DELAWARE DEPARTMENT OF TRANSPORTATION

Bicycle and Pedestrian Count Program Guide

JUNE, 2016

DelDOT

THIS PAGE INTENTIONALLY LEFT BLANK

TABLE OF CONTENTS

DELDOT COUNT PROGRAM GUIDE

APPENDIX

DelDOT Count Program Guide

This guide provides further detail on most components of the count program—this will enhance the recommendations made as part of the program framework (see final report memo). The intent of this Guide is to equip present and future DelDOT staff with the necessary tools to fully develop the count program. Once the program is up and running, staff may change over time; this Guide catalogs ongoing program activities and procedures which will reduce the need for extensive program training and orientation for onboarding staff. It also provides quick reference to the fundamentals of the program and delineates the established framework and strategy for counting in Delaware. There is some intentional redundancy between the final framework report and this Guide.

TYPES OF COUNTS

There are three basic types of active transportation counts that comprise a robust counting program:

1. recurring, short-duration counts;
2. permanent, continuous counts;
3. special study counts (one-time, or request driven counts)

Each type is described below in more detail in this Guide, though permanent and short-duration counts are covered in more depth as they are the major components of the statewide counting program.

Audience and Life of the Guide

The intended audience for the Guide is staff within DelDOT, its traffic monitoring vendors, and staff of other agencies who are coordinating counts with DelDOT. The Guide is technical in nature and focuses on the first three years of count program implementation. DelDOT will learn a great deal in this short timeframe. This Guide should be revisited after that initial period to consider changes to the count program, such as factor groups, count locations, number of days/weeks for the recurring, short-duration counts, etc.

1 Recurring, Short-Duration Counts

These are locations where counters are placed for 14 to 21 days, as proposed by the DelDOT program, aiming for a full 14 valid count days (consecutive days of uncorrupted 24-hour count data). Typically, counts are conducted at three-year intervals and are completed in routinely scheduled periods between April and November.

Data collected from short-duration counts can be used for a number of purposes:

- Given assigned factor types and a common count period,, recurring, short-duration count data can be compared with count data from permanent, continuous sites of the same factor group to extrapolate annual figures (annual average daily traffic, or AADT). This vastly expands the reach of the count program without the need for expensive permanent infrastructure.
- Tracking changes in volume and distribution over time (benchmarking)
- Establishing travel patterns to address location-specific planning and operational needs
- Evaluating the impact of network or infrastructure changes on travel volumes over time

The Count Program Strategy memo identifies an initial suite of ten short-duration counts per year to be rotated on a three-year schedule (30 pedestrian and 30 bicycle count locations over a full count cycle). New locations should be identified and added over time as permanent, continuous installations replace recurring, short-duration count sites or if resources exist to expand the count program.

2 Permanent, Continuous Counts

These types of counts are permanent installations at identified locations intended for continuous monitoring of pedestrian and/or bicycle volumes over time. Data from these counters form the spine of the count program - count locations are assigned a factor group type based on how they represent travel patterns. This allows for the development of annual extrapolation factors that can be applied to short-duration counts from similar factor type locations.[1] Data collected at a permanent count locations expand the understanding of the daily, weekly, and seasonal patterns of non-motorized travel behavior. The collected information can also shed light on the recurring effects of weather factors like extreme temperature or precipitation that have unique influences on pedestrian and bicycle travel. The Count Program Strategy memo recommends that DelDOT eventually reach a total of at least 9 to 15 permanent count installations throughout the state (based on at least 3 to 5 for each initial factor type). DelDOT staff will be called upon to consider additional continuous count locations as the program evolves, based on knowledge gained from a full cycle of recurring short duration counts.

3 Special Study Counts

An additional set of mobile counters is also being recommended to be available upon special request for special studies or for a local community request. These counts, which may or may not establish additional program count locations, would likely include lending equipment to other DelDOT divisions, local communities, counties, or MPOs. Although these counts may be considered one-off or single event counts, there could be a recurring need for request-driven data collection. Examples of these types of count data needs could include the evaluation of a specific area or condition based on a project or safety need.

All efforts should be made to see that these counts align with the protocols established for the DelDOT program to both address quality assurance of the data and allow for potential integration with the count program, where the data collected and site conditions fill a program need.

Agencies requesting counts or borrowing equipment should be strongly encouraged to meet the data collection parameters of the recurring short-duration count sites to increase the likelihood the data will be useful to the count program. In some cases, constraints may not allow for full adherence to the protocol, but the data collected may still have value based on volumes or patterns. In these cases the location could potentially be added to the candidate list for a future recurring short-duration count location.

1 Extrapolation factors are further discussed in the Guide. They are the multiplier used to estimate volumes at different times of year, annual volumes and other inferential values.

IDENTIFYING COUNT LOCATIONS

Screenline vs. Intersection Counts

There are two established types of counts: screenline and intersection. Screenlines count the number of pedestrians or bicyclists crossing an imaginary line along a street or trail and are the basis for the statewide count program. Intersection counts are almost always done manually and include counts of pedestrians crossing each intersection leg and/or counts bicyclists turning left, turning right, or going straight. Intersection counts are useful, however, they tend to be complex and are done for a specific purpose usually as an one-time count. For the purposes of the statewide count strategy, screenline counts are perfectly suited to the DelDOT count program. *Only screenline counts are being recommended for recurring, short duration and permanent, continuous count sites.*

COUNT PROGRAM LOCATIONS

Despite its relatively small geographic area, the state of Delaware has a rich geographic diversity, including urban, rural, and suburban areas featuring residential neighborhoods, commercial corridors, and rural farmland. These areas include popular destinations for walking and bicycling, such as parks, beaches, shopping districts, universities, etc. DelDOT has sought to conduct counts at a variety of locations that provide coverage of this diversity and are geographically representative of the state. Particularly important are the on-street and sidewalk activity patterns due to both the lack of previous data in this area and DelDOT's desire to address needs along the state system.

Identifying Count Location Candidates

For general counting purposes, count locations can be randomly selected or more carefully chosen by identifying locations thought to be representative of the travel behaviors being sought. The types of highway and bikeway facilities and general land usage of the area can be helpful in this identification.

For the purposes of the DelDOT program, 30 locations were identified from a larger pool of candidates to represent various typical conditions across the state and have been recommended and included in the framework report. The selections reflect a variety of contexts and street types within the areas of the state with different land use patterns. Because selection of additional sites will likely be necessary over the life of the program, the short discussion provided below will be helpful for future selections. Some key features to consider when identifying candidate locations include:

- Reliable representativeness of various street and land use types (e.g. local roads and state highways, town centers, urban travel corridors, and cross section of urban, suburban and tourist destinations)
- Reflect key travel routes for bicyclists or pedestrians based on known patterns or destinations
- A cross-section of facility types (on-street bicycle facilities, sidewalks, sidepaths, etc.)
- Placement of locations along key commute or travel routes. (e.g. bike lanes or sidewalks into central business districts, universities, or major attractions, such as a job center or beach). Note: pinch points along the network such as bridges or short-cut connectors can optimize the number of bicyclists or pedestrians using a route.
- Socioeconomic characteristics of the location relative to the state as a whole
- Locations with appropriate site conditions for count devices (elaborated further in the next section)

Extrapolation errors are generally lower when counts are taken at locations or times with higher activity levels.

Because it is still useful to know that a location is infrequently traveled, there is value in choosing a location with unknown levels of walking and bicycling; in the early stages of the program, however, it is more useful to focus on locations that are either known to be busy or expected to be.

For analytic purposes, examining fluctuations in count data will have greater validity with larger data sets and allow for greater likelihood of achieving statistical significance than examination of smaller data sets. After the program has expanded and additional

locations are added, it will be possible to explore other locations with potentially lower counts. At some point there may be a factor type identified for low volume locations, based on better understanding of low-volume travel patterns.

Site-Specific Location Considerations

Once a candidate location is determined to be appropriate, it will be important to perform a more detailed site analysis to determine the most effective placement/installation of counters to ensure both maximum capture of activity in that location and optimal performance of the count technology. Site-specific environmental and design factors will impact counter placement. The critical elements for identifying ideal screenline count locations are outlined below, and further detailed guidance is available in National Cooperative Highway Research Program (NCHRP) Report 797 and the 2013 Traffic Monitoring Guide (TMG).

