TECHNICAL WHITE PAPER

VEHICLE MILES TRAVELED CALCULATIONS USING THE SANDAG REGIONAL TRAVEL DEMAND MODEL

San Diego, California
May 2013

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TECHNICAL WHITE PAPER

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1.0 INTRODUCTION

In the last six years, the State of California has adopted key legislative bills that address the reduction of greenhouse gas (GHG) emissions. Specifically, Assembly Bill 32 (AB 32, 2006) sets a statewide GHG reduction target to return to the 1990 emissions level by the year 2020. In addition, in 2008, California adopted SB 375 which specifically addresses emissions from transportation. SB 375 directs California's Metropolitan Planning Organizations (MPO's) to meet GHG emission reduction targets established by the California Air Resources Board (CARB) through coordinated land use and transportation planning. Subsequently, Senate Bill 97 (SB 97, 2009) created guidelines for analyzing GHG emissions in environmental documents required under the California Environmental Quality Act (CEQA). For the purpose of this white paper, Vehicle Miles of Travel (VMT) are used as a proxy for greenhouse gases.

The Bureau of Transportation Statistics defines VMT as a unit to measure vehicular travel made by individual vehicles. Each mile traveled is counted as one vehicle mile regardless of the number of persons in the vehicle. Total vehicle miles is the aggregated total mileage traveled by all individual vehicles.

As a result of these acts, regional agencies, local governments, and private firms have worked to establish methodologies for analyzing the effects of development projects, climate action plans, and proposed general plan updates on GHG emissions as part of the CEQA process.

At the national-level, the International Council for Local Environmental Initiatives (ICLEI)-Local Governments for Sustainability has recently published a technical paper documenting a new national standard that establishes requirements and recommended best practices for developing local community GHG emissions inventory titled the "U.S. Community Protocol for Accounting and Reporting GHG Emissions (Community Protocol)"[1]. The recommended method presented in this document recognizes that local governments possess the authority to influence GHG emissions from passenger vehicle trips both inside and outside of a community's geographic boundaries. This method also recognizes that local governments cannot influence all passenger vehicle GHG emissions within their boundaries. As such, the recommended origin-destination method (using a travel demand-based model) better captures a local government's ability to affect passenger vehicle emissions than the previous method of using average trip lengths to calculate in-boundary emissions.

[1] **ICLEI-Local Governments for Sustainability US Community Protocol V1, October 2012. Appendix D: Transportation and Other Mobile Emission Activities and Sources.** http://www.icleiusa.org

The approach recommended by this national document discusses why it is important to determine VMT calculations using a large area such as a community's geographic boundaries. One reason to focus on community-wide boundaries is because a high proportion of pass-through traffic can occur in smaller study areas that are outside that area's influence. An example is an Interstate highway that passes through a small city. Another reason is that a low proportion of vehicle miles from trips that terminate or originate in a small study area occur outside the area's geographic boundaries and would be more accurately identified in an expanded community-wide study area.

The ICLEI-recommended method for calculating VMT is to use model data of all travel originating or terminating within the jurisdictional boundaries of a community. Trip tables from either a traditional 4-step travel demand model (trip-based) or from an activity-based travel demand model (tour-based) are required to calculate and extract disaggregated VMT data in this manner.

Congruent with the methodology presented by ICLEI, the SB 375 Regional Targets Advisory Committee, in their September 2009 report to the CARB, recommended the following method for allocating VMT to a study area for the purposes of a GHG analysis:

- Internal-Internal: all VMT should be included in the analysis
- Internal-External or External-Internal: 50% of VMT should be included in the analysis
- External-External: all VMT should be excluded in the analysis

Following these recommended methods of allocation, this white paper describes the analytical approach for disaggregating VMT into these categories using a suite of existing tools. The resulting study area VMT can then be applied to a calculation of transportation emissions for a GHG analysis of the study area.

