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Alternative Transportation Program
Washington Support Office

NPS Transit System Passenger Boardings Study: Converting Ticket Sales to Passenger Boardings

Big Bus stop in front of the Washington Monument

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This report examines the reporting of passenger boardings (unlinked passenger trips) by NPS transit systems that use a ticket sales conversion methodology. By studying and validating the park units' passenger boarding methodology from converting ticket sales, the Volpe Center found that most small systems are applying the correct multiplier, however, large, more complex systems have a more difficult time estimating their multiplier. Through one on-site visit and four qualitative interviews, the Volpe Center summarizes its qualitative and quantitative findings in this report.

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Executive Summary

There are 121 National Park Service (NPS) transit systems that account for a total of 36.5 million passenger boardings, which is comparable to transit systems in mid-sized cities such as Cleveland, Ohio or Austin, Texas.[*] Passenger boardings, also known as unlinked trips, is a standard descriptive characteristic used by the transit industry, with a boarding defined as each time a passenger physically boards a vehicle. Park units with transit systems report annually their passenger boardings, as well as other transit-related information, to the NPS Transit Inventory. With significant transit use occurring at NPS park units across the country, this report seeks to understand and validate one of the NPS's most commonly reported methodologies for estimating passenger boardings: ticket sales.

Ticket sales can be converted into passenger boardings by applying a statistically valid multiplier to accurately estimate the number of times a passenger would board a vehicle using a ticket. For example, the Eisenhower Shuttle at Eisenhower National Historic Site has a mandatory shuttle that provides visitors round-trip service to and from the site with the purchase of one ticket. Eisenhower Shuttle multiplies its ticket sales by two to report passenger boardings. Other shuttle systems with more than two stops (where riders have the option of getting on or off) require more analysis and validation to estimate a multiplier.

The Volpe Center conducted an on-site visit and qualitative interviews with NPS transit systems that utilize a ticket sales system in order to understand how parks are converting ticket sales to passenger boardings, to validate their methods, and to draw general conclusions and lessons learned regarding the ticket sales methodology. The on-site visit was conducted at National Mall & Memorial Parks (NAMA) and the qualitative phone interviews were conducted with Boston Harbor Islands National Recreation Area, Eisenhower National Historic Site, Grand Canyon National Park (GRCA) and Grand Tetons National Park.

For two of the park units in the study, the Volpe Center validated their passenger boarding estimates by calculating a ticket sales conversion factor. The quantitative findings are captured in Table 1 and illustrate that both systems were underestimating their passenger boardings. Based on this analysis, Big Bus is one of NPS's top ten largest systems (as measured by passenger boardings), and the Grand Canyon Railway is among the top 20 largest systems. These key findings allow the NPS to more accurately characterize the scale of its transit operations, so it can make better investment allocation decisions. Furthermore, with more accurate passenger boarding estimates, NPS can then better estimate transit impacts (e.g., on greenhouse gas emissions and performance of business/concessions operations).

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[*] 2014 NPS Transit Inventory and Performance Report

Table 1 Conversion Factor Findings

Transit System Name	2014 Reported Passenger Boardings	Original Conversion Factor	Volpe Calculated Conversion Factor	New Estimated Passenger Boardings
NAMA's Big Bus	385,683	1	3.25	1,253,469
GRCA's Grand Canyon Railway	164,828	1	1.96	323,128

The project team summarized its qualitative findings from the on-site visit and interviews into the following lessons learned, first for general ticket sale conversion methodology and second for conducting on-site passenger boarding counts.

General Ticket Sale Conversion

- Some NPS park units and concessioner staff did not seem to clearly understand the difference between a rider and a passenger boarding. Both are valid for tracking different aspects of system use, but they are measured differently. With improvements in the next data collection cycle for the NPS Transit Inventory, some transit systems may better understand a passenger boarding and methods to accurately calculate the measure.

- The meaning of "ticket sales" as a passenger boarding estimation methodology in the NPS Transit Inventory was unclear for some transit systems. The project team found that several systems that indicated they were using ticket sales were in fact performing manual counts to measure passenger boardings, rather than relying on ticket sales. For example, the ferry systems that operate off of the U.S. coast perform manual counts and were providing those numbers. Increased communication from the NPS Transit Inventory project team to park unit staff and concessioners providing the passenger boarding information may help minimize misinterpretation of the ticket sales methodology.

- Of the systems interviewed, the simple transit systems with straightforward ticket systems are accurately converting ticket sales into passenger boardings. Jenny Lake Shuttle boat and the Eisenhower Shuttle, for example, utilize straightforward ticket sales systems that ensure easy calculation of passenger boardings.

- For more complex transit systems (e.g. with multiple stops), several options exist for acquiring the data needed to develop a conversion factor. If resources and staff time allow, performing validation of passenger boardings through counts is the most accurate, similar to the effort Volpe conducted at NAMA. If available, systems may also utilize survey data asking passengers how many stops they got on during a visit and/or single ticket purchase. A third less costly, but also less accurate option is to gather qualitative data from transit vehicle operators who may have a general sense of how many times a passenger boards throughout a service day.

- The ticket conversion rate can be updated as the park unit and/or transit operator see necessary. Many changes may occur over time that can affect passenger boardings. Things such as changing visitation patterns, transit service changes like adding or removing stops, or different ticket types (e.g., annual passes, family tickets) may affect a park unit's calculation of passenger boardings through ticket sales. Park units should be aware of these changes and verify or update systems' conversion methodology as appropriate or on a regular schedule as staff time allows.

In addition to the lesson learned about ticket sales-to-passenger boardings conversion, the Volpe team also learned several lessons during its on-site visit that may help make the process of sampling passenger boarding counts easier for other park units looking to perform a similar analysis. The project team found that on-site data collection visits require flexibility and the team should be prepared to adjust sampling plans, as necessary, to maintain the integrity of the data. Additionally, communication is crucial, internally among staff who are conducting the passenger counts and externally with the transit system operator, NPS park unit staff, and other regional and national NPS management.

Based on this study's findings, many transit systems are reporting passenger boardings correctly using ticket sales. Some systems did not understand the passenger boardings metric, but did have the data to report passenger boardings correctly. Therefore it is important that park units and concessioners understand the passenger boarding definition during NPS Transit Inventory data calls. Converting ticket sales to passenger boardings can be more difficult for some systems to execute than others, due to system complexity, however, there are ways for those systems to accurately estimate passenger boardings using ticket sales through count sampling such as the one performed for NAMA.

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Introduction

This report documents the methodologies used by several National Park Service (NPS) transit systems to estimate passenger boardings based on ticket sales, validates the passenger boarding estimates for two park units, and draws general conclusions and lessons learned regarding estimation methodologies.