- Pinch points: Since pedestrians and bicyclists are impacted more by road conditions and can alter their route/direction with relative ease, it is best to choose a location where a bicyclist or pedestrian cannot skip or move around the counter. These spots include bridge and tunnel entrances, a collector road leading into/out of an area, routes parallel to high volume traffic routes, roads that directly link to trails, etc.
- Ideal path (especially for pedestrian counters): Choose a location where pedestrians and bicyclists are more likely to travel.
- Clear path: Choose a location where the pedestrian/bike path is not obstructed, is clearly delineated (usually by bicycle lanes or on wide shoulders), and it is uncommon for motor vehicles to deviate into pedestrian/bike space.
- Avoids interference: Avoid locations where surroundings can impact the counter, such as utility lines for loop detectors, water reflections for infrared counters, and heat vents for thermal counters (see vendor specific instructions for further considerations).
- Sidewalks that are in a constrained environment with good mounting locations for passive infrared (e.g. sign or lamp posts, utility poles, or other fixed objects in the right of way; locations that minimize background interference such as adjacent building face, fence or wall as a back drop).
- Bike lanes or shoulders that are adjacent to fixed objects that can be used to secure (lock) the counter and locations that minimize the likelihood of automobile traffic obstructing the tubes or places where bicyclist may swerve to avoid the counter.
- Avoid locations where congregating or waiting may obstruct counting (bus stops, driveways, building entrances or plazas).
- Tubes should be placed in locations of continuous movement away from intersections or stopping points that will reduce the effectiveness of the sensor.
- Consider locations that make it easy to mask or conceal equipment to avoid conspicuity that could lead to tampering, vandalism, or theft. If possible, use locations where activity increases the eyes on the street to discourage mischief.

SUPPORT FROM LOCAL PARTNERS

Selection of candidate count locations should primarily focus on meeting the needs of the statewide count program. However, there may be opportunities to expand the range of locations through participation of local partner agencies, who seek to expand the depth of local data collection. The value of these partnerships may have more to do with increasing overall data collection, coordination and understanding and may be less valuable as a means of providing counts that can be directly and reliably assimilated into the DelDOT count program.

Support for counting at the local level will benefit the count program by creating opportunities for increased resource participation and localized knowledge. A local partner can lend insight to the most used walking and bicycling routes, can confirm that counters are continuing to function properly, and can use collected information to reach out to others in the community regarding other active transportation planning efforts.

In some situations, a local partner might even be willing to set up and retrieve a counter if it is being used as a short duration count location.

In other cases, a partner may seek to develop a local count program and find it advantageous to take advantage of the DelDOT experience and replicate the DelDOT protocols at the local level. This type of initiative should be encouraged, even if the data are not shared since there will be better consistency in the data that are developed and increase uniformity of data standards that are sorely lacking.

One possible strategy is to encourage DelDOT and local communities to "consider counts in every project" resulting in the installation of permanent, continuous counters with key bicycle and pedestrian projects. The cost of installing counters for a major project or even a routine resurfacing project can be easily absorbed into the overall project budget and result in rapid expansion of data collection.

FACTOR TYPOLOGY

Factor groups are an important concept in active transportation counting that allows for extrapolation of short-duration counts to longer term figures. Factor groups are derived from locations that consistently demonstrate similar hourly and day-of-week travel behaviors based on common location characteristics and demographics. The data from all locations within one factor group are averaged together by day of week/month/year to create an average that can be applied to short duration counts of the same factor group for a more robust extrapolation of annual estimates of travel.

For the purposes of DelDOT's count program strategy, an objective method was used to help identify the factor groups using data from the pilot program at multiple locations. The method uses two metrics:

- WWI – Weekend traffic volume divided by weekday traffic volume
- AMI – morning peak (7-9am) traffic volume divided by mid-day (11am-1pm) traffic volume

Analysis of these two variables has led to identification of three general factor groups based on comparing the hourly traffic and weekday vs. weekend travel patterns:

	High AMI	Low AMI
Low WWI	Dual Peak	Mixed
High WWI	Mixed	Single PM Peak

- **Factor Group A:** characterized by the notable dual peak (AM and PM), this group generally follows standard commuting patterns that emphasize weekday and traditional peak travel times (am/pm peaks). This group will generally have higher weekday traffic volumes than weekend, and higher morning traffic volumes compared with the mid-day.

- **Factor Group B:** characterized by the single PM peak, this group generally reflects off-peak or non-commuter patterns and often has a single traffic volume peak in the afternoon. This group will generally have higher weekend travel volumes than weekday, and high mid-day traffic volumes compared with the morning volumes.

- **Factor Group C:** has mixed characteristics and does not generally indicate a Dual or Single PM Peak travel pattern. AM or PM peaks in this group may occur, but are not as distinct compared with the mid-day travel activity. This group will also likely cover many of the low-volume count locations where the patterns are less discernible.

To determine a location's factor group a rule of thumb has been established. The Factor Group classification is determined when the location first meets the following criteria, considered in this order:

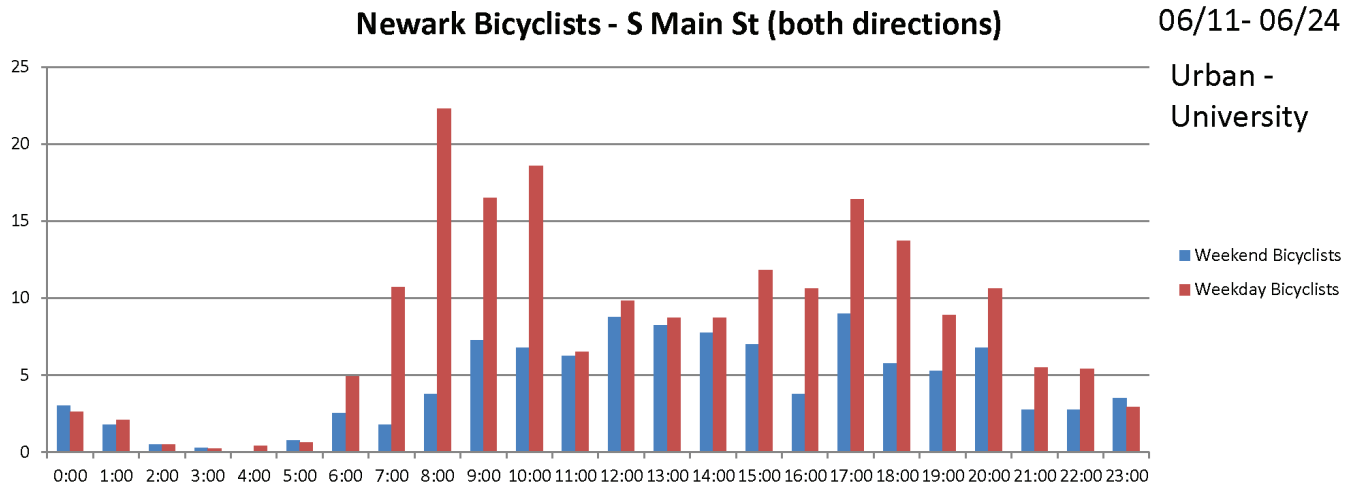
1. If AMI > 0.6, then the factor group is Dual Peak and Group A.
2. If WWI >= 1.2, then the factor group is Single PM Peak and Group B.
3. If WWI <= 0.8, then the factor group is Dual Peak and Group A.
4. If the location meets none of the previous criteria, it is Mixed and Group C.

A spreadsheet tool has been created to help DelDOT determine into which factor group a count location's data falls. Downloaded count data may be input directly into this spreadsheet which will calculate the WWI and AMI ratios.

These three factor groups are based on initial analysis of the limited data from the pilot and year one of data collection, and focus on hourly and day-of-week patterns that are not representative of all possible pedestrian and bicyclist travel patterns that will be captured by the count program. Over time, additional factor groups will be defined as additional distinct travel patterns are identified. For instance, it is likely that factor group C, the Mixed factor group, will divide into Mixed-Dual Peak and Mixed-Single PM Peak factor groups. Additionally, altogether new factor groups may be defined as different transportation patterns emerge. This may include special factor groups that reflect late-night travel patterns, seasonal patterns, or distinct mid-day peak patterns reflecting a high level of lunchtime walking and bicycling.

Data from the pilot program show that the majority of locations where data was collected are categorized as either group A, characterized by the Dual Peak or, group B, and characterized by the Single PM Peak. Although DelDOT should install permanent counters for all factor groups, DelDOT can prioritize which permanent counters to install first. It is recommended that, if feasible, DelDOT install permanent, continuous counters for the Group A locations first, then the Group B, followed by the Group C, or mixed factor group.

