AN INNOVATIVE APPROACH FOR ESTABLISHING VEHICULAR TRIP CAPS FOR NEW DEVELOPMENTS: A CASE STUDY IN SOUTHEAST WASHINGTON, DC

Jamie Henson
District Department of Transportation (DDOT)
55 M Street, SE
Washington, DC 20003
Phone: (202) 671-1324
Email: Jamie.henson@dc.gov

Anna Chamberlin
District Department of Transportation (DDOT)
55 M Street, SE
Washington, DC 20003
Phone: (202) 671-2218
Email: Anna.chamberlin@dc.gov

Ramgiridhar R. Kilim, PE, PTOE
CH2M Hill
15010 Conference Center Drive, Suite 200
Chantilly, VA 20151
Phone: (703) 376-5000
Email: Giri.Kilim@ch2m.com

Murat F. Omay (corresponding author)
Sabra, Wang & Associates, Inc.
7055 Samuel Morse Drive, Suite 100
Columbia, MD 21046
Phone: (240) 441-4807
Email: momay@sabra-wang.com

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ABSTRACT

A rapidly developing area of the City was beginning to experience land development pressure that has the ability to lead to a level of trip generation that would render the transportation network non-functional. The District Department of Transportation (DDOT) composed a methodology to evaluate potential impacts from future land development projects based on the trip generation and modal split assumptions found in a robust evaluation of the transportation network in that area of the City. The methodology focused on capping trip generation rates for a land development project to be consistent with rates assumed in previously completed study efforts that involved the region's travel demand model and microsimulation. The approach ties conditions expected in some future build-out scenario to the projected trip generation and/or the amount of on-site parking spaces needed by a new development project. Through this method, the amount of parking spaces and/or the vehicular trip generation estimates become a function of the planned travel conditions and can be capped to facilitate efficient traffic operations.

Key Words: Modal Split Assumption, Development Review, Traffic Impact Study, Trip Generation, Parking Cap, Trip Cap, Transportation Demand Management

INTRODUCTION

The District of Columbia faces significant demands on its transportation network due to the proliferation of land development projects. Many of the waterfront neighborhoods along the Anacostia River bound by the Potomac River and the Southeast Southwest Freeway are transforming from low density industrial uses to high density office, commercial, and residential uses. The existing roadway network is designed to facilitate suburban commuters and industrial uses with wide streets, minimal pedestrian facilities, and a disconnected roadway network. Most of the vehicular traffic traverses South Capitol Street and M Street, SE/SW, the two major arterials in this corridor of approximately 1.6 square miles. As described in the recent South Capitol Street Environmental Impact Statement (EIS) “Today, the South Capitol Street Corridor continues to connect downtown Washington to neighborhoods in the southeast and southwest quadrants of the District of Columbia and Prince George’s County, Maryland. South Capitol Street, particularly within the section between the United States Capitol and the Anacostia Waterfront, lacks any characteristics of its historic function as a gateway. The street’s present conditions are not appropriate to its central place and important function. South Capitol Street is an urban freeway that has become a conduit for through traffic at the expense of serving the immediate needs of the residents and businesses in the corridor. The transportation infrastructure is deteriorating and fails to provide necessary connections to community destinations for pedestrians, bicyclists, transit riders, or motorists” (Parsons Brinckerhoff, 2011).

The District Department of Transportation (DDOT) has aggressively pursued a major restructuring of its infrastructure in the area to facilitate the increase in development. The Agency is moving forward on building a multi-modal bridge, replacing an expressway with an urban boulevard, and implementing a new streetcar along the neighborhood’s main street. Extensive analysis was performed during the planning and environmental process for these projects. The analysis revealed a major bottleneck with the potential to stall the entire network where the two major arterial roads, South Capitol Street and M Street intersect. Despite the challenge, DDOT is moving to implement an urban solution to the area allowing a functioning roadway network that facilitates walkability and transit access.

The major threat to the area’s transportation network is the proliferation of vehicle trips resulting from the massive redevelopment of the area. Many of the redevelopment projects seek an amount of parking that could potentially lead to levels of trip generation that are inconsistent with a functioning vehicle travel network. DDOT has attempted to address these concerns through the development review process as parcels undergo a zoning review. During the zoning process, DDOT requests a transportation analysis under the guidelines of its Comprehensive Transportation Review (CTR) process that evaluates the potential development impacts to the transportation network as a result of the project. Details of the CTR are discussed in the proceeding sections of this paper.

During a CTR review for a site in the study area, DDOT became concerned about the potential for cumulative impacts from expected land development. To address this concern, DDOT began to proactively pursue a variety of methodologies to evaluate land development projects and limit cumulative impacts to ensure the two major arteries would still be able to function appropriately in the area.

Objective

The basic purpose of DDOT development review and its CTR process is to ensure that the District's transportation network maintains a functional travel network that supports increased levels of economic development without allowing travel delay to reach catastrophic intensities. This paper evaluates a systematic approach to controlling the vehicle travel demand through the development review process. The approach ties conditions expected in future build-out scenarios to the projected trip generation and/or the amount of on-site parking spaces needed by a new development project. Through this method, the amount of parking spaces and/or the vehicular trip generation estimates become a function of the planned travel conditions.