Purpose

Passenger boardings are an important performance metric used by transit systems across the country. A passenger boarding occurs each time a passenger boards a vehicle. This is an industry standard measure also known as an "unlinked trip" and is used by the Federal Transit Administration's National Transit Database. For transit systems that have only two stops, the conversion to passenger boardings using ticket sales is relatively straightforward; each ticket sold is multiplied by two to account for both legs of the trip. However, the conversion of ticket sales to passenger boardings can be difficult for complex systems with multiple stops and ticket types. This study seeks to address the following questions:

- What method(s) do park units use to convert ticket sales to passenger boarding estimates?
- What challenges do park units face in utilizing this methodology?
- What are the lessons learned regarding the ticket sales methodology?
- What recommendations, if any, can we share with park units utilizing a ticket sales estimation methodology?

In studying these questions, NPS transit systems may be able to share, adapt, and improve their passenger boardings estimation methodology with assistance from the Washington Support Office. This will lead to more accurate and defensible passenger boarding counts in the future.

Background

Each calendar year since 2012, the NPS Washington Support Office has completed an annual "NPS National Transit Inventory and Performance Report," which provides a summary of passenger boardings by different estimation methodologies, including manual, ticket sales, estimated and automated counters.[*] In the 2013 report, ticket sales comprised a sizeable share all systems (39 percent) and accounted for 7.8 million boardings, and in the 2014 report, those numbers

[*] All reports can be accessed on the NPS Transit Inventory and Performance Report website: https://hostedsites.volpe.dot.gov/NPSTransitInventory/login.html

increased to 43 percent and 17.7 million boardings. However, little is known about how park units use indirect methods to estimate passenger boardings. Ticket sales conversion to passenger boardings are an indirect counting practice that relies upon the park unit and/or transit service operator to manipulate ticket sale data to accurately capture the number of passenger boardings.

The 2014 NPS Transit Inventory and Performance Report collected data on the 121 existing NPS transit systems. The range of passenger boardings among those systems is wide. The largest transit system (by boardings) is the Statue of Liberty/Elis Island (STLI/ELIS) Statue of Liberty Ferries which reported 10,916,939 passenger boardings in 2014. In 2014, approximately 85 percent of boardings (30.9 million) were attributable to the ten highest use transit systems. Three of the top ten systems, STLI/ELIS, Golden Gate/Alcatraz National Park (GOGA/ALCA), and Valor in the Pacific National Monument (VALR), rely on ticket sales data to inform their passenger boardings number.

Ticket sales conversion is an indirect method of calculating passenger boardings that is low cost, low tech, and minimizes burden on staff. For those reasons it is appealing, but it is also a method transit agencies are employing less as counting technology improves and becomes less expensive (NYC Transit, 2003). The project team performed a thorough literature review and found that the most recent literature on passenger boarding count methodology focuses on direct ways of counting, such as manual or automated, and the emerging technologies associated with automated counting.

Methodology Overview

The study methodology includes both an on-site component and qualitative interviews. For the on-site visit, the Volpe Center conducted passenger boarding counts over a limited time period, acquired the ticket sales data for that same period and then calculated the number of boardings per passenger (e.g., a conversion rate). Then using the data collected on-site as well as data from the transit service provider, Volpe calculated a best estimation conversion factor. The Volpe Center also conducted qualitative interviews with a number of parks to better understand their method for converting ticket sales to passenger boardings, including any challenges or lessons learned.

Selection Criteria

The project team used four criteria to identify and select the most appropriate park units for the on-site validation and qualitative interviews. The information for these criteria was gathered using the 2013 NPS National Transit Inventory data, in addition to supplementary background research, including consulting with NPS Washington Office, Regional, and park unit staff. The criteria include (listed in order of importance):

- **Passenger boardings:** In addition to using this variable for the initial screening that defined the smaller sample, the number of passenger boardings also influenced the likelihood of an on-site visit or qualitative phone interview.
- **Complexity of the system (e.g., number of stops):** More complex systems had a greater likelihood of being selected for an on-site visit or phone interview.
- **System mode of transport:** The project team tried to include different types of systems for the on-site validation (e.g. ferry and shuttle); however this adjusted due to complications discovered about the large ferry systems (explained in Lessons Learned).
- **Owner/Operator of System:** The project team tried to select at least one NPS owned or NPS-operated system for the on-site visit. However, given the prevalence of non-NPS owned, non-NPS-operated systems that use the ticket sales methodology, this was not possible. For the qualitative phone interviews, capturing different business models was achieved.

Following the completion of the 2014 report, the Volpe team also took into account the extent to which passenger boardings reported in the Transit Inventory fluctuated between reporting periods, as this might signal an inconsistency in how ticket sales are being converted to passenger boardings.[*]

Using these criteria, an initial sample of park units was identified (see Literature Cited

NYC Transit, 2003 (http://ntl.bts.gov/lib/23000/23600/23620/psgr_ctg_svc_mon.pdf).

1. Crikelair, Tom; "Northeast Region of the National Park Service: Alternative Transportation Management System Phase 1 Final Report;" September 2011.

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[*] In a few cases, however, decreases in passenger boardings were explained by other factors. For example the Statue of Liberty National Monument experienced a significant decline in visitation between 2012 and 2013 due to Hurricane Sandy.

Appendix 1: List of Potential Systems). Throughout the identification process, the project team found several transit systems that had misreported ticket sales as its count methodology due to misunderstanding.[*] As this occurred, the project team adjusted its list of park units.

From the list of potential park units, the team, in consultation with NPS WASO, selected park units for on-site validation or qualitative phone interviews. The list of parks that participated in the study is outlined in the table below.

Table 2 Participating Park Units and Transit Systems

Park Unit	System Name	Interview Type
National Mall National Park	Big Bus	On-Site
Boston Harbor Islands National Recreation Area	Boston Harbor Islands Ferry	Phone
Eisenhower National Historic Site	Eisenhower Shuttle	Phone
Grand Canyon National Park	Grand Canyon Railway	Phone
Grand Tetons National Park	Jenny Lake Shuttle Boat	Phone

Findings

Findings from the on-site visit and the qualitative phone interviews are presented below.

On-Site Visit – National Mall National Park

The Big Bus system at NAMA was selected for an on-site visit due to the system's complexity as well as the willingness to participate of park unit staff and the transit service operator. Big Bus uses multiple ticket types and durations, and uses those sales to report passenger boardings. The system is relatively complex, offering a hop-on, hop-off service with multiple routes and many stops.

In order to better estimate a statistically valid tickets-to-boardings conversion rate for the National Mall's Big Bus system, a site visit was necessary to determine approximately how many passengers are carried by the system over the course of a service day. Passenger boarding data collected from the site visit provided a basis

[*] Misreporting may occur for two reasons: 1) the park unit misunderstood the definition of ticket sales methodology, or 2) the data collection team incorrectly assigned "ticket sales" to a unit that had not provided its count methodology. All park units considered for this study reported their count methodology, so errors in misreporting were due to misunderstanding.

on which to compare ticket sales data and compute the conversion rate, which was then used to calculate passenger boardings from number of tickets sold.

