015	1	4:00	5:00	0	0	0	0.00	0.00	
826	8/21/2015	1	16:23:36	1BICYCLE		1		9/16/2015	1	5:00	6:00	3	0	3	100.00	0.00	
827	8/21/2015	1	16:33:25	1BICYCLE		1		9/16/2015	1	6:00	7:00	2	1	3	66.67	33.33	

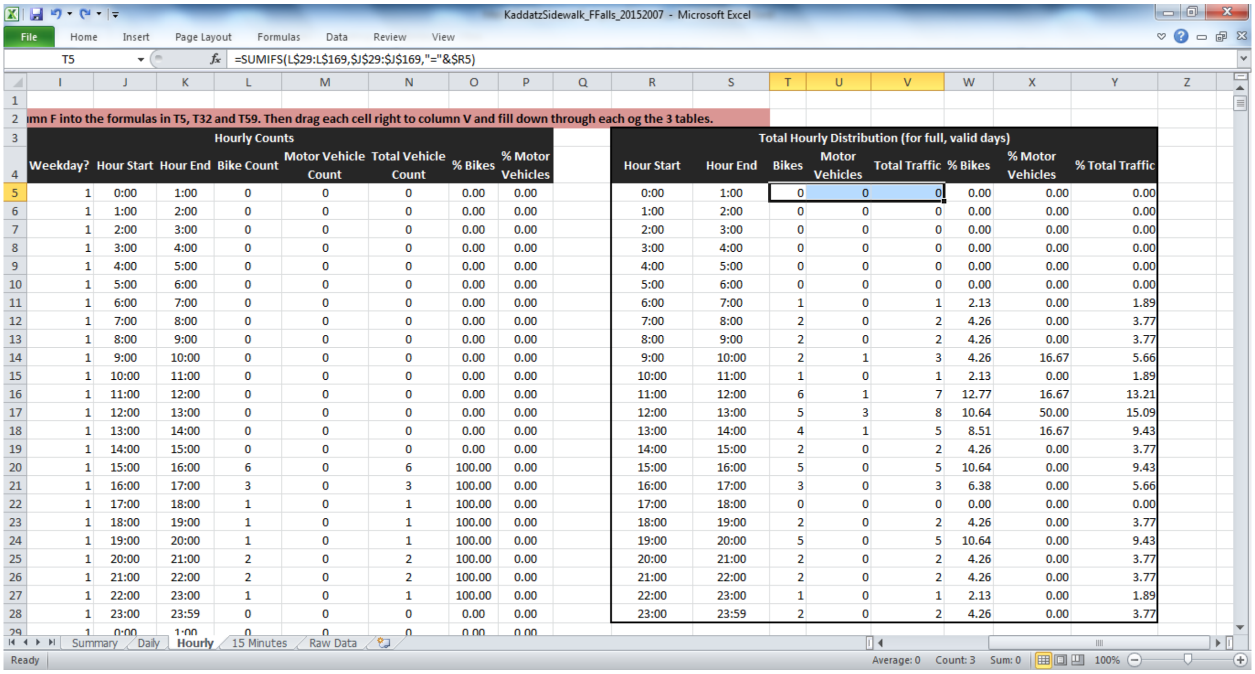
2. If the last visible row is NOT the midnight hour of the last complete day of your sample, copy the entire block of data from the last day (all 24 hours between Column H to Column P) and paste it in the first cell in Column H beneath the previous date (shaded cell in graphic below). Repeat pasting the 24 hour blocks of time until the last day of your count sample shows up in Column H.



3. Replace the height of the range with the “last valid row” number in cell T5:



4. Then drag the formula from T5 across to column V and fill down through the table.



Hourly Counts							
Weekday?	Hour Start	Hour End	Bike Count	Motor Vehicle Count	Total Vehicle Count	% Bikes	% Motor Vehicles
1	0:00	1:00	0	0	0	0.00	0.00
1	1:00	2:00	0	0	0	0.00	0.00
1	2:00	3:00	0	0	0	0.00	0.00
1	3:00	4:00	0	0	0	0.00	0.00
1	4:00	5:00	0	0	0	0.00	0.00
1	5:00	6:00	0	0	0	0.00	0.00
1	6:00	7:00	0	0	0	0.00	0.00
1	7:00	8:00	0	0	0	0.00	0.00
1	8:00	9:00	0	0	0	0.00	0.00
1	9:00	10:00	0	0	0	0.00	0.00
1	10:00	11:00	0	0	0	0.00	0.00
1	11:00	12:00	0	0	0	0.00	0.00
1	12:00	13:00	0	0	0	0.00	0.00
1	13:00	14:00	0	0	0	0.00	0.00
1	14:00	15:00	0	0	0	0.00	0.00
1	15:00	16:00	6	0	6	100.00	0.00
1	16:00	17:00	3	0	3	100.00	0.00
1	17:00	18:00	1	0	1	100.00	0.00
1	18:00	19:00	1	0	1	100.00	0.00
1	19:00	20:00	1	0	1	100.00	0.00
1	20:00	21:00	2	0	2	100.00	0.00
1	21:00	22:00	2	0	2	100.00	0.00
1	22:00	23:00	1	0	1	100.00	0.00
1	23:00	23:59	0	0	0	0.00	0.00
1	0:00	1:00	0	0	0	0.00	0.00