The objective of the effort is to leverage the analysis commissioned for the M Street SE/SW Study and the South Capitol Corridor environmental assessment process to inform its development review process. DDOT performed a robust evaluation of expected future land uses and the transportation conditions the area could expect upon build-out in approximately 25 years. During these evaluations, a methodology was employed that incorporated the region's travel demand model to forecast travel growth and microsimulation to evaluate facility operations. DDOT found that the network under future scenarios could provide a level of functionality that is acceptable though strained. Since a functional network was found in the evaluation process, DDOT attempted to take the land use and trip generation assumptions from these efforts and apply them to site specific development review projects.

As a result of the above, DDOT recognized the need for a higher level of certainty in trip generation forecasts. To address this concern, DDOT composed a methodology to evaluate future development projects based on the trip generation and distribution, and modal split assumptions of the travel demand model resulting from the land use growth that fed the travel forecast. The methodology determined the level of trip generation assumed for the parcel level in the area and proposed mitigation measures to the developers in the form of transportation demand management (TDM), trip caps, and/or a performance monitoring program to achieve the needed trip generation rates. DDOT utilized a recent development proposal as a case study and application of the modal split assumptions used in the South Capitol Street and M Street SE/SW transportation models to determine the maximum allowable number of net new vehicular trips, thus establishing a basis for the number of parking spaces that would be suitable for the subject development used as the case study.

Problem Statement

Transportation agencies serving urban areas are challenged to develop reasonable trip generation and modal split estimates, which are the necessary building blocks for evaluation of future transportation conditions. Currently, DDOT depends significantly on the forecasts and analyses developed by the traffic engineering firms hired by the developers. These forecasts almost exclusively utilize data from the most up to date Trip Generation Manual published by the Institute of Transportation Engineers (ITE) which includes trip rates and directional distributions for various land uses. The published trip rates are developed from actual data compiled from many sites across the country. However, these rates are published as a function of land use, typically in suburban settings where transit service and non-motorized facilities are not comparable to an urban environment (Shoup, 2003). In urban settings, vehicular trip generation becomes a function of land use density, proximity to transit, availability of parking, and overall accessibility. Therefore, forecasting vehicular trip generation and precise modal splits for new development proposals in dense urban environments becomes a complex task.

The challenge with using modal split and other trip generation data is that a variety of independent variables impact trip generation in ways that are difficult to quantify and developers in the District of Columbia desire to build an amount of parking that is inconsistent with a more preferable mode split. This combination can lead to a forecast with a wide margin of error and result in a level of trip generation that cannot be accommodated on the travel network. DDOT became concerned with the relatively high level of trip generation assumed at a specific site in the subject neighborhood and the cumulative impacts if the remainder of the area developed in a similar manner. If the projections for the site are achieved in each future development in the area, the travel network would likely be rendered non-functional.

REVIEW OF SIMILAR PRACTICES AND POLICIES

The determination of roadway link and node capacities through modeling and trip caps assignments for development proposals is not a new concept in transportation planning, nor is the use of parking supply as a transportation demand management measure. There are numerous procedures and practices employed by various state or municipal DOTs that resemble DDOT's methodology. However, setting the trip caps based on a combination of transportation demand management and parking maximums is a fairly new practice exercised in urban environments such as New York, Washington, DC, Seattle, Portland, and San Francisco. A 1992 document discusses transportation demand management comprehensively in sixteen different categories is compiled under *Transportation Control Measure Information Documents* prepared for the Environmental Protection Agency (EPA). Categories include Trip Reduction Ordinances, Employer-based Transportation Management Programs, and Parking Management, among many others (Cambridge Systematics, 1992). The EPA document emphasizes the relation between parking and trip generation, where increased supplies of parking could trigger increased trip generation.

City of Seattle Urban Mobility Plan Briefing Book

In May 2007, the Seattle City Council requested the Seattle Department of Transportation (SDOT) to develop an Urban Mobility Plan as a solution for replacing the Alaskan Way Viaduct. SDOT was requested to use a systems approach in the Urban Mobility Plan, including enhanced transit service, surface street and highway improvements, and other transportation programs and policies. The plan was intended to focus on the movement of people and goods to and through Downtown, rather than maintaining vehicle capacity of the existing SR 99 corridor.

As part of the Urban Mobility Plan, the City of Seattle developed a briefing book that contained information about how the existing transportation system operated, information on known and/or projected future conditions, and how issues were handled by municipalities in the US who faced similar challenges. The report on the Urban Mobility Plan was completed as part of the three-agency Central Waterfront Partnership Process and is based on the Interstate 5/Surface/Transit hybrid scenario that was developed as part of that process. Chapter 7A of the Briefing Book covers Best Practices in Transportation Demand Management (TDM) and Chapter 7B covers Best Practices in Parking Management. These chapters discuss trip cap as an effective method for managing future congestion levels and parking cap as an effective policy compared with parking minimums (Seatlle Department of Transportation (SDOT), 2008).