Service Characteristics

Big Bus is a concessioner service for NAMA, providing both live and audio-guided tours of landmarks along four fixed routes. Of the four fixed routes, the project team focused on the two routes – the red and the blue - that provide access to NPS sites.

Current Passenger Boarding Count Methodology

Currently the Big Bus system uses only ticket sales to provide passenger boarding estimate information, reporting one passenger boarding per ticket sold. This method results in undercounting of the actual passenger trips provided by the system. The current fare structure of the system is 24- or 48-hour hop-on, hop-off tickets. The ability for passengers to take as many rides as they desire within a time period likely results in more than one boarding for every one ticket sold. For this reason, the project team selected Big Bus for an in-depth study to calculate a conversion rate to estimate boardings per ticket.

Six different ticket types exist for the hop-on, hop-off service. The NPS only considers tickets purchased that provide access to national Mall sites, including:

- All Loop 24 hours
- All Loop 48 hours
- Patriot Tour – 24-hour Red Loop
- Combo All Loop
- 48 hours/Night Tour

To simplify the analysis, the project team references the ticket types based on active ticket time (24-hour or 48-hour). Each route makes approximately 24 stops primarily at sites within the National Mall, such as the Washington Monument, the Vietnam Memorial, and Arlington Cemetery, with a few stops at sites outside the National Mall (e.g., Pentagon City).

The main hub for the service is Union Station, where the majority of riders purchase tickets and board the tours. However, riders can also join the tour and purchase their ticket at any of the stops. Transfers are available to the system's other two routes (green and yellow routes) at different points throughout the National Mall. Big Bus red loop and blue loop tours depart Union Station approximately every 10-15 minutes starting at 8:00 AM, with the last departure around 6:00 PM. There is no specific schedule of departures; the service is primarily headway-based, and Union Station attendants can adjust departures as

necessary in response to demand.The map below depicts the detailed routes that the Big Bus operates (Figure 1).

Figure 1 Bus Big Map of Routes
Source: http://eng.bigbustours.com/washington/route-map.html

Sampling Methodology

The site visit focused on sampling trips and recording passenger boarding information, then used that sample to estimate the total number of system-wide boardings over the same time period. This estimation, combined with ticket sales data for those same days provided by the operators, would be used to calculate a conversion rate.

Estimation of Passenger Volume by Random Sample

Due to the high number of trips made daily by Big Bus and staffing limitations, the project team determined a stratified random sample would best fit its data collection needs. Typical random sampling of transit trips would involve randomly selecting specific scheduled trips from an entire service period. Using the Big Bus's approximate headways (15 minutes), the project team calculated expected departure times for both the red and blue routes throughout the day based on the first departure at 8:00 AM. This set of likely trips for the system was then stratified into five groups based on the time of day. Groups were organized such that randomly selected trips within each group could be linked together into a sampling schedule to be completed by an individual staff person.

Once the groups were established, sequential numbers were assigned to trips within each group, then numbers that corresponded with the trips were selected using a random number generator. This stratified random sample of all likely trips was then used to create the sampling schedule for each survey staff (See Appendix 2: NAMA Site Visit Sampling Schedule).

On-Site Visit

Working with Big Bus staff, the team selected dates that were representative of ridership on a typical summer weekend. Saturday, August 15, 2015, and Sunday, August 16, 2015 were chosen as there were no large special events and this was not a holiday weekend.

The Volpe team, comprised of five staff, arrived one day early so they could ride the Big Bus and familiarize themselves with the service prior to conducting the study. This initial ride enabled staff to determine where they should sit (or stand) to facilitate accurate passenger counts and to test different strategies for performing the boarding counts.

To collect the data, each staff person was provided with a unique sampling schedule, developed according to the sampling plan described above. Volpe staff used the expected route information and bus departure times on their schedule to determine which buses to ride. If a bus did not depart at the time listed on their sample schedule, staff were instructed to ride the next bus departing on the

specified route. Due to outside factors, however, staff's sampling schedules had to be modified once the team was on-site (see the On-site Changes in Sampling Plan below).

In addition to their sampling schedule, staff carried forms for recording the passenger boarding counts at each stop (see Appendix 3: NAMA Site Visit Data Collection Sheet). For each sampled trip, staff counted and recorded the number of passengers boarding and, if possible, alighting, at each stop. Staff also recorded any other interesting items of note about the trip, such as whether the vehicle was equipped with air conditioning, and if the trip used a recorded tour as opposed to a live tour guide. During the two-day visit, 30 trips were sampled out of a total of approximately 94 trips that operated.

On-Site Changes in Sampling Plan

Sampling plan changes were made on-site during the data collection process as it became apparent that staff would not be able to complete all of the sampled trips assigned to them, and as additional operational information became available to the project team. The following two factors contributed to the adjustment of the sampling plan:

- Due to the closure of the Arlington Memorial Bridge to two-way traffic and weight limit restrictions, the Big Bus staff deemed it more efficient to combine its red and blue routes. The main difference between the two routes was that the red route went to Arlington Cemetery and had an overall length of approximately two hours, while the blue route went to Pentagon City and had an overall length of two hours and twenty minutes. In running a combination route, the red/blue trip now stopped at both Arlington Cemetery and Pentagon City adding a minimum of 20 minutes to each trip. When developing the sampling schedule, Volpe staff was unaware that Big Bus was only running the longer combination routes, so staff was sometimes scheduled to sample their next trips before their prior ones had ended.

- Big Bus operates on a schedule using approximate headways which informed the sampling plans, however, throughout the day Big Bus attendants may adjust the schedule according to demand. For example, if many people are waiting for a bus at one time then they may run more frequent service during that time or if a bus it not yet full they may extend the headway time until the bus has almost reached capacity.

Due to these timing changes, the project team adjusted the sampling plan, while still preserving the randomness of the sample, to ensure that each team member had sufficient time to make all their assigned trips. If staff missed a trip due to the timing, they were instructed to get on the next scheduled departure as long as another staff was not covering it. In all, 35 trips were originally randomly selected for sampling and 30 of those trips were actually performed once the on-site adjustments were made.

Analysis

The aggregate dataset collected by the project team provided the sum of passengers boarding at each stop over the course of the service day for our sample. Based on this sample data, along with data on the total number of vehicle trips per day (provided by Big Bus staff), the project team estimated system-wide boardings per service day.

Average boardings by stop were calculated using the following equations (separately by service day observed; see Appendix 4: NAMA Data Analysis Results):

$$\#\ of\ total\ boardings\ observed\ by\ stop\ /\ \#\ of\ trips\ sampled = average\ boardings\ by\ stop\ (sampled)$$

Then:

$$Average\ boardings\ by\ stop * \#\ of\ total\ trips\ (sampled\ and\ unsampled) = estimated\ total\ boardings\ by\ stop\ for\ the\ service\ day$$

Then:

$$\sum Estimated\ total\ boardings\ by\ stop\ for\ the\ service\ day = estimated\ total\ system\ boardings\ for\ the\ service\ day$$

Table 3 below shows high-level summary data after performing the analysis above. For more detailed data analysis results, see Appendix 4: NAMA Data Analysis Results.