Total Hourly Distribution (for full, valid days)							
Hour Start	Hour End	Bikes	Motor Vehicles	Total Traffic	% Bikes	% Motor Vehicles	% Total Traffic
0:00	1:00	0	0	0	0.00	0.00	0.00
1:00	2:00	0	0	0	0.00	0.00	0.00
2:00	3:00	0	0	0	0.00	0.00	0.00
3:00	4:00	0	0	0	0.00	0.00	0.00
4:00	5:00	0	0	0	0.00	0.00	0.00
5:00	6:00	0	0	0	0.00	0.00	0.00
6:00	7:00	1	0	1	2.13	0.00	1.89
7:00	8:00	2	0	2	4.26	0.00	3.77
8:00	9:00	2	0	2	4.26	0.00	3.77
9:00	10:00	2	1	3	4.26	16.67	5.66
10:00	11:00	1	0	1	2.13	0.00	1.89
11:00	12:00	6	1	7	12.77	16.67	13.21
12:00	13:00	5	3	8	10.64	50.00	15.09
13:00	14:00	4	1	5	8.51	16.67	9.43
14:00	15:00	2	0	2	4.26	0.00	3.77
15:00	16:00	5	0	5	10.64	0.00	9.43
16:00	17:00	3	0	3	6.38	0.00	5.66
17:00	18:00	0	0	0	0.00	0.00	0.00
18:00	19:00	2	0	2	4.26	0.00	3.77
19:00	20:00	5	0	5	10.64	0.00	9.43
20:00	21:00	2	0	2	4.26	0.00	3.77
21:00	22:00	2	0	2	4.26	0.00	3.77
22:00	23:00	1	0	1	2.13	0.00	1.89
23:00	23:59	2	0	2	4.26	0.00	3.77

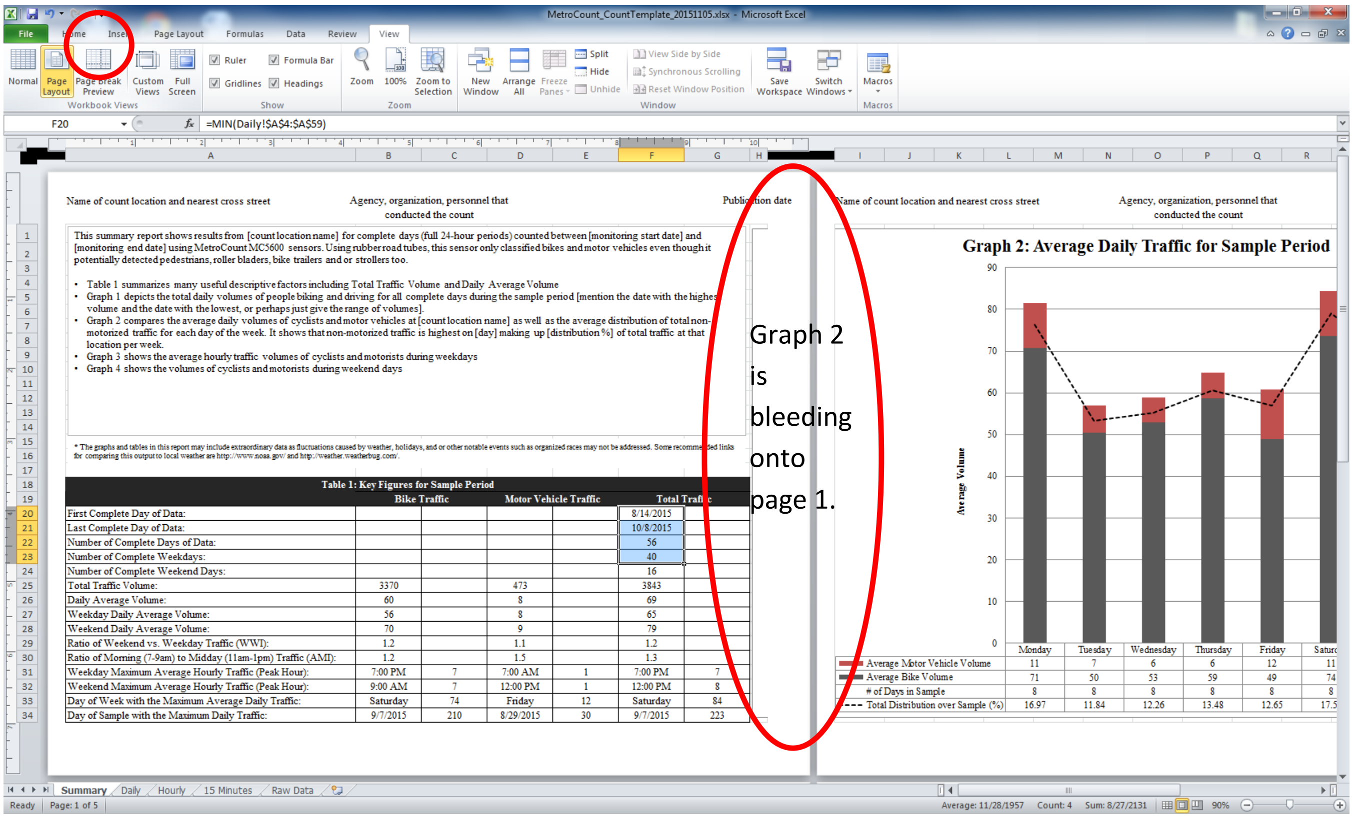
5. Repeat steps 2 and 3 for cells T32 and T59 starting with replacing the height of the ranges with the "last valid row" of data. **EXAMPLE:** The highlighted "2000s" are stand ins and should be replaced with the number of the last valid row: =SUMIFS(F$5:F$**2000**,$C$5:C**2000**,"="&$L5)