Arlington County (Virginia) Master Transportation Plan

This transportation plan discusses trip cap methods under the policy "Allow Developers to Cap-and-Trade the Number of Auto Trips Permitted per Site". The alternative approach Arlington advocates for managing traffic congestion is one similar to that promoted by some to manage and reduce air pollution. Rather than try to over-regulate each land use with specific TDM requirements tailored to all types of development, Arlington would create a market for auto trips similar to the widely-known cap-and-trade markets for specific environmental pollutants. Benefits of setting a “trip cap” for different corridors are also discussed, along with temporal variations, similar to temporal variations of tolling or congestion pricing policies and practices. Based on the Arlington model, a proposed new development in a congested corridor could gain approval by working to reduce its own trips, but also by buying trip “credits” from adjacent uses either in an auction or through an established trip bank. Arlington County Transportation Plan also cites that “This is the approach that Stanford University uses as part of its General Use Permit Agreement with Santa Clara County, CA. The County provides tremendous flexibility for campus growth, allowing nearly five million square feet of development, but has limited the peak period auto trips generated to 1989 levels. Different institutions on the campus, including the hospitals and various schools, must trade with each other to reduce campus-wide trips to create new development capacity. Under the recent update to the permit, the campus is now able to take credit for trips reduced at the nearby Stanford Research Park offices” (Arlington County, 2006).

Similarities to Development Impact Fee Assessment Process

The principle of the process discussed in this paper is similar to the common development impact fee assessment processes that are widely implemented by municipalities throughout the United States. A development impact fee is a type of financial exaction through which municipal governments condition development approval on receiving a fee to pay for infrastructure and services needed because of the development (Mathur & Smith, 2012). In a recent policy analysis paper (*Development Impact Fees in D.C.),* commissioned by DDOT, Bennett discusses that “One of the most important aspects of an impact fee program is that it specifies what type or amount of development will trigger the imposition of fees. Impact fees may be limited to certain land uses and sizes of new development only, or may include redevelopment projects. The trigger may simply be related to whether the development will generate infrastructure needs” (Bennett, 2013).

Typical components used in determination of transportation-related impact fees include a formula that incorporates expected net increase in vehicular trips generated by the proposed development and a pre-determined unit cost per trip. The unit cost per trip is determined by the proportional cost of the required infrastructure improvements to maintain the acceptable service adequacy of the roadway network. In principle, this is very similar to the approach that is discussed in this paper, where the proportional unit cost is replaced by the trip cap, and the capital infrastructure cost is replaced by the roadway capacity.

A typical trip generation assessment for impact fee calculation would include the development of base trip rates using the ITE Trip Generation publication or similar guidelines, application of a factor to determine person trips, application of a modal split percentage to determine the number of vehicular trips, deduction of pass-by and internally-captured trips to arrive at the new number of vehicular trips a development is expected to feed into the roadway network. Therefore, modal split assumptions are a key component in vehicular trip generation calculations for assessment of correct impact fees that would correlate with the needed infrastructure or transportation improvements for operational efficiency and safety. Because of the similarities in the impact fee assessment processes and the subject trip cap methodology, the correlation can be carried forward to the proposed methodology.

CURRENT COMPREHENSIVE TRANSPORTATION REVIEW (CTR) PROCESS

DDOT has recently revised its Comprehensive Transportation Review (CTR) process. The objective of the CTR is to assess the transportation impact of each development proposal from vehicular operations, pedestrian and bicycle circulation and safety, transit access, parking supply, loading access and management perspectives, as well as overall operational and safety elements in public space. Based on a set of established criteria, development proposals are required to undergo the CTR process and a traffic impact assessment must be prepared for DDOT's review. The description of the aforementioned revised process was covered comprehensively in a recent TRB paper titled "*Development Review in the District of Columbia: Transitioning from a Traditional Traffic Impact Study to Comprehensive Multi-Modal Transportation Review.*" The new CTR guidelines aim "to meet multi-modal strategic objectives in the District's Comprehensive Plan, [where] DDOT has transitioned to a structured model for evaluating transportation impacts and potential mitigation across all travel modes. This model is built upon new comprehensive transportation review guidelines, which replace the traditional traffic impact study and provide a standardized process to a developer, delineating the method of collecting and analyzing data in support of their project in order to be in compliance with DDOT policies. In addition, the new guidelines provide a process for the interpretation of data, allowing DDOT to develop opinions and recommendations to a zoning body on a development's impacts. Further, a new set of standardized forms and reporting documents ensure consistent and structured interaction among DDOT, developers, and zoning bodies, throughout the zoning process from project inception through permitting" (Zimbabwe, Henson, Parker, & White, 2013).

Trip Generation and Modal Split Assumptions used in the CTR Process

Trip generation analysis is one of the key components of transportation planning studies. When a transportation impact analysis is conducted for a new development, the first step for forecasting trip generation typically involves referring to trip generation rates and/or equations provided in the ITE Trip Generation Manual. It should be noted that the ITE Trip Generation method estimates trip ends as simple "vehicle trips" with no distinction between types of modes, but the regional transportation planning models typically forecasts "person trips", which are further categorized into motorized (autos, transit, commercial) and non-motorized (walk and bike) modes.

Where data is available, DDOT typically estimates modal split for a development proposal using the Washington Metropolitan Area Transit Administration (WMATA) Development-related Ridership Survey. The WMATA Survey is based on 2005 data for 49 sites by 13 Metrorail stations, where each location portrays a slightly different overall land use, density, and demographic composition. The Survey documents the "travel behavior of persons traveling to and from office, residential, hotel and retail sites near Metrorail stations. The 2005 effort sought to determine if modal splits for these land uses have changed over time and whether certain physical site characteristics still impact transit ridership" (WMATA, 2006).