Table 3 Summary of Sampled Boarding Counts and total Estimated Boardings

Day	Total Observed Boardings (Sample)	Vehicle Trips Sampled	Total Vehicle Trips that Day (Operator Data)	Estimated Total System Boardings
Saturday (8/15)	2,403	16	46 from Union Station, plus 1 dispatched to stop 11, and 4 dispatched to stop 20	7,062
Sunday (8/16)	1,448	14	47 from Union Station	4,861

Following the calculation of the estimated system-wide boardings for the service day, the project team again used operator-provided data on total number of trips per service day and number of tickets sold to estimate a ticket-to-boarding conversation rate.

Big Bus staff provided ticket sale and activation data for the dates sampled and for the ticket types that applied to the red and blue routes. Additionally, due to the timed nature of the ticket types (24-hour and 48-hour), the project staff removed tickets that would have been inactive during the time of sampling. Table 4 displays the active ticket types used by the project team in its analysis.

Table 4 Active Ticket Types for Analysis Period

Sales Day and Date	Ticket Type	Active Sat. 8/15?	Active Sun. 8/16?
Thursday, 8/13	24-hour (all types)	No	No
Thursday, 8/13	48-hour (all types)	**Yes ***	No
Friday, 8/14	24-hour (all types)	**Yes***	No
Friday, 8/14	48-hour (all types)	**Yes**	**Yes***
Saturday, 8/15	24-hour (all types)	**Yes**	**Yes***
Saturday, 8/15	48-hour (all types)	**Yes**	**Yes**
Sunday, 8/16	24-hour (all types)	**No**	**Yes**
Sunday, 8/16	48-hour (all types)	No	**Yes**

**Depending on when the tickets were sold, the ticket may have only been active for part of the day.*

The project team then aligned the hourly activation of tickets (provided by Big Bus) with the passenger boarding estimation data that is represented by service day. With the different time scales, the project team adjusted the ticket activation

data to represent the portion of the service day for which the tickets were active based on the time of day of activation. For example, if a ticket was purchased at the start of the service day, that ticket counted as 1.0. If a ticket was purchased halfway through the service day, that ticket counted as 0.5.

While it is possible to calculate the number of active tickets in any given hour (or by day) based on when the ticket was first activated, there is no way of knowing whether the rider actually **used** the ticket for the entire period for which it was active or only part of that period.

Initially, the project team bound the data by calculating a "high use" limit, based on maximum use of a ticket during its activation period. In other words, this method assumes that each passenger would use the ticket for the entire amount of time for which it was active (Table 5). For example if a 48 hour ticket is purchased Friday at noon, the ticket is counted as active and in use from Friday noon to Sunday noon.

Table 5 Hourly Ticket Sales Adjustment Example for High Use*

Activation Day and Time	Ticket Type	Active Sat. Hours per Ticket	Active Sun. Hours per Ticket	Daily Service Hours	Adjustment Ratio (Sat.)	Adjustment Ratio (Sun.)
Th, 8 AM	48-hour	0	0	12	0/12 = 0.0	0/12 = 0.0
Th, 2 PM	48-hour	6	0	12	6/12 = 0.5	0/12 = 0.0
Fr, 8 AM	24-hour	0	0	12	0/12 = 0.0	0/12 = 0.0
Fr, 2 PM	24-hour	6	0	12	6/12 = 0.5	0/12 = 0.0
Fr, 8 AM	48-hour	12	0	12	12/12 = 1.0	0/12 = 0.0
Fr, 2 PM	48-hour	12	6	12	12/12 = 1.0	6/12 = 0.5
Sa, 8 AM	24-hour	12	0	12	12/12 = 1.0	0/12 = 0.0
Sa, 2 PM	24-hour	6	6	12	6/12 = 0.5	6/12 = 0.5
Sa, 8 AM	48-hour	12	12	12	12/12 = 1.0	12/12 = 1.0
Sa, 2 PM	48-hour	6	12	12	6/12 = 0.5	12/12 = 1.0
Su, 8 AM	24-hour	0	12	12	0/12 = 0.0	12/12 = 1.0
Su, 2 PM	24-hour	0	12	12	0/12 = 0.0	12/12 = 1.0
Su, 8 AM	48-hour	0	12	12	0/12 = 0.0	12/12 = 1.0
Su, 2 PM	48-hour	0	6	12	0/12 = 0.0	6/12 = 0.5

**Example data – for illustration only; Compiled for hours of service from 8 AM to 8 PM*

Although some passengers will use their tickets to the full extent possible, not all will choose to spend as much time on taking multiple guided tours over a 24- or 48-hour period. Using the previous example, a rider who purchases a 48 hour ticket on Friday at noon is likely to use the ticket on Friday and Saturday, but may not use it on Sunday morning, despite the fact that it is still active. As a result, the project team did not use the "high use" assumptions to calculate active tickets, but modified those assumptions somewhat to more closely approximate average rider behavior. Under the modified assumptions, the estimation accounted for a partial day on the activation date of the ticket, but only accounted for a partial day on the ticket's expiration date if the ticket expired after noon, reasoning that visitors would not necessarily seek out the system early in the morning on the last day they were allowed to use the ticket, especially given that the shortest period of time available for a ticket to be active is 24 hours, and that tickets would tend to be purchased for use immediately on the first day available. This method provided the project team's "best estimate" of active tickets and was used to develop a recommended conversion rate (Table 6).

Table 6 Hourly Ticket Sales Adjustment Example for Middle Estimation*

Activation Day and Time	Ticket Type	Active Sat. Hours per Ticket	Active Sun. Hours per Ticket	Daily Service Hours	Adjustment Ratio (Sat.)	Adjustment Ratio (Sun.)
Th, 8 AM	48-hour	0	0	12	0/12 = 0.0	0/12 = 0.0
Th, 2 PM	48-hour	6	0	12	**0.0	0/12 = 0.0
Fr, 8 AM	24-hour	0	0	12	0/12 = 0.0	0/12 = 0.0
Fr, 2 PM	24-hour	6	0	12	**0.0	0/12 = 0.0
Fr, 8 AM	48-hour	12	0	12	12/12 = 1.0	0/12 = 0.0
Fr, 2 PM	48-hour	12	6	12	12/12 = 1.0	**0.0
Sa, 8 AM	24-hour	12	0	12	12/12 = 1.0	0/12 = 0.0
Sa, 2 PM	24-hour	6	6	12	6/12 = 0.5	**0.0
Sa, 8 AM	48-hour	12	12	12	12/12 = 1.0	12/12 = 1.0
Sa, 2 PM	48-hour	6	12	12	6/12 = 0.5	12/12 = 1.0
Su, 8 AM	24-hour	0	12	12	0/12 = 0.0	12/12 = 1.0
Su, 2 PM	24-hour	0	6	12	0/12 = 0.0	6/12 = 0.5
Su, 8 AM	48-hour	0	12	12	0/12 = 0.0	12/12 = 1.0
Su, 2 PM	48-hour	0	6	12	0/12 = 0.0	6/12 = 0.5

**Example data – for illustration only; Compiled for hours of service from 8 AM to 8 PM*

Activation Day and Time	Ticket Type	Active Sat. Hours per Ticket	Active Sun. Hours per Ticket	Daily Service Hours	Adjustment Ratio (Sat.)	Adjustment Ratio (Sun.)