"Daily" worksheet (aggregates data into days):

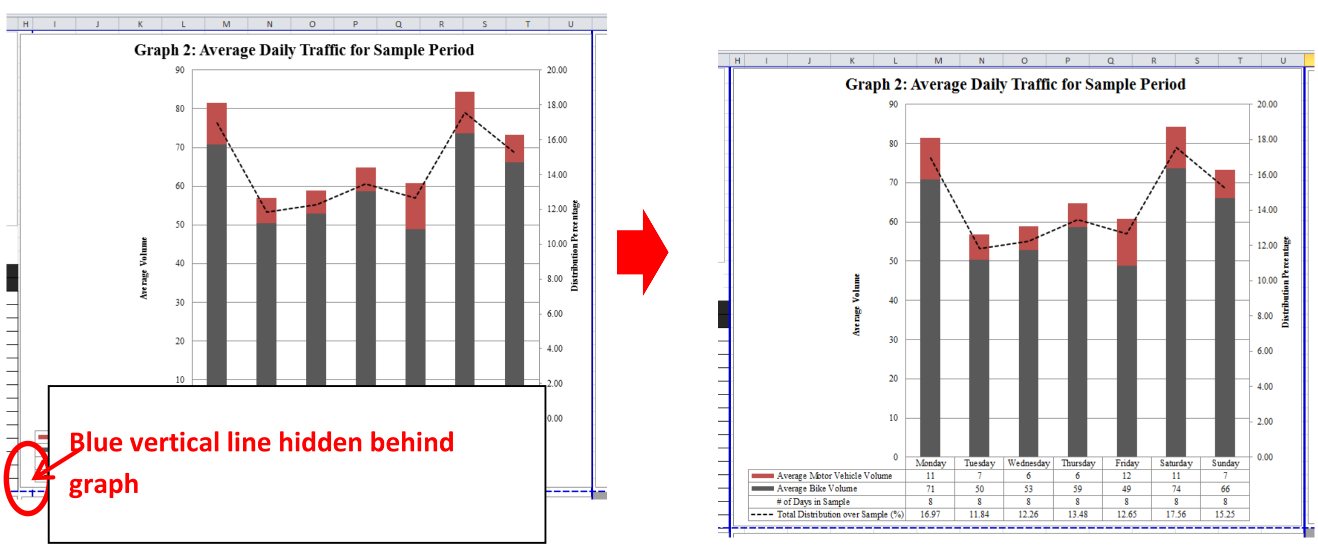
1. Data collected on the day of installation are automatically eliminated, but the days the equipment was installed, taken down and the days after take down must be manually removed from the main table
2. Eliminate incomplete days of data by selecting columns A through M of the rows of with dates when midnight to midnight was not continuously counted
3. Right click and choose "Delete" and then "Shift cells up"
4. The tables and graphs in the "Daily" and "Summary" worksheets will automatically correct themselves based on the changes to this table

"Summary" worksheet (aggregates data into days):

1. If the graphs and table are bleeding onto multiple pages as the picture below shows, click on the "View" tab in Excel, click "Page Break Preview," and then drag the blue dotted lines (both horizontal and vertical) until they box in each of your pages (shown on next page).