Although the new CTR procedures are in place, it is important to note that DDOT still faces known urban challenges related to the scope of data collection and analyses that can be limited to planning-level efforts, thus the assessment of real impacts of complex mixed-use development projects with multi-year development schedules can be difficult. Estimates for trip generation and modal split assumptions can be a hot topic of discussion among DDOT engineers and planners. Given that the District does not have an impact fee assessment process or similar mechanism, the need for developing a method to calculate accurate trip generation rates and trip/parking cap for the new developments is the most important tool to determine mitigation measures to ensure impacts to the transportation network are minimized.

CHARACTERISTICS OF THE DEVELOPMENT USED AS THE CASE STUDY

The development proposal used in this case study is located in Ward 6 in Southeast Washington, DC. The site is located on the southern side along M Street, SE, and north of N Street, SE between Van Street, SE and South Capitol Street. The proposed development program consists of 328,000 square feet of overall development, of which approximately 311,000 square feet is dedicated for office use and 17,000 square feet for street-level retail use. ***Figure 1*** includes an aerial image of the extended area, along with the roadway network and the locations of transit, bicycle and car sharing stations.

It is important to note that the location of the proposed site provides excellent access to high-quality transit service. The pedestrian access point of the site is located approximately 475 feet from the Navy Yard/Ball Park Metro Station, which is a station along the Green Line on the Metro system. Another entrance to the same metro station is approximately 1,350 feet to the east, and 2,675 feet from another station along the Green Line (Waterfront Station) to the west. The service along the Green Line runs in 6-minute frequency during the morning and afternoon peak periods and 15 to 20-minute frequency during the weekday off-peak periods and on weekends. In addition, the area is served by 13 different bus lines, and one Circulator route. The bus frequencies are between 10 and 40 minutes, where the average headway of all bus lines is approximately 25 minutes. There is one bus stop located on the same block of the proposed development site, and six bus stops within a two-block radius.

Proposed Parking Ratios

Current District of Columbia zoning regulations for parking requirements define the minimum number of parking spaces based on the size of a development, but does not include maximums. Based on the regulations, the proposed development would be required to provide a minimum of one space for each 1,800 square feet in excess of 2,000 square feet for the office uses and one space for each 750 square feet in excess of 3,000 square feet for the retail uses. Based on these ratios, the proposed development is expected to provide a minimum of 172 spaces for the office and 19 spaces for the retail portion. However, the development proposal consisted of 310 off-street parking spaces that would be shared by the office and retail portions of the development. The proposed number of 310 spaces is 119 spaces above the 191 off-street parking spaces required by regulation. Based on the proposed number of spaces, approximate parking ratios of 1.12 parking spaces per 1,000 SF of retail (19 retail parking spaces) and one parking space per 1,065 SF of office were observed (291 office parking spaces).

OVERALL APPROACH

The corridors that were studied to develop the methods and procedures discussed in this paper consist of two arterials, South Capitol Street and M Street, SE/SW. The intersection of South Capitol Street and M Street serves as the ‘master’ intersection of the local area roadway network, where capacity deficiencies and significant delays echo into the adjacent roadway network, thus diminishing levels of service and increasing safety conditions within the entire local transportation system.

Background

South Capitol Street is a six-lane principal arterial that runs in the north-south direction and carries an approximate Average Annual Daily Traffic (AADT) of 60,000 vehicles in the vicinity. South Capitol Street terminates at Independence Avenue/Access to the U.S. Capitol, and continues as North Capitol Street connects Interstates 295, 395, and 695 (to the south) through the Frederick Douglas Memorial Bridge to the northeastern sections of the District. The roadway has a posted speed limit of 25 mph and the intersection of South Capitol Street and M Street is grade separated, where turning movements to/from M Street are accommodated by an at-grade intersection created through auxiliary lanes from South Capitol Street. No parking is provided along the roadway within the vicinity of the subject site. M Street is a six-lane minor arterial that runs in the east-west direction connecting Maine Avenue, SW (to the west) to 11th Street, SE (to the east). The roadway carries an approximate AADT of 20,000 vehicles in the vicinity of the subject site. Adequate sidewalks are proposed along both sides of the roadway, as well as ADA-compliant ramps and accessible pedestrian signals (APS)/ count-down pedestrian signals (CPS) pedestrian signal equipment at the intersections. No parking is provided along the roadway during morning and afternoon peak periods.

DDOT envisions the M Street and South Capitol Street corridors as pedestrian-friendly, low-speed facilities with emphasis on transit and non-motorized transportation modes. DDOT undertook two distinct corridor-wide study efforts to evaluate and develop a location-specific action plan to modify the transportation infrastructure for both M Street and South Capitol Street corridors.