As the program matures and the initial set of factor groups is established, DelDOT should conduct a new analysis in 2019 or 2020 to consider counter additions and changes to its factor group categories. When the 2016 to 2018 recurring, short-duration count data have been collected and are ready to be expanded to annual counts, DelDOT should proceed carefully going through all of the necessary steps.



Bicycle travel varies by time of day and day of week

COUNTER PLACEMENT AND SET-UP

General Set-up Guidance

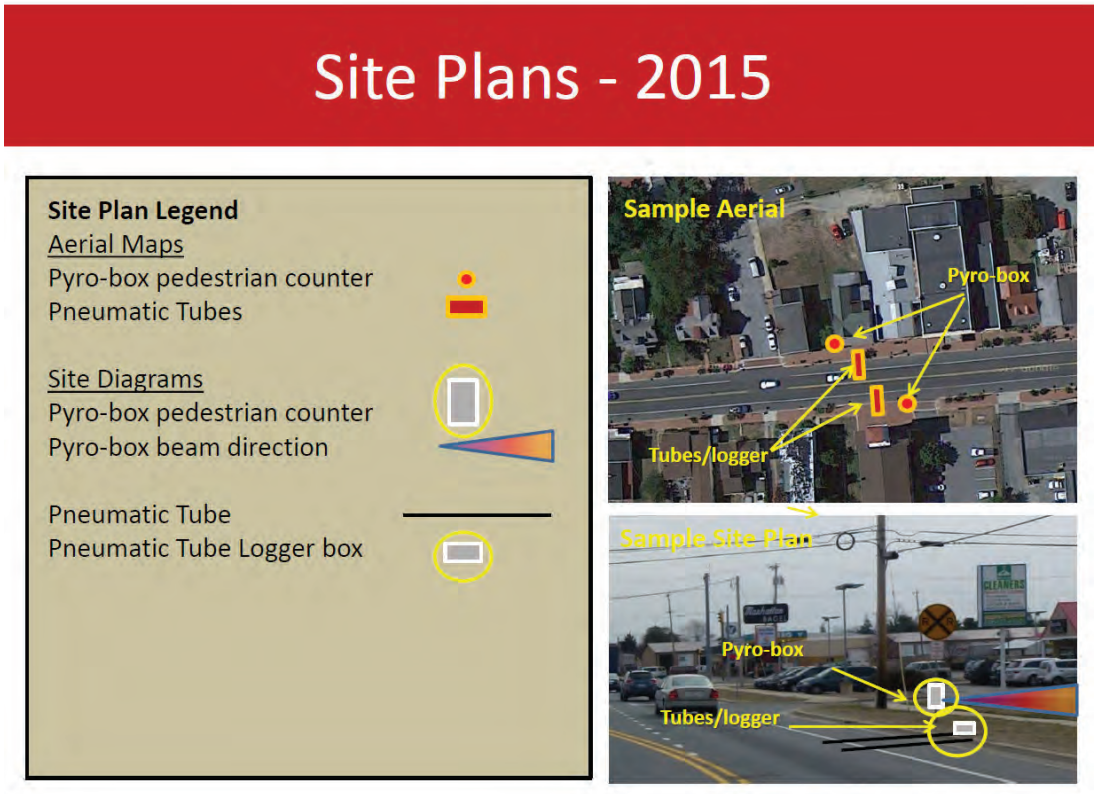
Creation of Site Plans

Every count site needs a detailed site plan for counter placement. Location considerations are outlined in the section below and should be consulted when choosing a count site and subsequently a specific location for the counter(s) at that site. The count program administrator should reference the site plans created for the 2014/15 pilot locations. A sample site plan from Newark is appended to the end of this memo, and the full range of pilot site plans has been provided to DelDOT. A simple overview site plan is provided as Figure 1 with a photo of the S. Main Street pyro box set-up in Smyrna.

These plans are designed with the installer in mind so he/she may use them in the field to properly place counters. The placement of counters is critical to ensuring an accurate count so all pedestrians and bicyclists passing the count location are captured. Site plans should be drafted while in the field at the count location and finalized after.

The count team should capture critical site information, such as the location of poles and trees as reference points, and the location of posts and poles that will be used for affixing counters. Photographs of the site should be taken, cataloged and overlaid with a diagram showing counter placement for the site plan. Prior to conducting field visits, aerial imagery and Google Street View photography should be used to assess the site for the best installation points for counters, which can be confirmed on the ground.

FIGURE 1: Simple overview of example site plan



Counter Installation/Retrieval Checklist

A checklist for counter installation has been created that will guide the installer through documentation of the counter placement. This verification of installation should be kept on file so it may be updated upon counter retrieval to document the state of the counter and site at the end of the count. Separate checklists are provided for pyro box and pneumatic tube counters (See Figure 3 for an example; a set of checksheets are in the appendix). This checklist includes documenting the installation with photos, so installation teams should be equipped to do so. Photographs will allow the retrieval team to note any differences when the counters are retrieved, e.g., damage, misalignment, etc.

A checklist has not been created for installation of permanent counters, but this could be done in the future once permanent counters are part of DelDOT's program. Their placement would require documentation of slightly different information from the recurring, short-duration counters.

Follow-up to Site Installation

While the site plans and installation checklist will ensure proper installation of counters, unforeseen circumstances may create issues for the count during counter deployment. The count team at DelDOT should anticipate the need to monitor count data as a routine part of the ongoing program.

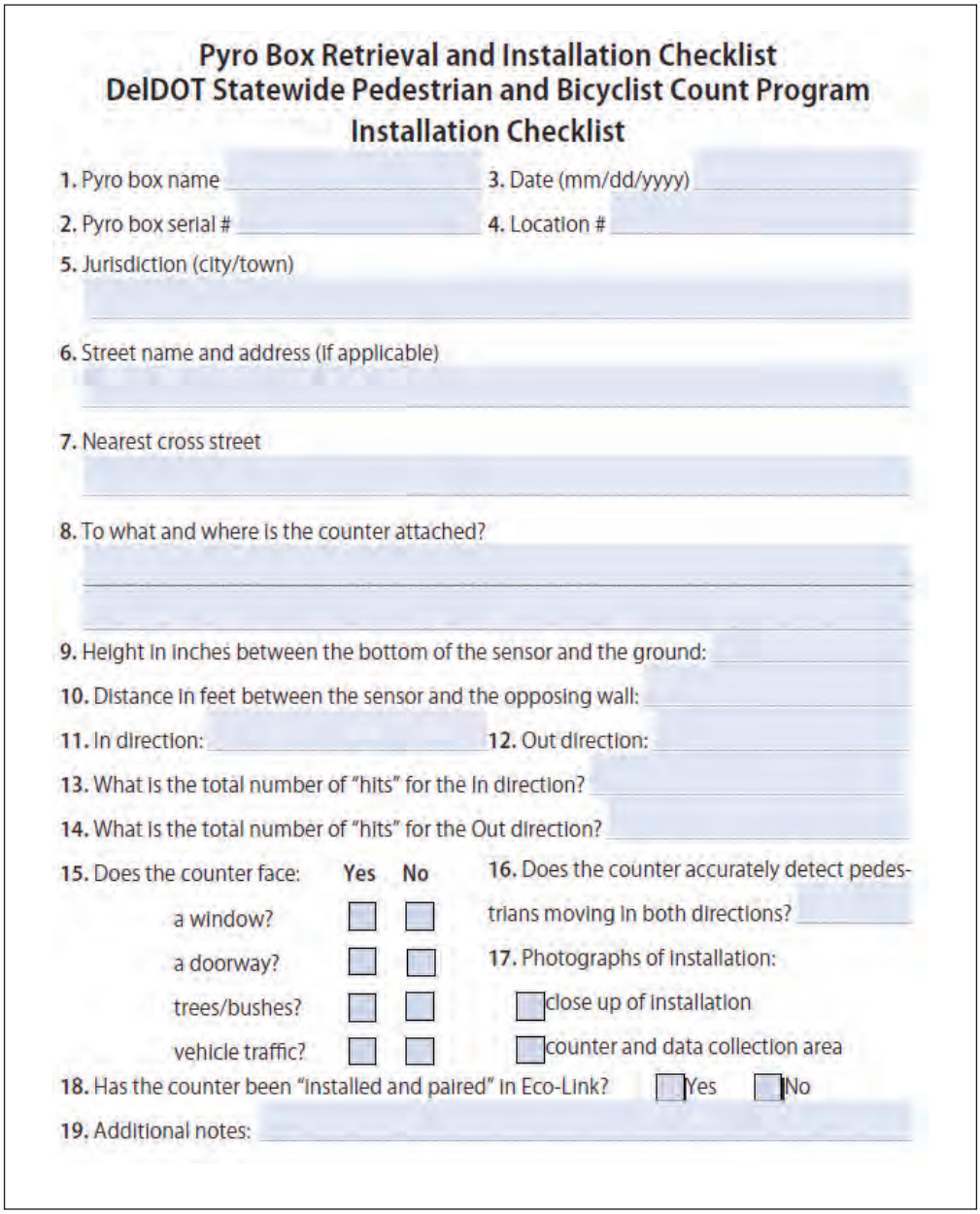
In addition to field validation that newly installed counters are functioning properly (using a notebook with Eco-Visio software to allow for direct monitoring of performance in real time), count data should also be monitored and evaluated remotely during active deployment. For recurring short-duration counts, a quick check of the web uploaded data should be performed each work day if possible to minimize the duration of any corruption of data. For permanent, continuous count locations, this check should occur weekly year-round.