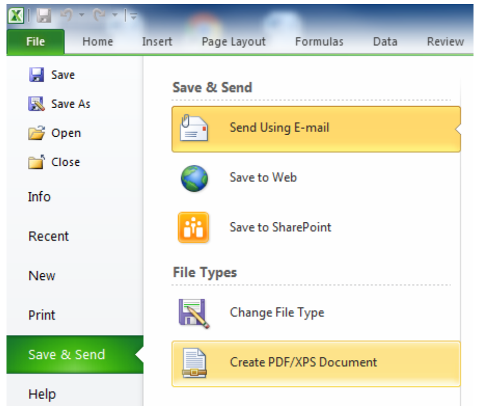
BEFORE **AFTER**



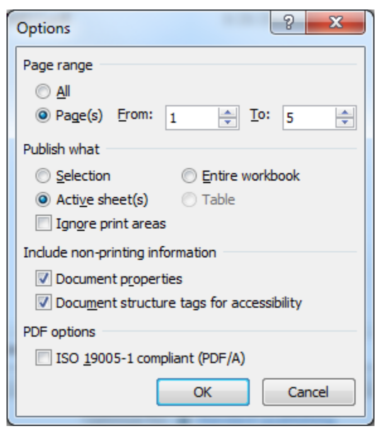
2. Read the prompts in the headers and then replace them with your count details

3. Edit the summary text box so that it addresses the specific collection site, characteristics, and data output.

Saving a PDF copy of your report:



1. Click on the "File" tab in Excel, click on "Save & Send" and choose "Create PDF/XPS Document"



2. When the "Publish for PDF or XPS" window appears, click on "Options" and enter the page range (typically 5 pages but if change accordingly if you customize the template or add extra tables / graphs).

3. Click "OK," name our file and chose a place to save it, then click "Publish"

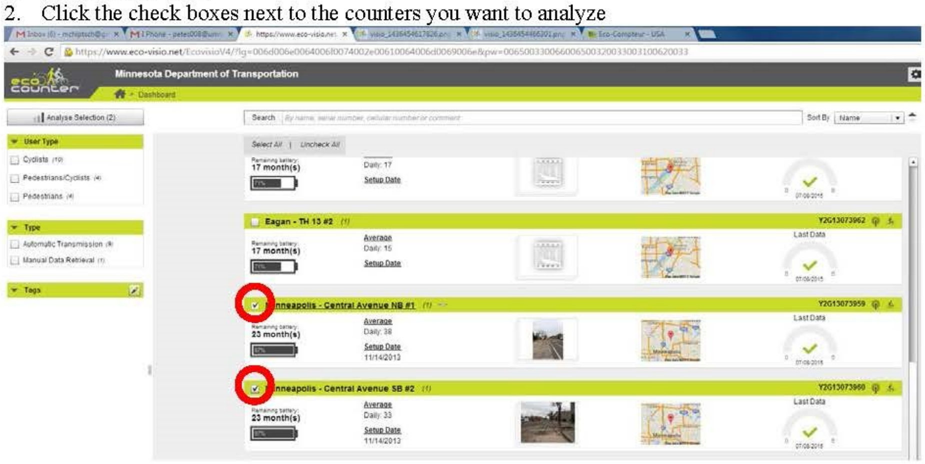
APPENDIX F

INSTRUCTIONS FOR CALCULATING FACTORS IN ECO-VISIO

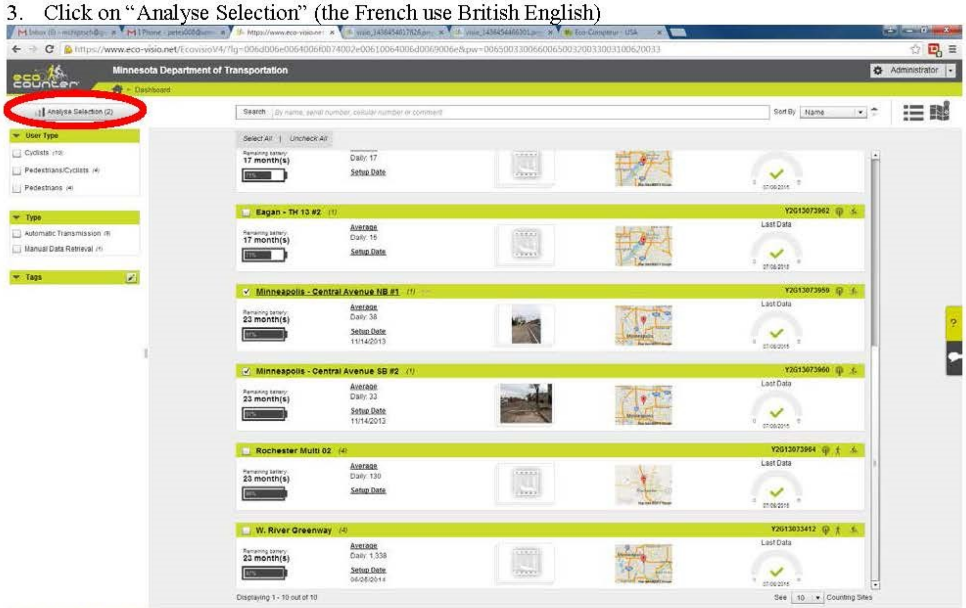
Instructions for Creating Directional factors for One Site with Two Counters Using EcoCounter Data in Eco-Visio