South Capitol Street Study **-** The study evaluated safety, multimodal mobility, and accessibility improvements to support economic development. The proposed improvements to South Capitol Street are intended to realize the vision set in the L'Enfant Plan through downgrading South Capitol Street from an expressway to an urban boulevard and gateway to the District of Columbia's Monumental Core. The project is expected to improve pedestrian mobility and safety by creating new transit stops and pedestrian facilities along South Capitol Street and Suitland Parkway to create new opportunities for movement throughout the corridor. Currently, some of the highest pedestrian fatality rates occur at three major intersections within the corridor.

M Street SE/SW Transportation Study - The study identified current and future transportation challenges and needed mitigation measures within an approximately 1.7-square-mile area along M Street SE/SW, and the Southwest waterfront from 12th Street, SE to 14th Street, SW and from the Southwest/Southeast Freeway south to the Anacostia River/Washington Channel. The study analyzed the integration of transit, bicycling and walking with motor vehicle traffic in order to best serve the neighborhoods in this burgeoning section of the city. Safety and access needs were balanced to address the travel needs of residents with those of visitors and workers who will be drawn to new retail and mixed use development planned for the area.

Development of the Methodology

DDOT leveraged results generated from these study efforts to inform the development review process for a land redevelopment project within the study area. Assumptions from these studies on trip generation from area land uses were utilized to inform the trip generation assumptions on development review projects in the immediate vicinity. The general methodology centered on the following five steps:

1) Evaluation of the travel demand model to perform updates/refinements as necessary
2) Suggestions for improvements to accommodate future needs

3) Performing operational analyses to test effects of the trip/modal split assumptions
4) Determination of the desired outcome/solution
5) Application of the assumptions from desired solution to development review context

The first four steps were accomplished through the M Street and South Capitol corridor efforts while the fifth was completed in the development review process. It is important to note that the purpose of this effort was not to comment on the approach to modeling or operations analysis. DDOT assumes that these efforts were completed in a manner that is consistent with best practices. The focus of this effort was to determine how to best leverage study efforts to address concerns that typically arise in the development review process.

Proposed Methodology

The following summary of the steps minimally addresses technical evaluation necessary for demand modeling and operations analysis and focuses on how to incorporate these results into development review processes.

1) Evaluation of the Travel Demand Model to perform Updates/Refinements as Necessary

The Metropolitan Washington Council of Governments (MWCOG), as the regional planning organization, and the National Capital Region Transportation Planning Board (TPB), as the designated Metropolitan Planning Organization (MPO), are responsible for the development and maintenance of the travel forecasting model for the Washington, DC area. The COG/TPB Travel Forecasting Model, Version 2.2 and land use data from Round 8.0 Cooperative Forecasting was used as the basis for developing the traffic model for this case study.

DDOT utilized the model and inputs to inform the travel forecasts for both the South Capitol Street and M Street, SE/SW corridors. Necessary validation and calibration were performed as part of these processes. In addition, the travel network was refined and the land use assumptions were updated. Updating land use assumptions was a key step, as this allows for a more accurate assessment in future development review needs. The findings from this review revealed significant differences at the traffic analysis zone (TAZ) level between both data sources. As a result of the findings, the study team recommended the adjusted proposed land use data for 2035 based on the land use data directly derived from the future developments planned within the study area. With the revised (increased) land use inputs in the study area, an increase in trip generation was certainly observed. Correspondingly, there was an increase in the non-motorized person trips (walk/bike trips) and internal capture as well. The reason behind this phenomenon could be due to the increase in zonal land use density (population per household, employees per square feet, etc.) equivalent to urban zones, thereby forecasting the corresponding person trips similar to urban in nature (more walking, more bicycling, reduced auto trip rate, etc.). It was evident from this case study that, reviewing and revising the land use inputs helped in forecasting trips that are more credible and reliable and is expected to influence the subsequent traffic operations tasks.

2) Suggestions for Improvements to Accommodate Future Needs

DDOT proposed a variety of improvements to infrastructure in the area as part of both the M Street and South Capitol Street corridors projects. The two major project in the immediate vicinity of the case study site include rebuilding the grade separated intersection of South Capitol Street and M Street to be an at grade intersection and implementation of streetcar on M Street.

Both improvements to the infrastructure cause traffic operations to deteriorate somewhat while significantly increasing pedestrian and transit access in the area.

3) Performing Operational Analyses to Test Effects of the Trip/Modal Split Assumptions
Significant operational analysis was performed to evaluate future operations with the proposed changes. After incorporating growth forecasts, projected volumes were analyzed in a robust microsimulation performed in VISSIM. Such microsimulation takes into account fine grain vehicle, pedestrian, and transit movements and shows the resulting conditions. Rather than focusing on operations at a single intersection, microsimulation takes into account system impacts by considering how operations at various intersections interact. Because microsimulation accounts for many types of movements and consider potential spillback through the network, it provides the highest level of certainty regarding future operations of the facilities.

4) Determination of the Desired Outcome/Solution
Analysis produced for these studies evaluated the potential impacts of the future land uses along with proposed changes in infrastructure. The studies concluded that the transportation network could handle the proposed changes along with growth in land use. However, conditions in the area will be at capacity. Further, significant deviations from the forecast could lead to dramatic impacts to travel conditions in the area.