***Denotes partial, non-activation day before noon, which is uncounted in this model*

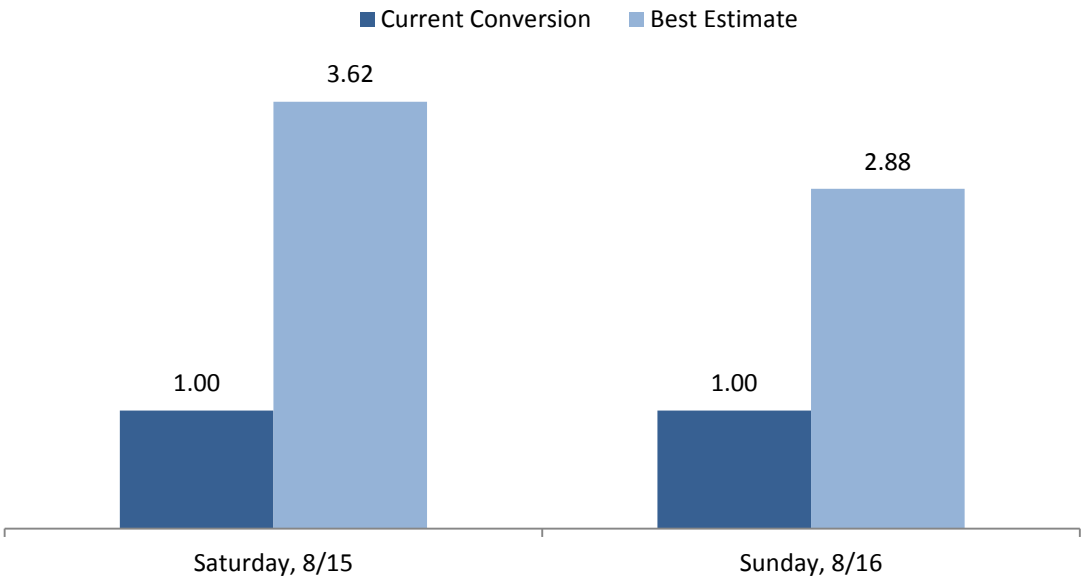
Figure 2 Total active tickets and adjusted active tickets for each scenario by service day

Once each ticket sale adjustment was calculated using the best estimate methodology described above, the estimated passenger volume for each day was divided by the adjusted ticket sales total for each day. This resulted in a conversion rate of 3.62 for Saturday and2.88 for Sunday (Table 7).

Table 7 Estimated Conversion Rates for Big Bus transit service

Day and Date	Estimated Total Passengers	Tickets Active (Total, Big Bus)	Tickets Active (Volpe Adjusted)	Conversion Rate Estimate
Saturday, 8/15	7,062	3,839	1,950	**3.62**
Sunday, 8/16	4,861	3,556	1,690	**2.88**

Figure 3 Current conversion rate and calculated conversion rates by service day



Results

Using the analysis above, the project team recommends that the Big Bus use an average of the Saturday and Sunday best estimation conversion factor for future data calls as this likely represents passenger behavior most accurately. This results in a conversion factor of **3.25**. This estimation balances those visitors that may take full advantage of the ticket activation time with those visitors that may only ride the entire route once for the guided tour. Additionally, it balances the different behavior of visitors by weekday as the conversion rates for Saturday and Sunday differed significantly. Table 8 displays the results of applying that conversion factor to the original numbers reported in 2014.

Table 8 Results of conversion factor application for NAMA's Big Bus

Year	Original Reported Boardings (tickets sold)	Conversion Factor	New Estimated Total Passenger Boardings
2014	385,683	3.25	1,253,469

Looking to the future and if resources become available, the project team also recommends further study of the Big Bus's passenger boardings as there are two main limitations to the data collected by the project team:

- Data showed that the day of the week does impact the number of boardings per ticket; days other than Saturday and Sunday should be sampled to provide a more robust picture of how passengers behave on weekdays.

- Data was collected in the summer, which is peak tourism season for NAMA and Washington, D.C. Other seasons should be sampled as well, such as in the winter to see how weather may affect passenger boardings.

The application of the conversion factor results in approximately 1.3 million boardings, making Big Bus among the top ten largest systems in the NPS Transit Inventory. Applying the conversion factor of 3.25 allows the system to more accurately measure boardings and enables comparisons to other transit systems within the National Park Service.

Qualitative Interviews

The following documents the information collected during one-hour phone interviews with identified points of contacts for each of the selected transit systems. The purposes of the interviews were to:

- Document overall transit system operations
- Obtain detailed information on the ticket sales system
- Understand how ticket sales are converted to passenger boardings
- Collect detailed information on challenges and lessons learned regarding the ticket sales methodology

Qualitative interviews were conducted with contacts for Jenny Lake Shuttle Boat (Grand Teton National Park), Eisenhower Shuttle (Eisenhower National Historic Site), Grand Canyon Railway (Grand Canyon National Park), and Boston Harbor Ferries (Boston Harbor Islands National Recreation Area).

Jenny Lake Shuttle Boat, Grand Tetons National Park

Service Characteristics

The Jenny Lake Shuttle Boat is a ferry service transit system that transports visitors from the base of Mount Teewinot across Jenny Lake to the Cascade Canyon trailhead in Grand Tetons National Park in Wyoming. The ferry service is owned and operated by Jenny Lake Boating, Inc. through a concession contract with the park. This seasonal system runs a ferry approximately every 15 minutes from 10:00

AM to 4:00 PM, May 15 to June 16 and September 8 to September 27; and 7:00 AM to 7:00 PM, June 7 to September 7. The ferry ride takes approximately 10 to 12 minutes. The concessioner operates three 34-passenger and one 44-passenger boats.

Tickets for the service cannot be purchased or reserved in advance. Tickets may only be purchased on the boat dock located in the South Jenny Lake area at one of two cash registers. The concessioner does not distribute paper tickets, but instead stamps ferry users' hands with stamps that include an environmentally-conscious message, such as "Be Bear Aware" or "Leave No Trace." Visitors may purchase adult, senior, or child round-trip or one-way tickets. Additionally, a family may choose to purchase a family ticket (priced for 2 adults and 2 children) that will allow any number of family members under 18 to be included. The family ticket is only sold as a round trip ticket. The Jenny Lake Shuttle Boat also sells annual passes to primarily local customers, which allows unlimited annual access to the ferry service for a one-time fee. Approximately 50 to 150 of these annual passes are sold each year. If a visitor does not have a ferry ticket when on the West side of Jenny Lake, the visitor is allowed to board the ferry and must pay for the ticket once on the other side.