FIGURE 2: Photo of pyro box set-up

When checking data, staff should be vigilant for any significantly odd deviations in the totals (continuous counts of zero at known active locations, spikes of unreasonably high numbers, etc.). Diligent monitoring of the equipment will greatly reduce the likelihood of missed or corrupted data collection and minimize disruption to the data collection calendar.

In addition to the monitoring, the data administrator can set up automated alerts or flags for unusual data reports using the Eco-Visio settings. This creates a secondary alert to unusual outcomes that may indicate issues with the equipment or count site. Finding these errors quickly will enable DelDOT to send a staff member to fix the counter(s) and miss minimal count days in a deployment. At times, some errors may be automated or related to transmission and remedied through customer support with the vendor. Always contact the vendor about an error prior to making a trip to the field, as the solution may not require a field visit.

FIGURE 3: Checksheet for Counter Installation



Pyro Box Retrieval and Installation Checklist
DelDOT Statewide Pedestrian and Bicyclist Count Program
Installation Checklist

1. Pyro box name _____ 3. Date (mm/dd/yyyy) _____
2. Pyro box serial # _____ 4. Location # _____
5. Jurisdiction (city/town)
6. Street name and address (if applicable)
7. Nearest cross street
8. To what and where is the counter attached?
9. Height in inches between the bottom of the sensor and the ground: _____
10. Distance in feet between the sensor and the opposing wall: _____
11. In direction: _____ 12. Out direction: _____
13. What is the total number of "hits" for the In direction? _____
14. What is the total number of "hits" for the Out direction? _____
15. Does the counter face: Yes No
    a window? ☐ ☐
    a doorway? ☐ ☐
    trees/bushes? ☐ ☐
    vehicle traffic? ☐ ☐
16. Does the counter accurately detect pedestrians moving in both directions? _____
17. Photographs of installation:
    ☐ close up of installation
    ☐ counter and data collection area
18. Has the counter been "installed and paired" in Eco-Link? ☐ Yes ☐ No
19. Additional notes: _____

Specific Guidance

The pilot counts conducted in 2014 and 2015 used Eco-Counter brand count equipment. This section details considerations and lessons learned for the installation of each counter type.

Pyro box counters consist of a single box with Length – 12"; Width – 8"; Depth – 4". These units, generally mounted to a fixed post, use passive infrared beams that capture pedestrians and bicyclists crossing perpendicular to the counter's face. The pyro cannot distinguish between bicycles and pedestrians independent of other technology (combination of a loop detector or tubes to classify bicycles), but does track the direction of travel (logged as "in" or "out" – should note direction placement during each install). Ideal locations for these counters are along a path or sidewalk 6 to 10 feet in width with an opposing blank wall. If no wall is available for background, the sensitivity of the counter should be tested, including the distance to which the counter detects pedestrians and bicyclists. The following considerations should also be taken into account:

- Avoid pointing sensors at windows
- Avoid putting counter in direct sunlight
- Aim sensor to be perpendicular to pedestrian traffic direction
- Avoid pointing at building entrances
- Never point sensors into road traffic

The pyro box comes with installation hardware included, both an adjustable metal collar, and a bracket and screws can be used to secure the mounting bracket with relative ease. Ideal locations include round lamp-posts or utility poles that facilitate the use of the adjustable metal collar. When using the adjustable metal collar to install on locations with painted finishes, it is a good idea to use padded insulation tape to avoid damaging the finish. Where only metal sign posts or other thin posts are available, the installation will require using the metal bracket and screws, which are tamper-resistant when installed correctly. The installation generally takes around 15 minutes, but may take longer, especially if using the bracket and screws.

Boxes should be placed as close to 30 inches from the ground as possible, and careful attention should be given to the orientation of the mounting plate and direction of the beam (the sensor can be switched to cast the beam in either direction from the box). It is also good practice to take field notes and always indicate the orientation of the beam in relation to the sensor "IN" and "OUT" reading (labeled on the sensor). Boxes should be mounted right side up, but can be inverted where needed. The units cannot, however, function properly when mounted sideways as the beams are ineffective side-by-side. Always have on hand and consult the detailed installation instructions from the vendor when performing installations.

Eco-Counter Pyro Boxes

Pyro box installation

Eco-Counter Pneumatic Tubes

Pneumatic tube set-ups consist of two tubes and a counter box and are used to count bicyclists only. The Eco-Counter Tube system includes two variations of tubes: the first, the traditional pneumatic tube, is appropriate for trails, paths, or any bicycle-only locations, the other, the mixed-traffic tube, is intended for on-street use. These are special tubes that have a slightly larger profile but allow for the sensor to differentiate bicycle from motor vehicle traffic, provided the sensitivity settings are correct (See Eco-Counter instruction manual for more details about the tubes and settings).

The tubes must be affixed to the ground and the box locked to a post for security. The tube spacing should closely adhere to a 12-inch spacing perpendicular to the path of travel across the extent of the bicycle travel way. A chain (included) should be used to lock the box, and though Eco-Counter provides basic combination locks, they were not found to be sufficient or easy to use. Locks used must fit within the metal case of the counter box. When tubes are installed for on-street applications, installers will need to follow DelDOT safety guidelines for working in an active traffic zone and plan for management of traffic to ensure safety of personnel.

Tubes should be affixed to the pavement using metal anchors (i.e. Chinese finger grips, mesh grips, etc.) that are nailed into the pavement in accordance with vendor instructions. These nails should be placed at a 45-degree angle toward the direction of traffic for best anchoring. The nails and loop can be supplemented using Gorilla tape, which can provide extra adhesion and also help reduce the conspicuity of the tubes. *(ONE CAVEAT–Excessive use of the tape can cause the tubes to become worn or more difficult to work with as the tape will sometimes permanently affix to the tubes.)* A site should be selected which does not require that the tubes cross a sidewalk. If this is unavoidable (e.g., where no post is available for locking the counter box in a buffer between the sidewalk and roadway), the tubes should be completely taped down so they do not create a walking hazard.

Experience with the pilot implementation found significant issues with tubes that were installed into vehicle travel lanes. It is our recommendation that DelDOT avoid the practice of installing tubes into

Eco Logger and Tubes

Measuring for Tube Installation

Installed Tubes

vehicular travel lanes. This guidance conflicts with Eco-Counter prescribed best practices, which suggests installing the tubes into the roadway far enough that bicyclists will not go around them. However, our experience found that regardless of how well attached to the road the tube is, under constant automobile traffic the tubes were prone to loosen and eventually fail during deployment. Untethered tubes can pose safety issues for bicyclists and pedestrians and are more likely to be damaged and unable to be re-used.

Under conditions where the tubes must be deployed into the travel lane (narrow shoulders or shared roadways), they should be installed to extend far enough that the end of the tube is beyond the regular wheel path of passing vehicles. When the tube end is installed on the wheel path, the likelihood of damage and failure of the tube cap is far greater. In these instances careful installation and use of supplemental fasteners and tape are recommended.