5) Application of the Assumptions from the desired Solution to Development Review Context
In order to maintain functionality of the system, it was concluded that future land development projects needed to achieve a reasonable vehicle trip generation, where trip limitations (or caps) would be applied to developments based on their location and land use/development program. DDOT determined that, in order to facilitate mobility for the area, all office development projects in the area should achieve or exceed 80-90% of employees traveling by a non-automotive mode. This mode split was derived from a review of forecasted travel patterns generated by the travel demand model. The model projects approximately 1.75 vehicle trips per employee per day. Of those, about 20% occurred in the AM peak period and 20% in the PM peak period. Those trips were further subdivided into the peak hour. Approximately 40% of the peak period trips occur in the peak hour. Thus, DDOT found that in the peak period, to allow for functionality of the travel network, vehicle trips should be limited to approximately 0.15 trips per employee. DDOT interpreted this as a non-auto mode split of approximately 80%-90%.

Applying the trip generation and modal split assumptions used in the process to the development proposal used as the case study equated to a reduction of the vehicle trip rates in the peak hour by approximately one third to about 125 total trips in both the AM and PM peak hours. Coincidentally, this can be equated to the level of trip generation that could be expected from providing a level of parking equivalent to the zoning minimums which is roughly equivalent to one space per seven employees if each employee is assumed to utilize 250 square feet.

RESULTS AND FUTURE DIRECTION

This paper summarized DDOT's efforts to examine the feasibility of developing a systematic process to determine corridor-wide or sub-area modal split assumptions that would allow the transportation network to operate at acceptable saturation levels. The effectiveness of the system-wide modal split assumptions were tested by using regional transportation demand and corridor-wide microscopic models. Based on the measures of effectiveness obtained from the model outputs on system-wide saturation levels, DDOT evaluated the effectiveness of applying the corridor-wide assumptions to new development proposals in the localized area by using a recent development proposal as a case study.

From an application standpoint, DDOT used the case study to approach the developer and discuss potential trip reduction measures to be implemented in order to achieve the targeted trip generation levels, thus maintaining the functionality of the roadway network at desired levels in the long run. DDOT was in the opinion that the level of proposed parking will encourage an excessive amount of vehicle trips. Therefore, DDOT initially expressed its preference to the developer as reduction in the parking supply by approximately 100 spaces. Although the quality and modal diversity of the current and future transportation system supported the mode choice assumptions (i.e., transit, bicycling, walking, and car/bicycle-sharing), the developer insisted that the current market conditions would not allow the development project to be feasible, if parking supply is reduced to the levels that DDOT requested. Based on the constraint presented by the developer, DDOT agreed to implementation of an obligatory monitoring program that includes strategies to require 'a level of vehicle trips consistent with the reduced amount of parking.'

However, in the future, DDOT would like to take the findings of the efforts outlined in this paper and transfer the knowledge to investigating other innovative methods that would provide alternative approaches and/or solutions to the issue, of which, some are discussed briefly in the following paragraphs.

Applications of the subject Methodology

In line with the objectives of the subject planning efforts discussed in this paper, DDOT is in the process of evaluating the establishment of a repeatable method to evaluate new development proposals elsewhere in Washington DC. This further evaluation would allow DDOT to establish area or corridor-wide trip and/or parking caps in areas experiencing significant development and associated trip generation.

Changes in DC Zoning Regulations for Parking Requirements

Approximately four years prior the date of this paper, the DC Office of Planning (DCOP) undertook a study to measure the effects of changing the DC Zoning Regulations to include parking maximums instead of the current minimums. Although the proposal for changing the regulations for parking are still under consideration, the discussions and method described in this paper would be an informative component in those evaluations. The method to assess the roadway and intersection capacities under the future conditions and to determine the maximum allowable number of parking spaces on a parcel level would provide a tool to evaluate the conditions on a system-wide level rather than as an isolated condition associated with a parcel.

Further Research: Evaluation of Trip and Parking Generation in Highly Urbanized Areas

During the development stages of the methodologies described in this paper, and after evaluating the outcomes of the case study application, it was reinforced that further research on trip and parking generation in urban settings was needed. Subsequently, DDOT initiated the research efforts on assessing trip and parking generation rates in the District of Columbia and other highly urbanized areas. This research proposes to develop multimodal trip and parking generation rates that better reflect the relationship between land use, transportation and travel demand for specific land use types located in heavily urbanized settings, especially in Washington DC. The research conducted for this project would account for how the built environment (e.g., both land use and transportation) influences travel behavior (number of trips, trip length, mode choice), and determine trip and parking rates that reflect the entire activity spectrum of different development/place typologies. The research would also account for the relationship between parking and trip generation. Details of this effort are available from the authors upon request.

Trip and/or Parking "Cap and Trade"

After the discussions summarized in this paper, another discussion topic developed around establishment of a "cap and trade" trip bank for trip credits and debts is a new method under considerations by several transportation planning agencies. Developers that produce vehicle trips in excess of their vehicle mode split goal and/or approved vehicle site trip rate can buy down trips from a bank of trip credits supplied by developers whose projects produce vehicle trips that are below the threshold for their site. If a development is under the threshold, they can apply for a trip credit and then sell the vehicle trip credits to another developer within the same policy area. This could also be extended to parking spaces, where developers would apply for the excess parking spaces in the 'parking bank' specific to a corridor, area, development district, or neighborhood. This topic is being programmed for further research by one of the authors of this paper.