Passenger Boarding Count Methodology

In 2014, the Jenny Lake Shuttle Boat reported 219,619 passenger boardings counted through ticket sales data. With a relatively simple system of two-stops and differentiated ticket types based on number of times a passenger may ride the system, the conversion methodology of ticket sales to passenger boardings is not complex. The Jenny Lake Shuttle Boat system keeps the ticket types simple, making tracking and recording of passengers simple and conversion to passenger boardings straightforward. Each ticket type sale is recorded through a different key code in the cash register. Those sales are totaled daily to create daily ridership data.

Family tickets are multiplied by five, as that was the observed average for families buying this ticket type. Proper steps were taken to estimate the number of passengers for the family ticket type, which is the sale of one ticket allowing the round-trip boardings of an unknown number of passengers. During the first year of sale, Jenny Lake Shuttle Boat staff recorded the number of family members included each time a family ticket was purchased. At the end of the year, the ferry service had a defensible average number of passengers per family ticket sold to use when reporting to the National Park Service. Looking to the future, the concessioner may want to perform those observations again to validate and update their average family size number.

Currently, annual pass holders are not captured in the conversion methodology. An average of 100 Annual Passes are sold each year and staff estimates Annual Pass holders use the ticket an average of 10 times during the year. That could account for 1,000 to 2,000 passenger boardings depending on the number of one-way trips or round-trips. In 2014, that would have represented less than one percent of passenger boardings. If annual pass ownership grows in the future, Jenny Lake Boating should consider accounting for annual pass holders in its conversion methodology.

Monthly summaries by round-trip and one-way passengers are provided to the National Park Service's Grand Teton's Concession Management Specialist. The National Park Service staff multiplies only the round-trip tickets by two and sums that result with the one-way passengers to calculate passenger boardings. This calculation is performed on each monthly total received by the park staff to achieve total annual passenger boardings. An example of the data received by park unit staff and the calculations performed are displayed below in Table 9.

Table 9 Example monthly passenger and passenger boarding data for Jenny Lake Shuttle Boat

Ticket Type	Tickets Sold	Appropriate Multiplier	Passenger Boardings
Round Trip	4,261	2	8,522
One way (East)	1,458	1	1,458
One way (West)	1,114	1	1,114
Total	5,833		11,094

Eisenhower Shuttle, Eisenhower National Historic Site

Service Characteristics

Due to the lack of available parking, the Eisenhower National Historic Site is only accessible through the Eisenhower Shuttle, which departs from the Gettysburg National Military Park Visitor Center and Museum and then returns to the same location. The transit service is owned and operated by the Gettysburg Tour Center through a concession contract with the park unit. The Gettysburg Foundation, a non-profit organization that runs the park's museum, is responsible for selling tickets for the shuttle. During the peak summer season, the shuttle departs the visitor center every half-hour beginning at 9:00 AM and ending at 5:00 PM. During the fall and winter, the schedule adjusts to less frequent service as visitation is lower.

Tickets can be reserved in advance or purchased in the visitor center and are sold on a first come first serve basis. If tickets are reserved in advance, the visitor must go to the visitor center desk to pick up their tickets. The shuttles in operation are 44-passenger and 57-passenger vehicles. Due to the limited amount of seating available, the Gettysburg Foundation closely tracks its ticket sales to ensure it does not go over-capacity. As this system provides sole access to the historic site, each ticket sold is a round-trip ticket.

Passenger Boarding Count Methodology

The Eisenhower Shuttle reported 101,276 passenger boardings for calendar year 2014. As mentioned, due to capacity limits the concessioner closely tracks its ticket sales to ensure all ticket reservations are valid. For example, although children under age six are free, a ticket is still administered to account for a seat being taken. When a ticket is administered, the concessioner denotes it in their cash register data. At the end of each day, the Gettysburg Foundation provides a ticket sales report to NPS park unit staff. This report provides the total number of each ticket type sold that day. The park uses this number to generate its monthly visitation data as well as inform its passenger boardings for the transit system. When the park unit supplies passenger boardings to the NPS Transit Inventory, park staff multiplies the total number of tickets sold by two to account for the round-trip. Since there is no other way for a visitor to access or exit Eisenhower National Historic Site, multiplying all the tickets sold by two is accurate.

Grand Canyon Railway, Grand Canyon National Park

Service Characteristics

The Grand Canyon Railway is an historic train service that departs daily at 9:30 AM from Williams, Arizona and drops passengers off at the South Rim of Grand Canyon National Park (GRCA) around 11:45 AM. The return, southbound, trip departs GRCA at 3:30 PM and returns to Williams at 5:45 PM. Occasionally during peak season the Grand Canyon railway will use a second train to accommodate demand, which then departs Williams at 10:00 AM and departs GRCA at 4:00 PM. The rail service is owned and operated by Xanterra Parks and Resorts, Incorporated.

Tickets can be purchased online in advanced of a visitor's trip and can be purchased as part of a vacation package. There are six cabin options visitors may choose from, each providing a slightly different experience and accommodating a different number of visitors. Each ticket reservation is a round-trip ticket, providing both north- and southbound service. Although passengers reserve round-trip tickets, they are not required to take the train southbound to leave

GRCA. For example, a passenger may take the train northbound into the park unit, but have plans to take a shuttle bus to another location outside of GRCA.

Passenger Boarding Count Methodology

In 2014, Grand Canyon Railway reported 164,828 passenger boardings. This is equivalent to the number of ticket sold and did not account for the southbound passenger trips. If passengers were required to partake in both the north- and southbound trips, then the conversion rate would be two; however, with a small amount of passengers opting out of the southbound trip, the conversion factor is less than two. In understanding that passengers are not required, nor expected, to take the full round-trip, the project team calculated a conversion factor for the Grand Canyon Railway.

The Grand Canyon Railway has southbound data from its train dispatch office. Using the dispatch office's manually counted data provided by Xanterra and park unit staff, the project team calculated a **1.96** conversion factor for the Grand Canyon Railway. This would bring estimated total passenger boardings for 2014 to 323,128 (Table 10). For future data calls, the Grand Canyon Railway can apply this conversion factor to the number of tickets sold for more accurate passenger boardings.

Table 10 Results of conversion factor application for GRCA's Grand Canyon Railway

Year	Northbound Passengers (tickets sold)	Southbound Passengers	Conversion Factor	New Estimated Total Passenger Boardings
2014	164,828	158,300	1.96	323,128

Ferry Systems, Boston Harbor Islands National Recreation Area

Ferry systems operating in the U.S.'s open water must perform manual counts of passengers to comply with maritime safety regulations enforced by the U.S. Coast Guard. The Boston Harbor Islands National Recreation Area (BOHA) and Statue of Liberty/Elis Island National Parks (STLI) staff confirmed that these required manual counts informed the passenger boarding numbers reported to the NPS Transit Inventory. Additionally, discussion with Tom Crikelair who wrote the "Northeast Region of the National Park Service: Alternative Transportation Management System Phase 1 Final Report" validated that the systems use passenger counts from selected islands with an applied conversion factor to account for the islands without manual counts (Crikelair, 2011).