Additional Deployment Considerations

The recommended deployment options will generally represent a need to deploy a full set (four counting devices) at each count location. This is generally the case for pedestrians (pyro boxes) and bicycles (pneumatic tubes). This is because each device can only detect bicycles and pedestrians on a single side of a street at a time: one infrared (pyro box) detector on each sidewalk, and one tube counter in each bike lane or on each side of the roadway, shoulder, or mixed vehicle traffic flow. When candidate locations are identified and site plans developed, there may be instances where fewer counters will be necessary based on the site conditions. For example, there may be just one side sidewalk present, or a single bike lane on a one-way street, or a path where just one or two counters are needed. If this does occur, it may provide opportunities to utilize idle count devices for other uses or to perform side-by-side calibration to test the consistency of the equipment. In the near term, it is recommended that DelDOT anticipate using a pair of devices for all count locations.

Prior to the 2016 deployment, researchers are encouraged to analyze data from previous years' deployments in order to establish permanent control count locations. These pilot locations should be seen as representative locations where consistent volumes are expected to occur. The permanent count devices installed may include using permanent infrared devices for sidewalks, but likely need to be an inductive loop for the on-street bicycle locations, since tube counters are only intended for short duration use. Over time, these locations will be useful to track the full impact of temporal and seasonal travel patterns.

DATA MANAGEMENT

Automated counters provide a very detailed account of the number of pedestrians or bicyclists that trigger a count within a certain timeframe. Although this is comprehensive, the data may have errors that will require cleaning or adjustments before it can be used. There are two types of errors that occur when automated counters are used to collect data:

- **Systematic undercounting** – this counting error is inherent to limits of the technology used to collect counts. Occlusion, a common systematic undercounting, occurs when two people walk or bicycle side-by-side past the sensor and are only counted as one person. Another common cause of systematic undercounting occurs when pedestrians or bicyclists travel around the detection zone and are thus "missed" by the counter. Systematic undercounting is addressed by adjusting the count data.
- **Corrupt count data** – this counting error occurs when the count equipment malfunctions as a result of damage or improper installation, or when an external variable, such as a blocked sensor, affects the counter's accuracy. In many cases, corrupt count data can be addressed by substituting data based on the good data from the counter. In some cases the amount of corrupt data may exceed what can be corrected through reasonable substitution, in which case the counts will need to be excluded or collected a second time.

The process described below will help DelDOT remove these data errors for subsequent reporting and extrapolation.

Data Retrieval

The current Eco-Counter equipment being used has the advantage of daily automatic transmission of data via cellular transmission where it is immediately available through the Eco-Visio web portal. This remote transmission is advantageous because it eliminates the need for field data retrieval and allows for quality monitoring of data transmission. Any additional equipment introduced through other vendors may require different levels of effort to export data. This issue should be considered in conjunction with future decisions about additional technologies and vendors used for the DelDOT program.

Routine Data Cleaning

Data cleaning involves the processes in place for performing adjustments for known systematic undercounting based on technology limitations, and/or replacing corrupt data with estimation based on formulas to impute missing values based on good data. In some cases this practice includes omission of data where not enough valid data are collected to allow for reasonable substitutions. As mentioned earlier, the Eco-Counter system used in the pilot program has a function that allows for automatic email notification of count anomalies based on DelDOT prescribed condition parameters. If a counter counts significantly more or less activity than expected, an automated email can be sent to the program manager. An incorrect count should be replaced with an average from similar day-of-week and time-of-day counts. For short-duration counts, data from the installation and removal days should not be included in final count data to ensure that all reported data are limited to valid days of full 24-hour collection.

Data Adjustment

Adjusting refers to using a correction factor to account for systematic undercounting based on the limitations of the technology. In addition to occlusion and missed pedestrians and bicyclists, counts can also be influenced by extreme heat or cold that impacts sensor accuracy. All counter technologies will have different levels of accuracy. Accuracy is less important than precision. It is more important to measure magnitudes of change over time instead of the most accurate count. Therefore it is more important to use count technology that consistently performs in the same fashion. Over time consistently observed correction factors for specific devices or technologies will reduce the need to observe and update correction factors.

Correction factors are developed through comparing a manual count to counter-produced data. Ideally, this count is performed over a six-hour period. Time synchronization of the counter should be performed in conjunction to ensure observation and recording reflect the same period (this can also be performed by visually monitoring the recording of the device on-site with use of a laptop equipped with the Eco-Visio software). Each permanent counter should have one to two manual verification counts per year, and short-duration counters should have one. An average percentage deviation will be calculated from comparison of the manual and counter counts.

Correction and adjustment factors are not always used in active transportation counting. Limited resources and staffing can make manual confirmation counts infeasible. DelDOT may choose to forgo the application of adjustment and/or correction factors, which are still good practices, provided the reported data clearly indicates these steps were not performed when sharing the data.

Monitoring the device on-site

DATA EXTRAPOLATION AND FACTOR GROUPS

The framework of the recommended pedestrian and bicyclist count program uses a small number of permanent continuous counts (9-15 permanent counters) and a larger number of short-term counts (30 initial short-term count locations, 10 counts per year). This framework lends itself well to using the permanent counters as reference, or indicator locations, based on the identification of the three factor groups described in the Factor Typology section of this guide.

Traditionally, transportation volume estimates use two scaling factors to extrapolate a short-term count into a yearly volume estimate: a month-of-year factor and a day-of-week factor. Month-of-year is the ratio of average monthly traffic to AADT and day-of-week is the ratio of average day week traffic to AADT. Recent research has shown that this practice, although a standard for automobile count extrapolation, does not account for the greater variability in active transportation (Hankey, 2013).[2] Conceivably one day counts can be generated that use a day-to-year scaling approach to estimate yearly pedestrian and bicyclist volumes. The day-of-year approach uses a specific scaling factor for each day of the year, comparing the volume of a single day's active transportation volumes to that of the entire year's volume. While this approach can account for much of the variability of walking and bicycling, such as weather or holidays, the approach recommended for DelDOT uses a more conservative, two week count timeframe for its recurring short-duration counts. That specific two-week timeframe is then scaled to the year.

To use the two-week approach, it is recommended that DelDOT collect two types of information, the first of which is pedestrian and bicyclist counts at recurring, short-duration locations. The second piece of information is the yearly volume data from the permanent, continuous counters that will be used as the baseline to extrapolate the recurring, short-duration count.

It is recommended that DelDOT extrapolate the recurring, short-duration counts using long-term volume patterns at locations that are in the same factor group.[3] The recommended three permanent counters per factor group will provide a robust baseline for use in scaling. An average of the annual volumes for each counter is then used as the volume comparison for the extrapolation.

Data Sharing and Reporting

Once the data have been adjusted and cleaned of erroneous counts and they are ready to be shared and reported. This information has also been included in the final report (recommended counting framework).

Intra-agency Data Sharing

Once data are cleaned and in a state to be understood by parties outside the count program, they should be made available to pertinent divisions throughout DelDOT. The raw count data are immediately available to those with password access to the website. This access should be limited to the person(s) who will perform the initial quality control including identifying corrections and cleaning the data. It will be important to define how the data are made available to internal and external parties to ensure that common and consistent data are being used for whatever purposes.

It is recommended that DelDOT only publish data that includes the routine correction factors, as well as data corrected from corrupt periods or omissions, and include the specific correction factors used and to which data they are applied. For longer periods of missed or corrupted data, it may be more appropriate to exclude these data periods and publish the counts with missing data periods to ensure the integrity of the published data. Decisions about this should be based on staff confidence in the reliability of the corrections applied.

It is imperative that all users understand the nature of the data and inherent limitations, particularly regarding edited versus raw data. This transparency in how the data are collected and edited will increase

2 Hankey, Steve; Lindsey, Greg; Marshall, Julian. "Day-of-Year Scaling Factors and Design Considerations for Non-motorized Traffic Monitoring Programs." Transportation Research Board Annual Meeting, 2014.

3 Transportation Research Board of the National Academies. National Cooperative Highway Research Program, Report 797, Guidebook on Pedestrian and Bicycle Volume Data Collection. 2014

the integrity of the data. Some agencies or researchers may wish to obtain raw data for purposes of study or analysis. Raw data should not be routinely distributed, but should be made available upon request, provided the user is informed of the limitations of the raw data. Informal or formal collaborations may naturally be formed with researchers who may provide meaningful insights into data anomalies.

These published data should be provided to relevant sections within DelDOT, including planning, operations, traffic monitoring, and modeling sections. It may be valuable to develop routine internal reports to summarize the data collected and provide easy reference to the latest numbers. For instance, other DOTs have applied the use of their count data to evaluate TAP applications. Estimates of use for proposed projects are either generated or verified based on count data from count locations with the same basic land use and population density characteristics.