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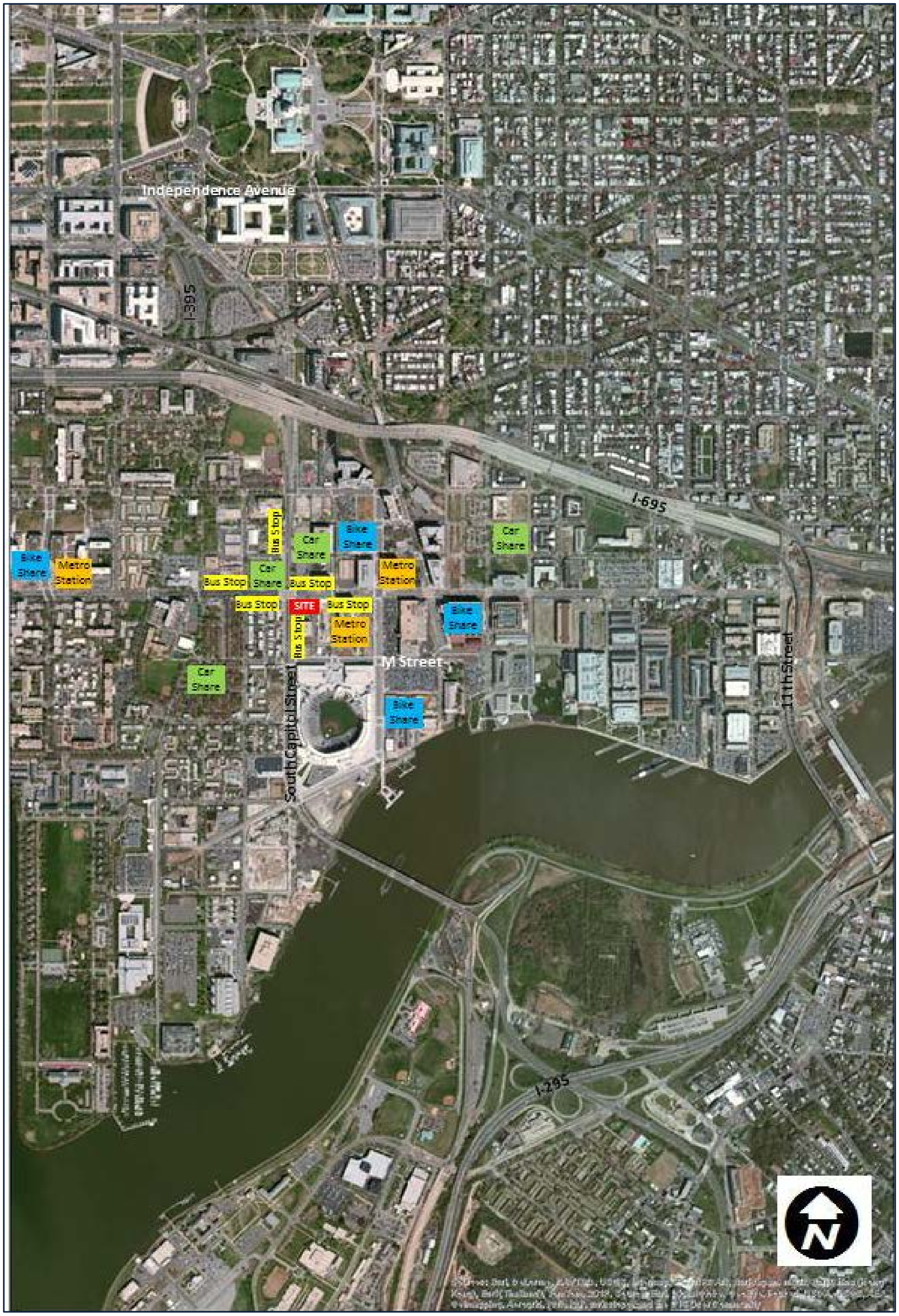
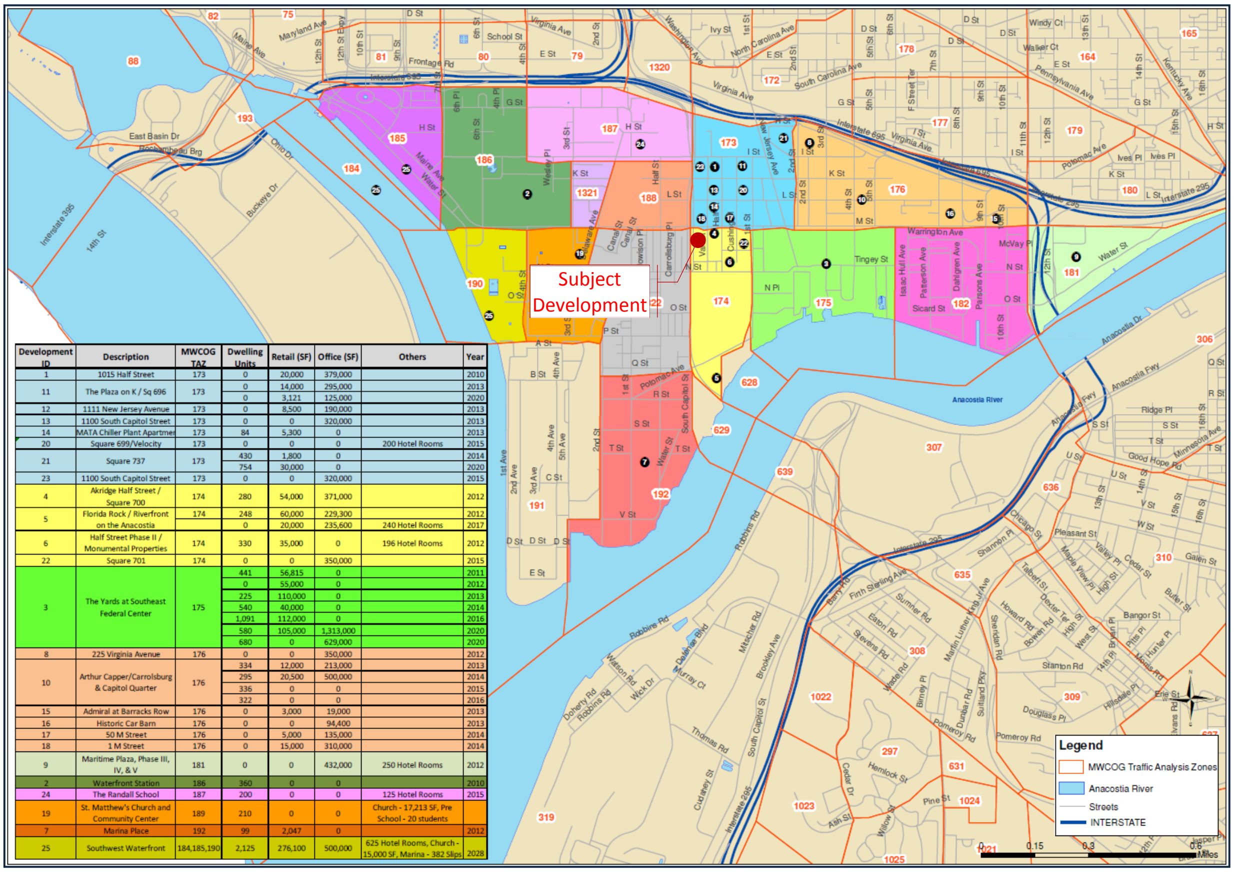
LIST OF FIGURES