A glossary of acronyms and terms is provided in ***Appendix A.***

2.0 METHODOLOGY

To date, the methodologies that have been developed focus on specific land uses as well as incorporation of average trip lengths (ATL). The methodology outlined in this paper switches the focus to trip ends (Origin and Destination patterns) with the intent of removing the uncertainty and potential for error in using average trip lengths, as recommended at both the state and national level.

This section of the white paper presents a methodology that utilizes existing tools for VMT and GHG analysis. The three main tools required for the analysis include:

1. A travel demand model
2. A Geographic Information System (GIS)
3. A spread sheet

Note that this method can be applied using any travel demand model software, a GIS that is capable of producing spatial overlays, and any spread sheet software.

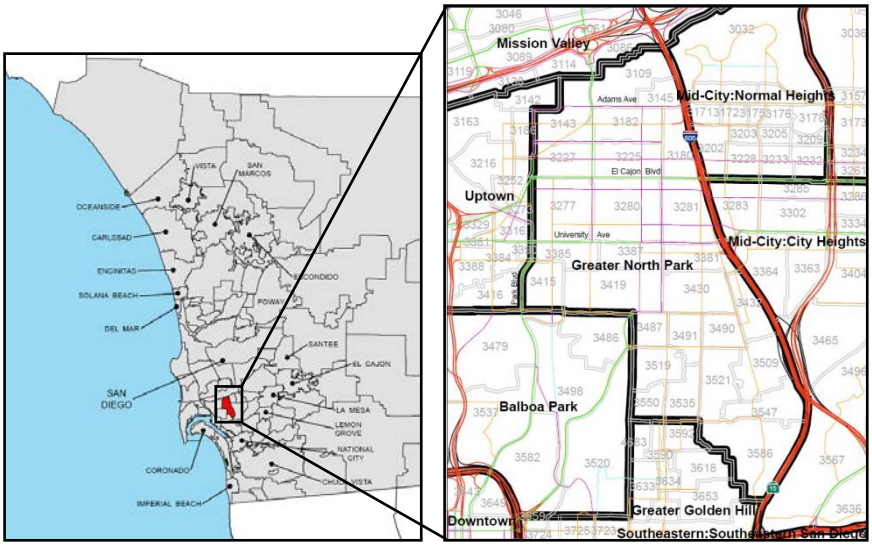
This methodology is intended to be used to analyze whole cities, communities within a large city and/or large-scale developments. The analysis area should include multiple Traffic Analysis Zones (TAZs).

The first step in the process is to define a study area. It should be noted that the size and shape of the study area can affect the analysis, as mentioned in the ICLEI protocol. For example, the larger the study area (community-wide) and the more homogeneous the study area shape, the more Internal-to-Internal trips and VMT will be captured. Conversely, smaller study areas with odd and/or linear shapes tend to have less Internal-to-Internal trip and VMT capture. Therefore it is recommended that a small or linear study area be expanded to a more homogenous study area size and shape, and that a normalized metric of VMT per acre be included in the analysis.

CASE STUDY: THE COMMUNITY OF GREATER NORTH PARK

The community of North Park was chosen as a test study area for this paper. North Park, depicted in ***Figure 2–1***, is located in the central part of the City of San Diego and is defined by the City as a Community Plan Area (CPA). The community of North Park is bound by the other CPAs of Uptown and Balboa Park to the West, Golden Hill to the South, City Heights and Normal Heights to the East and Mission Valley to the North. The community boundary to the east is defined by the freeways I-15 and I-805, and defined by Park Blvd to the west. North Park is subdivided into 27 TAZs, and none of those TAZs overlap into adjacent community plan areas.