8/4/2015

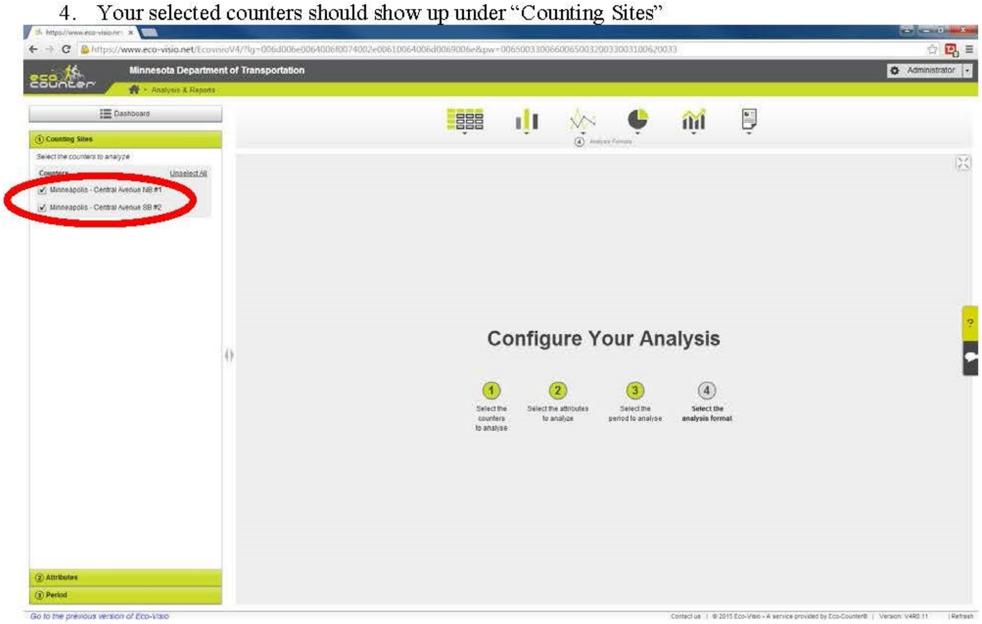
1. Log into Eco-Visio
2. Click the check boxes next to the counters you want to analyze



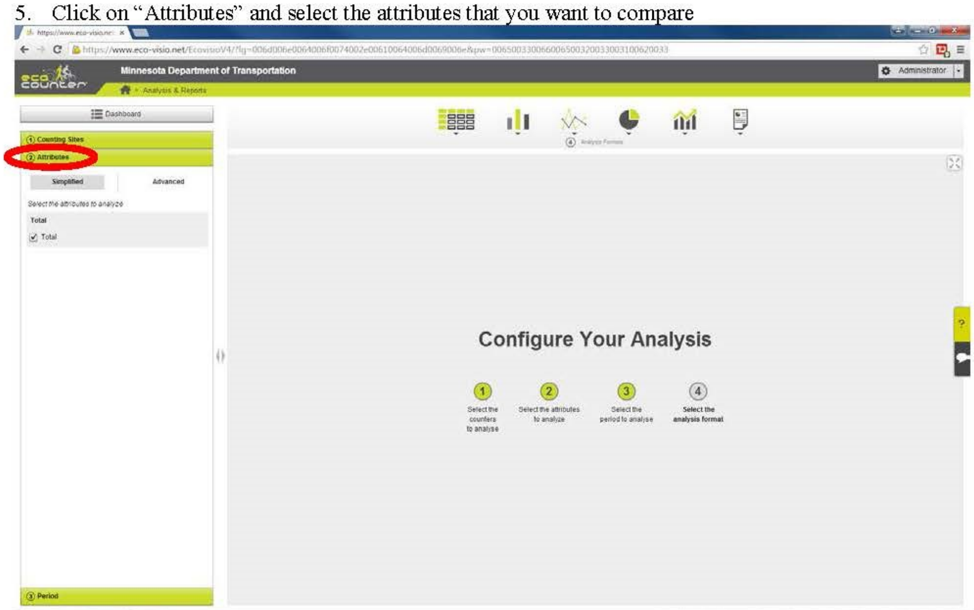
3. Click on “Analyse Selection” (the French use British English)