Public Data Sharing

An online data dashboard or web portal is recommended for public-facing data sharing. Currently DelDOT is using the Eco-Visio website, which could be linked from the DelDOT Dashboard. Both raw data and some basic statistics and reports should be included on the site. Shared public data should be in the same cleaned and adjusted state as any data shared internally. They should be made available in downloadable formats in the hourly and daily totals by location, with maps and reports that include the AADBT (annualized average daily bicycle traffic) and AADPT (annualized average daily pedestrian traffic) figures for the program count locations. Adjustment factors and corrections used in that process should be shared publicly to further transparency efforts.

Reports

Annual and special reports are a good way to analyze and share data. Eco-Visio's built-in report feature allows agencies to create a standard reports quickly. The report can include the agency's logo, a photo of the counting site, and two pages of key figures and pertinent graphs illustrating typical weekday and weekend trends. Reports for the two pilot years have been produced and are included in the appendix.

APPENDIX

COMPARISON OF PEDESTRIAN AND BICYCLE COUNT TECHNOLOGY

Effectiveness of various technologies based on site characteristics

There are a variety of methods available to count pedestrians and bicyclists. The project team has been researching these technologies extensively. Based on conversations with the project team, a matrix has been developed to compare some of the most common counting technologies that are in current practice, including passive infrared, active infrared, radio beam, pneumatic tubes, inductive loops, piezoelectric sensor, radio beam, and automated video.

The existing market technologies offer a wide variety of costs and functionality that need to be considered when identifying appropriate technology for the program data collection goals. There are a number of key questions that help better inform which technology is most appropriate:

- Who will be counted?
  (e.g., pedestrians, bicyclists, both)
- What types of sites will be counted?
  (e.g., sidewalks, trails, roadways bike lanes, wide shoulders or mixed traffic)
- What characteristics will be collected?
  (e.g., simple volumes, direction of travel, gender, behavioral characteristics)
- For what duration and frequency will counts be conducted?
- What resources will be required?
  (e.g., cost of equipment, installation, and maintenance; time and cost of training; lead time to procure and install counting devices; time to clean and analyze data)
- How easy is it to work with the equipment?
  (e.g., durability, theft/vandalism-resistance, assistance from equipment vendors)
- How mobile or portable is the equipment?
  (e.g. ability to move and redeploy devices for multiple locations)

Tube counter secured to pole

Conversations with DelDOT staff have helped identify some key priorities for the pilot data collection program, including a focus on data collection along the street network (both on-street bike lanes and sidewalk locations) and optimizing deployment by using portable devices to monitor numerous locations for short durations.

The matrix on the following page includes a comparison of these technologies based on factors deemed relevant to the DelDOT pedestrian and bicycle count program. The passive IR detector and pneumatic tubes are highlighted as suggested technologies for conducting sidewalk counts and on-street bicycle monitoring, respectively.

	Type of Users Detected				Types of Sites				
Characteristic	All People	Pedestrians vs. Bicyclists	Bicycles vs. Automobiles	Bicycles Only	Shared Use Path	Sidewalks	On-Street Bike Lanes	On-Street Shared Lanes (mixed traffic)	
Automated Video	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
Manual Counts	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	
Passive Infrared	Yes				Yes	Yes			
Active Infrared	Yes				Yes	Yes			
Pneumatic Tubes			Yes	Yes	Yes		Yes	Yes	
Inductive Loops			Yes	Yes	Yes		Yes	Yes	
Piezoelectric Sensor				Yes	Yes		Yes		
Passive IR + Inductive Loops	Yes	Yes		Yes	Yes	Yes			
Radio Beam (single frequency)	Yes				Yes	Yes			
Radio Beam (multi-frequency)	Yes	Yes		Yes	Yes	Yes			

Other Features

	Direction of Travel	Appropriate Duration of Count	Portability	Site Preparation	Installation	Notes
	Yes	Short (1 to 7 days)	High	Minimum	Quick/some equipment mounting	High cost automated or manual reduction of results
	Yes	Short (2 to 12 hours)	Very High	Minimum	Quick/No special equipment	Requires specific protocols and training for count staff/volunteers
	Yes	longer duration (2 weeks to continuous)	High	Some	Quick/some equipment mounting	Sensitive to ambient background temperatures (uses human heat signature for detection).
	Yes	longer duration (2 weeks to continuous)	Moderate	Some	Quick/some equipment mounting	Requires mounting sender and receiver on opposite sides of travel way
	Yes	Short duration (several days to a month)	High	Some	Quick/some equipment mounting; staking tubes	Sometimes prone to vandalism, or avoidance where tubes are installed conspicuously
	Yes	Permanent installation continuous counts	Low	Significant	Complex; require special equipment/ contractors	Generally only useful for permanent count location; temporary surface loop detector technology is available
	Yes	Permanent installation continuous counts	Low	Significant	Complex; require special equipment/ contractors	Not widely used, product availability may be limited
	Yes	Permanent installation continuous counts	Low	Significant	Complex; require special equipment/ contractors	Uses combination of IR and Inductive loops to distinguish peds/bikes in mixed traffic scenarios - can be accomplished manually by using appropriate combination of suitable devices.
		longer duration (2 weeks to continuous)	Moderate	Some	Quick/some equipment mounting	Requires mounting sender and receiver on opposite sides of travel way; subject to false positives with any object breaking beam (leaves, heavy snowfall, background motion)
	Yes	longer duration (2 weeks to continu-ous)	Moderate	Some	Quick/some equipment mounting	Requires mounting sender and receiver on opposite sides of travel way; subject to false positives with any object breaking beam (leaves, heavy snowfall, background motion)

INSTALLATION AND RETRIEVAL CHECKSHEETS

Pyro Box Retrieval and Installation Checklist
DelDOT Statewide Pedestrian and Bicyclist Count Program
Installation Checklist

1. Pyro box name _____ **3.** Date (mm/dd/yyyy) _____

2. Pyro box serial # _____ **4.** Location # _____

5. Jurisdiction (city/town)

_____

6. Street name and address (if applicable)

_____

7. Nearest cross street

_____

8. To what and where is the counter attached?

_____

_____

9. Height in inches between the bottom of the sensor and the ground: _____

10. Distance in feet between the sensor and the opposing wall: _____

11. In direction: _____ **12.** Out direction: _____

13. What is the total number of "hits" for the In direction? _____

14. What is the total number of "hits" for the Out direction? _____

15. Does the counter face:

	Yes	**No**
a window?	☐	☐
a doorway?	☐	☐
trees/bushes?	☐	☐
vehicle traffic?	☐	☐

16. Does the counter accurately detect pedestrians moving in both directions? _____

17. Photographs of installation:

☐ close up of installation

☐ counter and data collection area

18. Has the counter been "installed and paired" in Eco-Link? ☐ Yes ☐ No

19. Additional notes: _____

_____

Pyro Box Retrieval and Installation Checklist
DelDOT Statewide Pedestrian and Bicyclist Count Program
Retrieval Checklist

1. Pyro box name _____ **3.** Date (mm/dd/yyyy) _____

2. Pyro box serial # _____ **4.** Location # _____

5. Is the counter in the same position as it was when installed? If not, what has changed?

_____

6. Is there any visible damage or vandalism to the counter? If so, what?

_____

7. After connecting the counter through Eco-Link, what is the total number of "hits" in each direction? In: _____ Out: _____

8. After removing the pyro box, is there any visible damage to the post/pole it was attached to? If so, what?

_____

9. Additional retrieval notes:

_____

_____

Pyro Box Retrieval and Installation Checklist
DelDOT Statewide Pedestrian and Bicyclist Count Program
Installation Checklist

1. Pyro box name _____ **3.** Date (mm/dd/yyyy) _____

2. Pyro box serial # _____ **4.** Location # _____

5. Jurisdiction (city/town)

_____

6. Street name and address (if applicable)

_____

7. Nearest cross street

_____

8. To what and where is the counter attached?

_____

_____

9. Height in inches between the bottom of the sensor and the ground: _____

10. Distance in feet between the sensor and the opposing wall: _____

11. In direction: _____ **12.** Out direction: _____

13. What is the total number of "hits" for the In direction? _____

14. What is the total number of "hits" for the Out direction? _____

15. Does the counter face:

	Yes	**No**
a window?	☐	☐
a doorway?	☐	☐
trees/bushes?	☐	☐
vehicle traffic?	☐	☐

16. Does the counter accurately detect pedestrians moving in both directions? _____

17. Photographs of installation:

☐ close up of installation

☐ counter and data collection area

18. Has the counter been "installed and paired" in Eco-Link? ☐ Yes ☐ No

19. Additional notes: _____

_____

Pneumatic Tube Retrieval and Installation Checklist
DelDOT Statewide Pedestrian and Bicyclist Count Program
Retrieval Checklist