Source: Sabra, Wang & Associates, Inc. (2013)

1 **FIGURE 1 Site Location and Roadway Network, Transit, Bicycle and Car Sharing Facilities in the Area.**



Development ID	Description	MWCOG TAZ	Dwelling Units	Retail (SF)	Office (SF)	Others	Year
1	1015 Half Street	173	0	20,000	379,000		2010
11	The Plaza on K / Sq 696	173	0	14,000	295,000		2013
			0	3,121	125,000		2020
12	1111 New Jersey Avenue	173	0	8,500	190,000		2013
13	1100 South Capitol Street	173	0	0	320,000		2013
14	MATA Chiller Plant Apartmer	173	84	5,300	0		2013
20	Square 699/Velocity	173	0	0	0	200 Hotel Rooms	2015
21	Square 737	173	430	1,800	0		2014
			754	30,000	0		2020
23	1100 South Capitol Street	173	0	0	320,000		2015
4	Akridge Half Street / Square 700	174	280	54,000	371,000		2012
5	Florida Rock / Riverfront on the Anacostia	174	248	60,000	229,300		2012
			0	20,000	235,600	240 Hotel Rooms	2017
6	Half Street Phase II / Monumental Properties	174	330	35,000	0	196 Hotel Rooms	2012
22	Square 701	174	0	0	350,000		2015
3	The Yards at Southeast Federal Center	175	441	56,815	0		2011
			0	55,000	0		2012
			225	110,000	0		2013
			540	40,000	0		2014
			1,091	112,000	0		2016
			580	105,000	1,313,000		2020
			680	0	629,000		2020
8	225 Virginia Avenue	176	0	0	350,000		2012
10	Arthur Capper/Carrolsburg & Capitol Quarter	176	334	12,000	213,000		2013
			295	20,500	500,000		2014
			336	0	0		2015
			322	0	0		2016
15	Admiral at Barracks Row	176	0	3,000	19,000		2013
16	Historic Car Barn	176	0	0	94,400		2013
17	50 M Street	176	0	5,000	135,000		2014
18	1 M Street	176	0	15,000	310,000		2014
9	Maritime Plaza, Phase III, IV, & V	181	0	0	432,000	250 Hotel Rooms	2012
2	Waterfront Station	186	360	0	0		2010
24	The Randall School	187	200	0	0	125 Hotel Rooms	2015
19	St. Matthew's Church and Community Center	189	210	0	0	Church - 17,213 SF, Pre School - 20 students	
7	Marina Place	192	99	2,047	0		2012
25	Southwest Waterfront	184,185,190	2,125	276,100	500,000	625 Hotel Rooms, Church - 15,000 SF, Marina - 382 Slips	2028

Source: CH2M Hill, Inc. (2012)

FIGURE 2 Traffic Analysis Zone (TAZ) Structure and Locations of Background Developments used in the Transportation Demand Model.