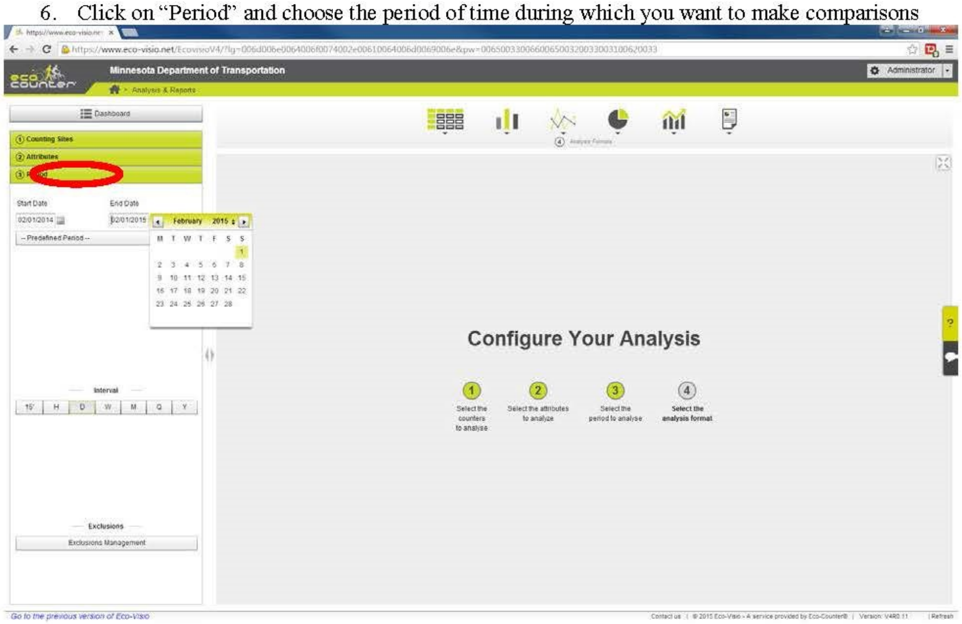
4. Your selected counters should show up under "Counting Sites"



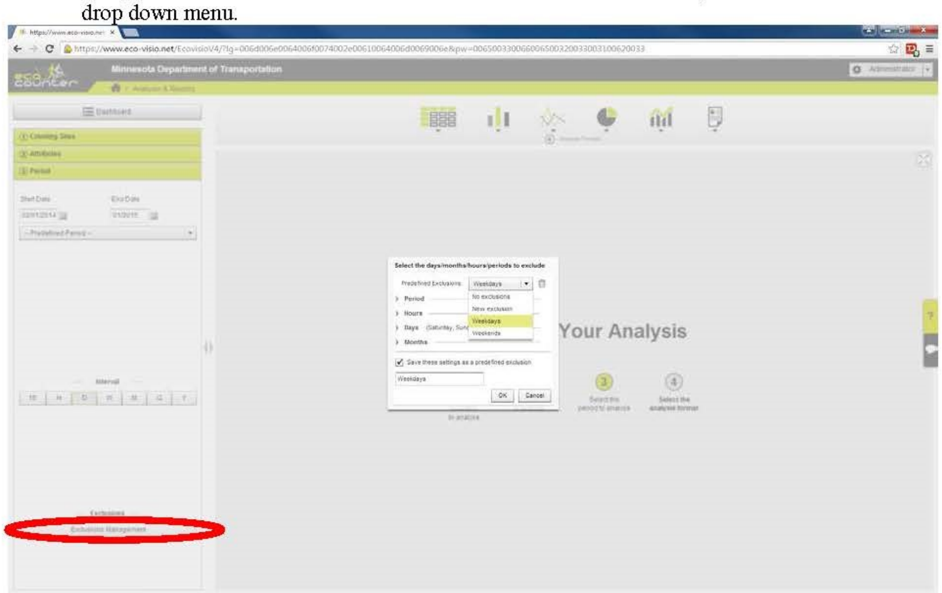
5. Click on "Attributes" and select the attributes that you want to compare



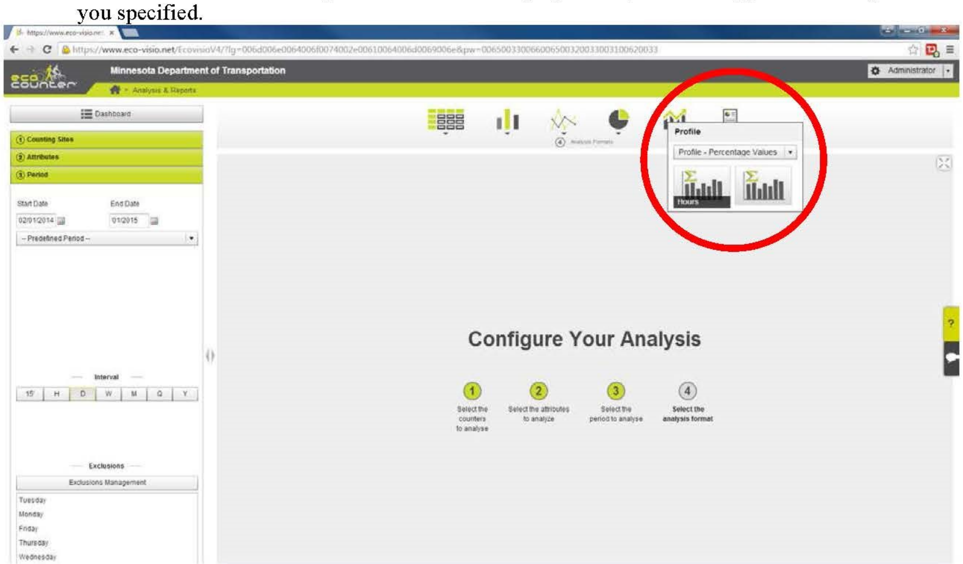
6. Click on "Period" and choose the period of time during which you want to make comparisons