1. Tube counter name _____ **3.** Date (mm/dd/yyyy) _____

2. Tube counter serial#_____ **4.** Location # _____

5. Are the tubes in the same position as it was when installed? If not, what has changed?

_____

6. Is there any visible damage to either of the pneumatic tubes? If so, what?

_____

7. Is there any visible damage or vandalism to the counter? If so, what?

_____

8. After connecting the counter through Eco-Link, what is the total number of "hits" in each direction? In: _____ Out: _____

9. Additional retrieval notes:

_____

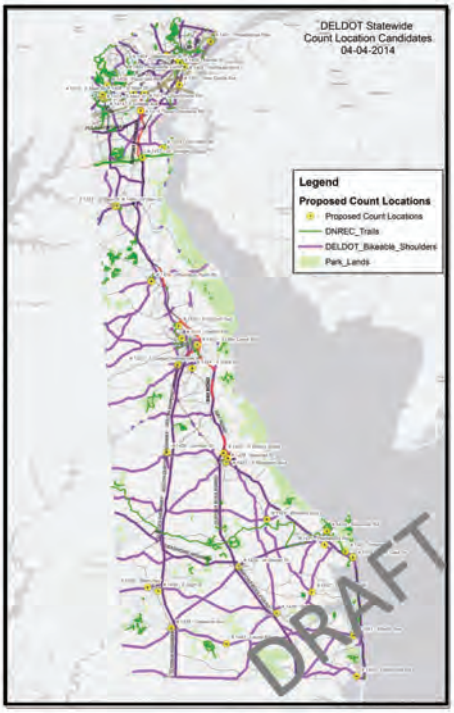
_____

SAMPLE OF SITE LOCATION INFORMATION FROM 2014 PILOT

Count Site Planning

DelDOT Statewide Bicycle and Pedestrian Count Program

April 2014

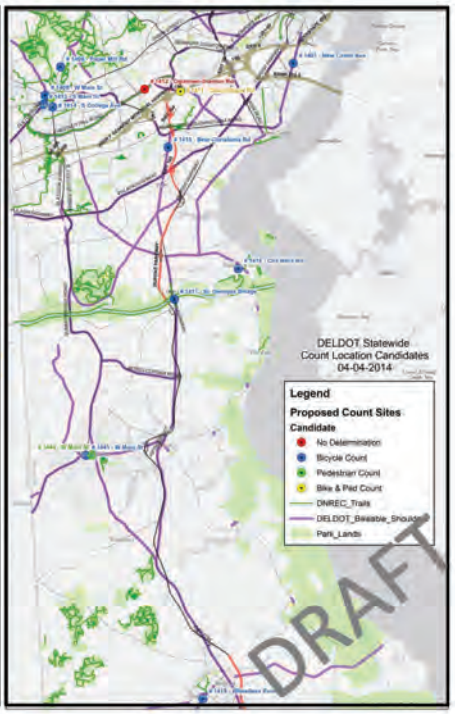


Site Evaluation

Evaluated Candidate Locations

ID	Location	Community	BIKE	PED
1407	New Castle Ave	New Castle	2	
1408	Paper Mill Rd	Newark	2	
1409	W Main St	Newark	2	
1410	E Main St	Newark		2
1411	Churchmans Rd	Newark	1	1
1412	Ogletown-Stanton Rd	Newark	*Remove?*	
1413	S Main St	Newark	2	
1414	S College Ave	Newark		
1415	Bear-Christiana Rd	Bear	2	
1416	Cox Neck Rd	Delaware City	2	
1417	St. Georges Bridge	Middletown	2	
1419	Wheatleys Pond Rd	Smyrna	2	
1443	W Main St	Middletown	2	
1444	W Main St	Middletown		2

Proposed First Count Installations (May 1)
- **1409 Bike (tubes)**
- **1410 Ped (pyro-box)**



Key to Site Diagrams

Sidewalk PEDESTRIAN Passive IR Installation

- Location ID — **1410 SSW**
- South Sidewalk (SSW)
- Data Logger (pyro-box)
- IR beam position

On-Street BICYCLE Pneumatic Tube Installation

- Location ID — **1409 EB**
- Eastbound Bike Lane (EB)
- Data Logger
- Pneumatic Tubes
- Securing chain

Abbreviations

NB	Northbound bike lane or bikeable shoulder	Bicycle
SB	Southbound bike lane or bikeable shoulder	Bicycle
EB	Eastbound bike lane or bikeable shoulder	Bicycle
WB	Westbound bike lane or bikeable shoulder	Bicycle
NSW	North sidewalk	Pedestrian
SSW	South sidewalk	Pedestrian
ESW	East sidewalk	Pedestrian
WSW	West sidewalk	Pedestrian
SUP	Shared use path	Both

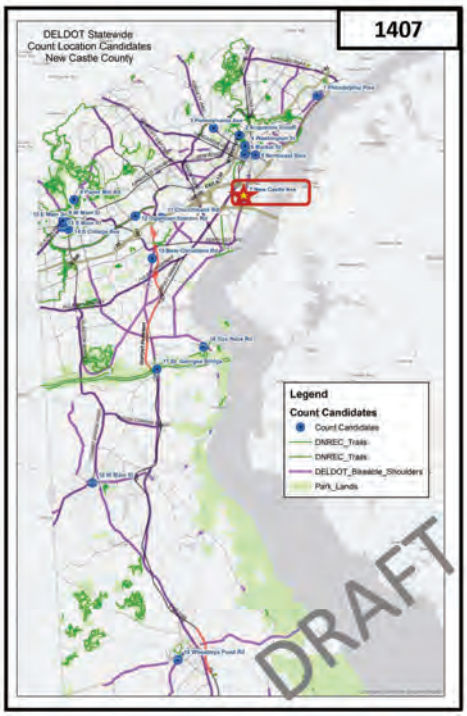
DRAFT

Location:
1407
New Castle Ave
New Castle
New Castle County

Bike Count: **YES**
Bike Facility: **Bikeable Shoulders (2)**
Pedestrian Count: *NO*
Pedestrian Facility: *Sidewalks*
Functional Class: *Minor Arterial*

Notes:

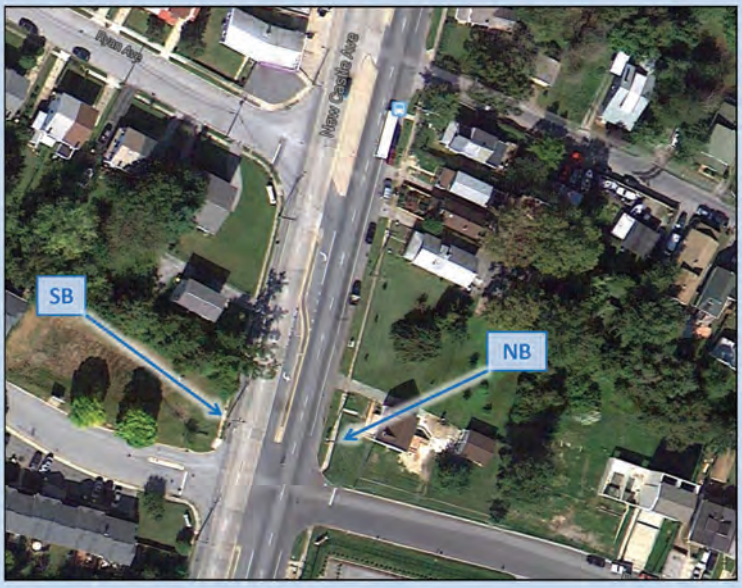
Pneumatic Tube installation will require traffic maintenance *(temp lane closure during work)*



Location: 1407 New Castle Ave - New Castle (just north of Rose Lane)