Figure 2–1
Study Area Map



Alternatives analysis is a term used to describe the process of incrementally comparing one scenario to another, and travel demand models are one example of a tool used in the planning practice for comparing alternatives. ***Figure 2–2*** shows the four travel demand model land use and network alternatives that were created in support of this white paper:

Figure 2–2
Travel Demand Model Alternatives

ALTERNATIVE	LAND USE	NETWORK
2008	Existing	Existing
2050 A	Adopted General Plan	Adopted Circulation Element
2050 B	Proposed Project	Adopted Circulation Element
2050 C	Proposed Project	Proposed Network Enhancement

The base year scenario was created to ensure consistency throughout the analysis and provides a bench mark for current conditions. The 2050 scenarios were created using SANDAG's "Series 12" Growth Forecast and Travel Demand Model. The three 2050 scenarios are based on the 2050 Revenue Constrained network as defined in the 2011 Regional Transportation Plan. *Alternative A* includes no changes and thus is the Adopted scenario. *Alternative B* adds a proposed development into TAZ 3491 which is located in the middle of the community of North Park. *Alternative C* includes the proposed development in TAZ 3491 plus upgrading 32nd Street

between Redwood Street and University Avenue from a Two-Lane Local Collector to a Four-Lane Collector with a raised median. For the purpose of comparing apples to apples, all four scenarios have consistent TAZ systems. *Alternatives A and B* utilize the same network, however, *Alternative C* includes an upgraded network. To maintain the synonymous comparison, an additional metric of VMT per lane mile has been developed and documented later on in *Section 2.0* of this paper. ***Appendix B*** contains the results of the trip generation model for TAZ 3491 for the four scenarios.

VMT is a straight-forward calculation that includes traffic volume multiplied by the length of the roadway segment. VMT is usually measured on a daily basis or for a 24-hour period for each link in the road network. A network link is a modeling term used to identify road segments between two or more end points where the network might be accessed by vehicular traffic. Twenty-four hour volumes are often referred to as Average Daily Traffic (ADT) volumes. The 24-hour traffic volume and link lengths are the only two variables required to calculate VMT. This calculation can actually be made using any of the three tools previously noted in this paper(GIS, a Travel Demand Model, or a spreadsheet). Depending on how link lengths are stored, either of these two formulas can be applied:

1. Use where link lengths are stored in miles:
   VMT = ADT * LINK LENGTH

2. Use where link lengths are stored in feet:
   VMT = (ADT * LINK LENGTH) / 5,280

The main benefit of this methodology is the ability to define VMT by origin-destination (OD) pairs as well as by functional classification. Functional classifications are coded on a travel demand model network using GIS. VMT by OD pair includes the disaggregation of VMT into the following categories:

1. **Internal-to-Internal (I-I)**

   This category includes trips that have both the Origin and Destination (two trip-ends) within the same city/community/development being analyzed. This, however, is not intra-zonal trips, which is defined as trips that start and end within the same TAZ and discussed later in this paper.