7. Click on "Exclusion Management" and choose the data you'd like to EXCLUDE from the analysis, or choose one of the "Predefined Exclusions" like "Weekdays" or "Weekend" from the drop down menu.



8. Click on the icon at the top and choose "Profile – Percentage Values" from the drop down menu. Then select "Hours" and a graph will automatically be prepared for you showing percent distribution of bike traffic by hour on weekend days (Saturday and Sunday) for the time period you specified.



9. Click on the settings icon and add a title and make other simple edits if needed

10. Click on the  Export icon and “Save as” something, somewhere that you can find again.

11. Repeat steps 1-10 to get the Weekday hourly distributions
12. If you want to get distributions by Month, in the “Exclusions Management” pop-up, exclude every month but the one you want to analyze by.

APPENDIX G
LIST OF MANUAL BICYCLE AND PEDESTRIAN COUNTS IN MINNESOTA

APPENDIX 2: Manual Count Summaries by City 2012-2014

MnDOT Manual Counts				Fall 2012				Spring 2013						Fall 2013				Fall 2014					
City	Number of Times Counted	2013 Population	City Class	Count Locations	Count Hours	Mean Hourly Bike Count	Mean Hourly Ped Count	Count Locations	Count Hours	Mean Hourly Bike Count	Mean Hourly Ped Count	Max Hourly Bike Count	Max Hourly Ped Count	Count Locations	Count Hours	Mean Hourly Bike Count	Mean Hourly Ped Count	Count Locations	Count Hours	Mean Hourly Bike Count	Mean Hourly Ped Count	Max Hourly Bike Count	Max Hourly Ped Count
Alexandria	2	11,580	3	3	18	4	3											2	14	3	4	6	9
Austin	1	24,763	2															5	79	6	6	13	61
Bemidji	1	14,435	3	16	114	11	21																
Blaine	1	60,407	2	2	13	2	5																
Bloomington	2	86,319	2	7	36	7	8											3	18	9	12	15	27
Brainerd	1	13,487	3															7	9	8	27	13	66
Breckenridge	1	3,366	4	3	27	4	10																
Carlton	1	859	4											2	8	10	12						
Cloquet	2	12,050	3	3	48	2	3											3	36	3	7	9	24
Coleraine	2	2,002	4	1	10	1	3							1	10	2	2						
Cook	1	572	4					2	8	2	7	3	18										
Coon Rapids	1	62,103	2	4	14	9	13																
Detroit Lakes	2	8,899	4	3	12	4	20											3	18	2	22	5	43
Dilworth	2	4,124	4	3	18	7	22							2	8	2	2						
Duluth	1	86,128	1	3	36	11	72																
Eagan	2	65,453	2	1	4	18	1											1	6	7	3	11	10
East Grand Forks	2	8,602	4	3	28	8	5	6	98	22	16	76	136										
Edina	1	49,376	2	3	8	5	7																
Faribault	2	23,414	2	1	8	5	27											3	18	8	24	13	36
Fergus Falls	2	13,351	3	3	27	3	21											3	18	7	32	15	69
Fridley	2	27,667	2	5	35	4	17	2	5	4	22	6	75										
Glenwood	1	2,530	4	2	18	1	43																
Grand Marais	1	1,340	4															4	24	2	20	7	39
Grand Rapids	2	10,989	3	4	40	3	7							4	40	3	5						
International Falls	2	6,352	4	3	16	9	14							3	14.25	8	16						
La Prairie	1	671	4											1	10	2	1						
Lilydale	1	873	4	2	4	27	3																
Long Prairie	1	3,381	4	2	12	2	18																
Luverne	1	4,662	4	1	2	4	10																
Mankato	1	40,641	2															4	34	7	11	15	29
Marshall	2	13,483	3	4	15	6	11											6	56	3	6	7	21
Mendota	1	210	4	1	6	65	3																
Mendota Heights	2	11,172	3	1	2	48	9											1	6	28	0	37	1
Moorhead	2	39,398	2											9	36	23	35	4	22	7	6	11	14
Pillager	1	459	4					1	2	1	6	1	6										
Pipestone	1	4,157	4	1	2	7	8																
Princeton	1	4,694	4	3	18	4	8																
Richfield	1	36,175	2	4	22	10	13																
Rochester	2	110,742	1	8	56	13	63											4	24	24	83	42	208
Rosemount	1	22,666	2	4	42	4	10																
Sartell	3	16,277	3	1	2	6	14	1	2	13	15	15	17	1	2	12	9						
Sauk Rapids	4	13,270	3	1	2	15	29	2	4	10	7	19	10	1	2	7	4	1	2	7	1	7	1
South St. Paul	2	20,436	2	1	2	2	35											1	6	6	17	10	28
St. Cloud	4	66,297	2	2	4	6	21	7	14	8	32	25	149	6	12	12	83	7	14	9	94	21	482
St. Joseph	4	6,656	4	1	2	10	4	1	2	6	19	7	21	1	2	3	3	1	2	0	4	0	4
St. Paul (Vento Park)	1	294,873	1	3	6	57	12																
Two Harbors	1	3,666	4	11	56	2	9																
Wadena	2	4,133	4	3	30	3	12	2	26	1	10	4	54										
Waite Park	4	6,664	4	1	1	5	9	1	2	3	8	3	8	1	2	3	5	1	2	5	1	5	1
Walker	2	928	4	2	12	2	16	2	8	0	16	0	51										
West St. Paul	2	19,756	3	1	4	4	46											1	6	3	25	5	28
Willmar	1	19,680	3															5	30	5	20	11	56
Winona	1	27,546	2															8	42	10	27	28	86
Worthington	1	12,943	3															5	34	5	6	15	17
Mean	2	26,050	3	3	20	10	16	2	16	6	14	14	50	3	12	7	15	3	22	7	19	13	57
Median	1	12,497	3	3	14	5	11	2	5	4	15	6	21	2	9	5	5	3	18	7	12	11	28
Max	4	294,873	4	16	114	65	72	7	98	22	32	76	149	9	40	23	83	8	79	28	94	42	482