On-Street Bicycle – Pneumatic Tube Counters – mixed traffic

1407 BIKE (2) NB/SB



Location: 1407 NORTHBOUND - east curbside, just north of Rose Lane

On-Street Bicycle – Pneumatic Tube Counter

1407 NB BIKE

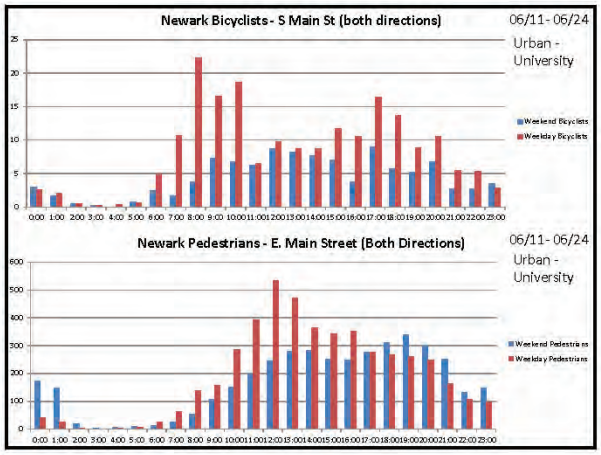
Install mixed traffic tubes just north of intersection; secure logger to sign post. (8' shoulder; 11' 6" travel lane – install tubes to center of outside lane – about 15')

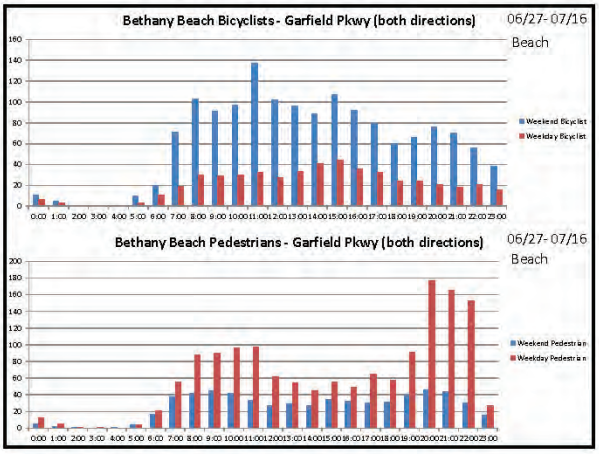
Location: 1407 SOUTHBOUND - west curbside, just north of Mansion Pkwy (opp. Rose Lane)
On-Street Bicycle – Pneumatic Tube Counter

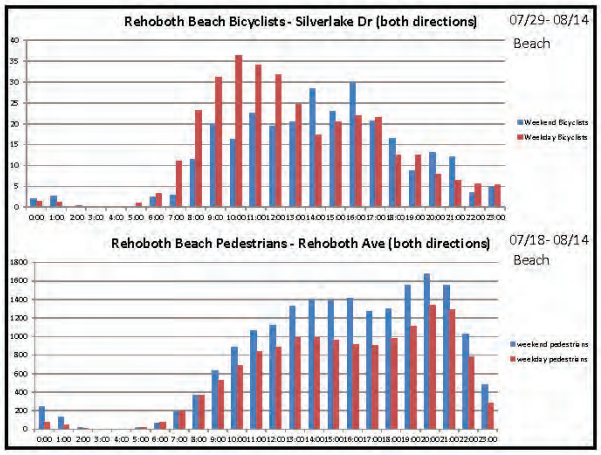
1407 SB BIKE

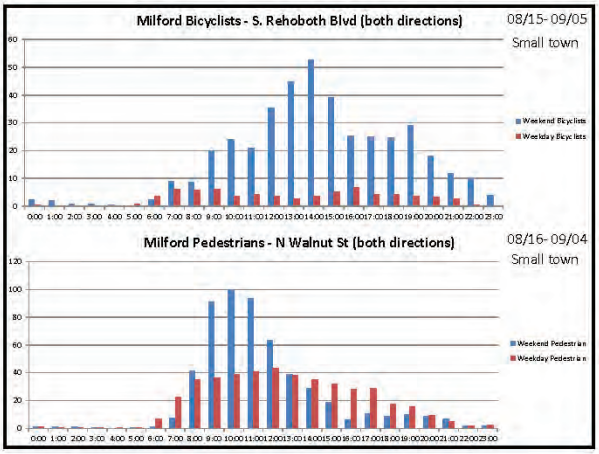
Install mixed traffic tubes just north of intersection; secure logger to sign post. (8' shoulder; 11' 6" travel lane – install tubes to center of outside lane – about 15')

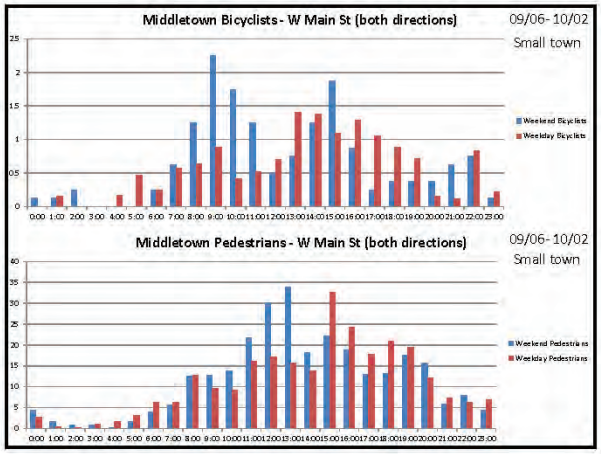
2014 PILOT REPORT

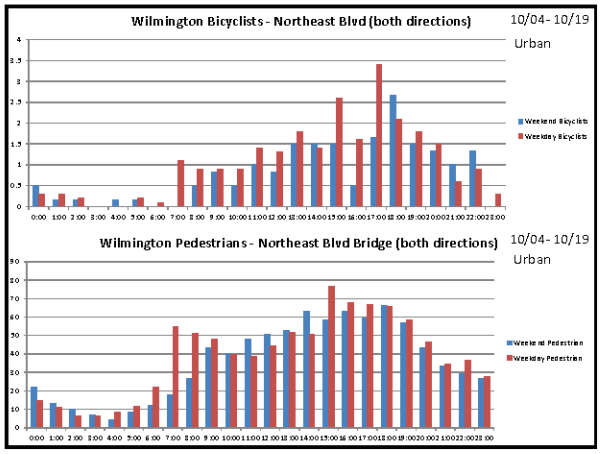


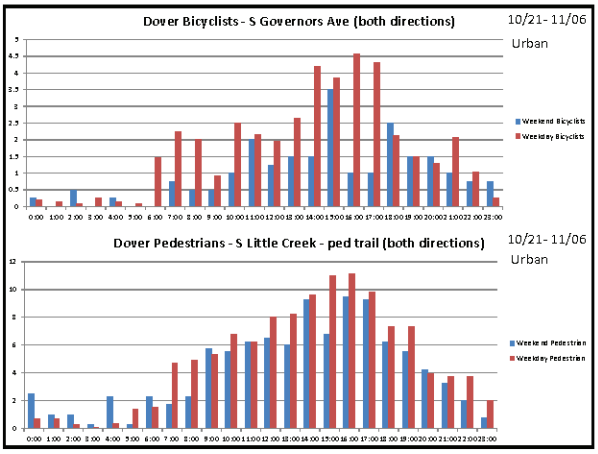


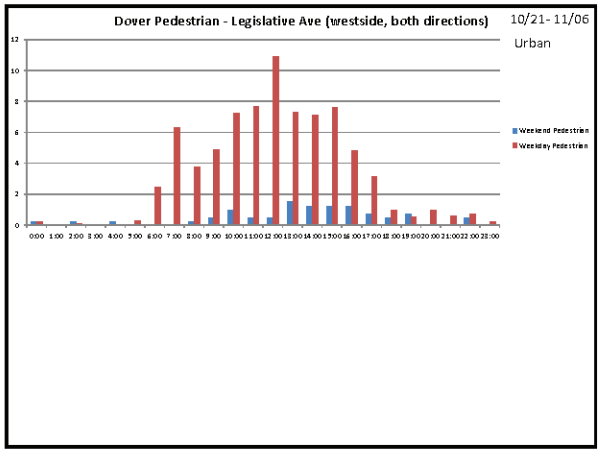







Wilmington Bicyclists - Northeast Blvd (both directions)
10/04- 10/19
Urban
Weekend Bicyclists
Weekday Bicyclists
Wilmington Pedestrians - Northeast Blvd Bridge (both directions)
10/04- 10/19
Urban
Weekend Pedestrian
Weekday Pedestrian


Dover Bicyclists - S Governors Ave (both directions)
10/21- 11/06
Urban
Weekend Bicyclists
Weekday Bicyclists
Dover Pedestrians - S Little Creek - ped trail (both directions)
10/21- 11/06
Urban
Weekend Pedestrian
Weekday Pedestrian


Dover Pedestrian - Legislative Ave (westside, both directions)
10/21- 11/06
Urban
Weekend Pedestrian
Weekday Pedestrian