These mandatory manual counts would also apply GOGA/ALCA and VALR, two systems that are in the top ten largest systems from the NPS Transit Inventory. BOHA's Boston Harbor Island Ferries accounted for 145,227 passenger boardings and, as mentioned previously, STLI is the largest transit system in the NPS and accounts for over 10 million passenger boardings. Based on this information, these systems should be categorized as a manual count methodology rather than a ticket sales methodology.

Lessons Learned

Through the on-site visit and qualitative interviews, the project sought to gather information about how NPS transit systems convert ticket sales into passenger boardings. The project team summarized its findings into the following lessons learned, first for general ticket sale conversion methodology and second for conducting on-site passenger boarding counts.

General Ticket Sale Conversion

- Some NPS park units and concessioner staff did not seem to clearly understand the difference between a rider and a passenger boarding. Both are valid for tracking different aspects of system use, but they are measured differently. With improvements in the next data collection cycle for the NPS Transit Inventory, some transit systems may better understand a passenger boarding and methods to accurately calculate the measure.

- The meaning of "ticket sales" as a passenger boarding counting methodology in the NPS Transit Inventory was unclear for some transit systems. The project team found that several systems that indicated they were using ticket sales were in fact performing manual counts to measure passenger boardings, rather than relying on ticket sales. For example, the ferry systems that operate off of the U.S. coast perform manual counts and were providing those numbers. Increased communication from the NPS Transit Inventory project team to the NPS park unit staff and concessioners providing the passenger boarding information may help minimize misinterpretation of the ticket sales methodology.

- Of the systems interviewed, the simple transit systems with straightforward ticket systems are accurately converting ticket sales into passenger boardings. Jenny Lake Shuttle boat and the Eisenhower Shuttle, for example, utilize straightforward ticket sales systems that ensure easy calculation of passenger boardings.

- For more complex transit systems (e.g. with multiple stops), several options exist for acquiring the data needed to develop a conversion factor. If resources and staff time allow, performing validation of passenger boardings through counts is the most accurate, similar to the effort Volpe conducted at NAMA. If available, systems may also utilize survey data asking passengers how many stops they got on during a visit and/or single ticket purchase. A third less costly, but also less accurate option is to gather qualitative data from transit vehicle operators who may have a general sense of how many times a passenger boards throughout a service day.

- The ticket conversion rate can be updated as the park unit and/or transit operator see necessary. Many changes may occur over time that can affect passenger boardings. Things such as changing visitation patterns, transit service changes like adding or removing stops, or different ticket types (e.g., annual passes, family tickets) may affect a park unit's calculation of passenger boardings through ticket sales. Park units should be aware of these changes and verify or update systems' conversion methodology as appropriate or on a regular schedule as staff time allows.

Conducting On-Site Passenger Boarding Counts

- On-site data collection visits require flexibility and project teams should be prepared to adjust sampling plans to maintain the integrity of the data collected.

- Communication is crucial to smooth execution of a data collection site visit. The project team must internally communicate as well as externally communicate with the transit system operator, NPS park unit staff, and other regional and national NPS management.

- If possible, include the "on-the-ground" transit operations staff in the pre-visit call to ensure that accurate information about daily operations is communicated to the visiting project team; this will minimize surprises (e.g., operational fluctuations) that might impact data collection.

- If resources allow, an on-site "data collection coordinator" should be stationed at a common site or may need to roam amongst various sites. . This coordinator would ensure that the data collection is running smoothly and would make any adjustments, if needed, to the data collection plan. The coordinator would also enable easier feedback, communication, and distribution of materials among all project team members.

Conclusion

Based on this study's findings, many transit systems are reporting passenger boardings correctly using ticket sales. Some systems did not understand the passenger boardings metric, but did have the data to report passenger boardings correctly. Therefore it is important that park units and concessioners understand the passenger boarding definition during NPS Transit Inventory data calls. Converting ticket sales to passenger boardings can be more difficult for some systems to execute than others, due to system complexity, however, there are ways for those systems to accurately capture passenger boardings using ticket sales through count sampling such as the one performed for NAMA. More accurate boarding estimates will not only help make investment allocation decisions among units, but will also allow NPS to better characterize the scale of its transit operations and its financial needs. With more accurate passenger boarding estimate, NPS can then better estimate transit impacts on greenhouse gas emissions and performance of its business/concessions operations.

Literature Cited

2. NYC Transit, 2003 (http://ntl.bts.gov/lib/23000/23600/23620/psgr_ctg_svc_mon.pdf).
3. Crikelair, Tom; "Northeast Region of the National Park Service: Alternative Transportation Management System Phase 1 Final Report;" September 2011.

Appendix 1: List of Potential Systems

Table 11 List of Potential Systems

Park Unit Code	System Name	Interview Type	Reason for No Interview
NAMA	Big Bus	On-Site	
BOHA	Boston Harbor Islands Ferry	Phone	
EISE	Eisenhower Shuttle	Phone	
GRCA	Grand Canyon Railway	Phone	
GRTE	Jenny Lake Shuttle Boat	Phone	
GOGA/ALCA	Alcatraz Cruises Ferry	None	Manual counts
STLI/ELIS	Statue of Liberty Ferries	None	Previously studied; manual counts
FOSU	Ferry service	None	Manual counts
HAFE	HAFE shuttle transport	None	Manual counts
BOHA	BOHA Ferries	None	Manual counts
DEPO	Red Meadows Shuttle Bus	None	Unable to contact
YOSE	Tram Tours and Hiker Shuttle	None	Simple system
EVER	Gulf Coast and Flamingo Boat Tours	None	Simple system
PIRO	Pictured Rocks Cruises	None	Simple system
GRCA	South Rim Bus Tours	None	Simple system
GUIS	Ship Island Ferry	None	Simple system
MUWO	Muir Woods Shuttle	None	Bad timing
MEVE	Long House Trailhead tram and Half-day ranger guided	None	Bad timing
CHIS	Island Packers	None	Bad timing
PORE	Headlands Shuttle	None	Bad timing
DENA	Bus Tours and Shuttle Service	None	Simple System
PINN	Pinnacle Shuttle	None	Unable to contact