APPENDIX 2: Manual Count Summaries by City 2012-2014

			Fall 2012					Spring 2013						Fall 2013				Fall 2014					
City Statistics	Number of Times Counted	Population	City Class	Count Locations	Count Hours	Mean Hourly Bike Count	Mean Hourly Ped Count	Count Locations	Count Hours	Mean Hourly Bike Count	Mean Hourly Ped Count	Max Hourly Bike Count	Max Hourly Ped Count	Count Locations	Count Hours	Mean Hourly Bike Count	Mean Hourly Ped Count	Count Locations	Count Hours	Mean Hourly Bike Count	Mean Hourly Ped Count	Max Hourly Bike Count	Max Hourly Ped Count
North Dakota Counts																							
Fargo	1	113,658	1											20	80	12	31						
Grand Forks	1	54,932	2	2	16	23	25																
West Fargo	1	29,878	2											3	12	6	19						

APPENDIX H
GRANT PROPOSAL TO FHWA FOR COLLABORATION WITH LOCAL GOVERNMENTS

APPENDIX H: MnDOT's proposal to FHWA for a small pilot project to support data formatting and submission to TMAS.

MINNESOTA DEPARTMENT OF TRANSPORTATION

Office of Transit and Office of Traffic Data Analysis

PURPOSE

The Minnesota Department of Transportation requests funding for personnel to augment statewide activities to implement bicycle and pedestrian monitoring and to initiate a pilot project with one or more local jurisdictions to collect, summarize, and archive bicycle and pedestrian counts. The long-term goal of the project is to develop and institutionalize MnDOT procedures for collecting and reporting bicycle and pedestrian counts to TMAS, FHWA's national traffic count archive.

OBJECTIVES

The specific objectives for this project are to:

- Format all automated bicycle and pedestrian traffic counts completed by MnDOT in 2013, 2014, 2015, and 2016 in the TMAS data format and submit files to FHWA for inclusion in TMAS. MnDOT estimates that counts were completed at about 90 sites between 2013 and 2015. These include counts at 10 permanent locations and approximately 80 short duration monitoring sites. The number of locations where monitoring will be completed in 2016 depends on local participation in MnDOT's new program to loan portable automated counts to local jurisdictions in each of its eight administrative districts.
- Initiate collaboration with one or more local jurisdictions to collect historic bicycle and pedestrian counts and develop protocols for local jurisdictions to submit data to TMAS. Hennepin County is a likely partner because it is the most populated county in Minnesota and has initiated a program to count bicycles at approximately 60 locations in the County. Other potential partners are the Metropolitan Interstate Council in Duluth, MN (MPO), Arrowhead Regional Development Commission in Duluth, MN (RDC), and the Headwaters Regional Development Commission in Bemidji, MN (RDC). These regional planning agencies collaborated with local jurisdictions to monitor non-motorized traffic in 2015 and have plans to do so in 2016.
- Summarize findings in a brief, technical memorandum for FHWA, including both challenges in collecting and formatting data from local organizations and effective procedures that emerged from collaboration.

For More Information

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