Appendix 2: NAMA Site Visit Sampling Schedule

Table 12 Sampling Schedule for Saturday, 8/15/15

Expected Route	Approx. Departure	Approx. Return	Approx. Break	Surveyor
Red	8:30 AM	10:30 AM	50	Staff 1
Red	11:20 AM	1:20 PM	50	Staff 1
Blue	2:10 PM	4:30 PM	10	Staff 1
Blue	4:40 PM	7:00 PM	(end)	Staff 1
Red	8:50 AM	10:50 AM	50	Staff 2
Blue	11:40 AM	2:00 PM	20	Staff 2
Red	2:20 PM	4:20 PM	30	Staff 2
Red	4:50 PM	6:50 PM	(end)	Staff 2
Red	9:10 AM	11:10 AM	40	Staff 3
Blue	11:50 AM	2:10 PM	30	Staff 3
Blue	2:40 PM	5:00 PM	10	Staff 3
Red	5:10 PM	7:10 PM	(end)	Staff 3
Blue	9:40 AM	12:00 PM	30	Staff 4
Red	12:30 PM	2:30 PM	60	Staff 4
Red	3:30 PM	5:30 PM	0	Staff 4
Red	5:20 PM	7:20 PM	(end)	Staff 4
Red	10:20 AM	12:20 PM	20	Staff 5
Red	12:40 PM	2:40 PM	90	Staff 5
Blue	4:10 PM	6:30 PM	(end)	Staff 5

Table 13 Sampling Schedule for Sunday, 8/16/15

Expected Route	Approx. Departure	Approx. Return	Approx. Break	Surveyor
Red	8:30	10:30	30	Staff 1
Blue	11:00	13:20	0	Staff 1
Blue	1:15	3:35	25	Staff 1
Red	14:00	6:00	(end)	Staff 1
Blue	9:00	11:20	0	Staff 2
Blue	11:15	1:35	40	Staff 2
Red	2:15	4:15	(end)	Staff 2
Red	9:30	11:30	15	Staff 3
Blue	11:45	2:05	25	Staff 3
Blue	2:30	4:50	(end)	Staff 3
Blue	9:45	12:05	40	Staff 4
Blue	12:45	3:05	25	Staff 4
Blue	3:30	5:50	(end)	Staff 4
Red	10:00	12:00	15	Staff 5
Red	12:15	2:15	60	Staff 5
Red	3:15	5:15	(end)	Staff 5

Appendix 3: NAMA Site Visit Data Collection Sheet

National Mall Passenger Volume Sampling, August 2015

Trip and Sampling Information

Day: Sunday	Date: 8/16/15
Route: Red/Blue - Combo	Approx. Sched. Departure: 11:45 AM
Surveyor Initials: LED	Vehicle Number: AYA29
Data Entry Date: 8/18/15	Data Entry Initials: EB

Boarding and Alighting Data by Stop

Stop ID	Stop Description		Pass. On	Pass. Off
1	**Union Station**	Departed at: 11:44 AM	23	
2	**US Capitol and Botanical Garden** 1st St NW by Garfield Memorial		6	2+2+2+4 10
3	**American Indian Museum** Intersection of Independence Ave and Maryland Ave		0	0
4	**Air and Space Museum** Independence Ave and 6th St		8 8	2+4 6
5	**Smithsonian Castle** Intersection of 12th St and Independence Ave		4	0
6	**Washington Monument West** Raoul Wallenburg Pl b/t Jefferson and Independence Ave		0	0
7	**Bureau of Engraving and Holocaust Museum** Raoul Wallenburg Pl off Maine Ave		3	0
8	**Jefferson Memorial** East Basin Dr behind Jefferson Memorial		5+3+5 13	9
9	**FDR and MLK Memorial** West Basin Dr between Ohio Dr and Independence Ave		6 6	0
10	**Lincoln Mem. South and Korean War Mem.** Daniel French Dr		10	15
11	**Lincoln Mem. North and Vietnam War Mem.** Constitution Ave and 22nd St		12 21	9 9

19
21
25
28
32
38
33
55

SU 8/16/15 11:45 AM

Stop ID	Stop Description		Pass. On	Pass. Off	
14	**WWII Memorial** Constitution Ave at 18th St		0	5	50
15	**Washington Monument East** Jefferson Dr at 14th St		0	0	
12 Red	**Arlington National Cemetery (Red Only)** Arlington Cemetery Bus Parking		18	11	57
13 Blue	**Pentagon City Mall (Blue Only)** Outside Arlington Fashion Centre		4	8	53
16	**American History Museum** Constitution Ave at 14th St		2	11	44
17	**Natural History Museum** Constitution Ave at 11th St		3	9	38
18	**Convention Center** K St between 7th and 9th St at Carnegie Library		2	0	40
19	**City Center** 10th St between H St and G Pl, behind Hyatt		0	0	
20	**Ford's Theatre and Madame Tussauds** 10th St at F St outside Madame Tussauds		17	26	31
21	**White House** Pennsylvania Ave between 14th St and 15th St		4	0	46
22	**National Archives and National Art Gallery** Pennsylvania Ave at 7th St		1	2	45
23	**Liaison and Hyatt Hotels** Outside Liaison Hotel across from Hyatt		0	0	
24	**Union Station**	Returned at: 2:08 PM		45	✓

Additional Notes

Appendix 4: NAMA Data Analysis Results

Table 14 Saturday (8/15) Passenger Boarding Estimations

Stop	Total Observed Boardings	Trips Sampled	Average Boardings (sampled)	Total Service Day Stops	Expected Total System Boardings
1	749	16	46.8	46	2153
2	125	16	7.8	46	359
3	10	16	0.6	46	29
4	170	16	10.6	46	489
5	17	16	1.1	46	49
6	87	16	5.4	46	250
7	10	16	0.6	46	29
8	83	16	5.2	46	239
9	56	16	3.5	46	161
10	157	16	9.8	46	451
11	99	16	6.2	47	291
14	44	16	2.8	47	129
15	52	15	3.5	47	163
12	132	16	8.3	47	388
13	94	16	5.9	47	276
16	90	16	5.6	47	264
17	51	16	3.2	47	150
18	31	16	1.9	47	91
19	6	16	0.4	47	18
20	104	16	6.5	51	332
21A	190	16	11.9	51	606
21B	12	16	0.8	51	38
22	13	16	0.8	51	41
23	21	16	1.3	51	67
TOTAL	**2,403**				**7,062**

Table 15 Sunday (8/16) Passenger Boarding Estimations

Stop	Total Observed Boardings	Trips Sampled	Average Boardings (sampled)	Total Service Day Stops	Expected Total System Boardings
1	346	14	24.7	47	1162
2	59	14	4.2	47	198
3	7	14	0.5	47	24
4	111	14	7.9	47	373
5	29	14	2.1	47	97
6	40	14	2.9	47	134
7	23	14	1.6	47	77
8	87	14	6.2	47	292
9	10	14	0.7	47	34
10	90	14	6.4	47	302
11	96	14	6.9	47	322
14	25	14	1.8	47	84
15	15	14	1.1	47	50
12	95	14	6.8	47	319
13	36	14	2.6	47	121
16	46	14	3.3	47	154
17	12	14	0.9	47	40
18	18	14	1.3	47	60
19	13	14	0.9	47	44
20	134	14	9.6	47	450
21A	104	14	7.4	47	349
21B	24	14	1.7	47	81
22	11	14	0.8	47	37
23	17	14	1.2	47	57
TOTAL	**1,448**				**4,861**