2. **Internal-to-External, and External-to-Internal (I-E, E-I)**

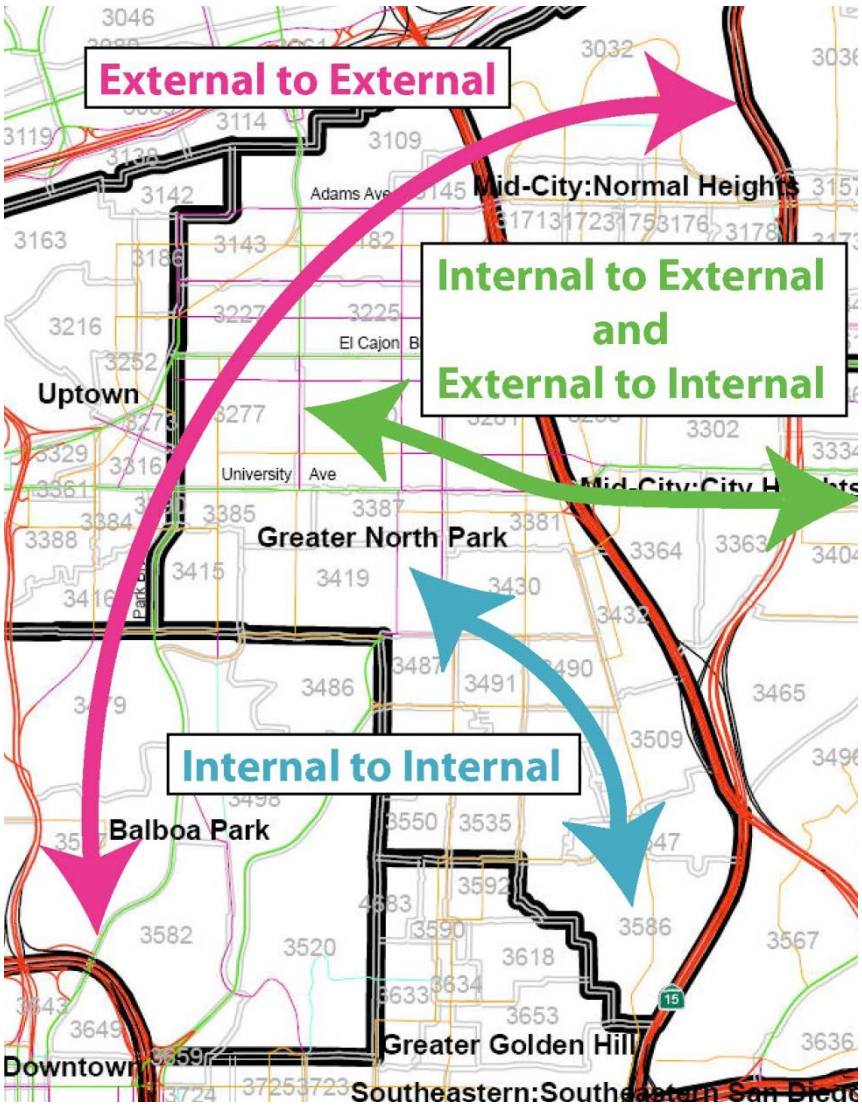
   This category includes trips with either the Origin or Destination (one trip-end) within the city/community/development being analyzed. Internal-to-External and External–to-Internal have been combined into one category as directional VMT is not an important variable when analyzing GHG.

3. **External-to-External (E-E)**

The third category includes trips with neither Origin nor Destination (zero trip-ends) within the city/community/developments being analyzed. These are essentially trips passing through the city/community/development.

Figure 2–3 illustrates the three types of disaggregated VMT.

Figure 2–3
The Three VMT Categories



To disaggregate VMT using the OD methodology, the following detailed steps are recommended:

Step 1. Run a travel demand model on a set of land use / network scenarios. The scenarios will ultimately be compared to one another (alternatives analysis). Ensure there are no errors and the traffic assignment step completed normally.

Step 2. Use the travel demand model to run a "study area" select zone assignment. This includes defining a select zone analysis by combining all TAZs within the study area into one query. Repeat as necessary for each alternative being analyzed.

Step 3. Compress the resulting select zone trip table into two districts: the defined study area is district 2, and the rest of the region is district 1. This step is essential for extracting Internal-to-Internal VMT. Repeat as necessary for each alternative being analyzed. Export the compressed trip tables into a format that can be read by a spread sheet. (See ***Figures 2–4*** through ***2–7***)

Figure 2–4
Base Year 2008 Select Zone Trip Table Before Compression

ORIGINS \ DESTINATIONS	TAZ	1	2	3	4	5	6	7	8	9	…4683
	1	6	0	0	0	0	0	0	0	0	0
	2	4	2	0	0	1	3	0	0	0	0
	3	0	0	0	0	0	0	0	0	0	0
	4	0	0	0	3	0	0	2	1	0	0
	5	2	1	0	0	2	2	0	0	0	0
	6	6	4	0	0	1	3	0	0	0	0
	7	0	0	0	2	0	0	2	0	0	0
	8	0	0	0	0	0	0	0	101	0	0
	9	0	0	0	0	0	0	0	0	0	0
	…4683	0	0	0	0	0	0	0	0	0	4

Figure 2–5
4683 TAZs Compressed into Two Districts

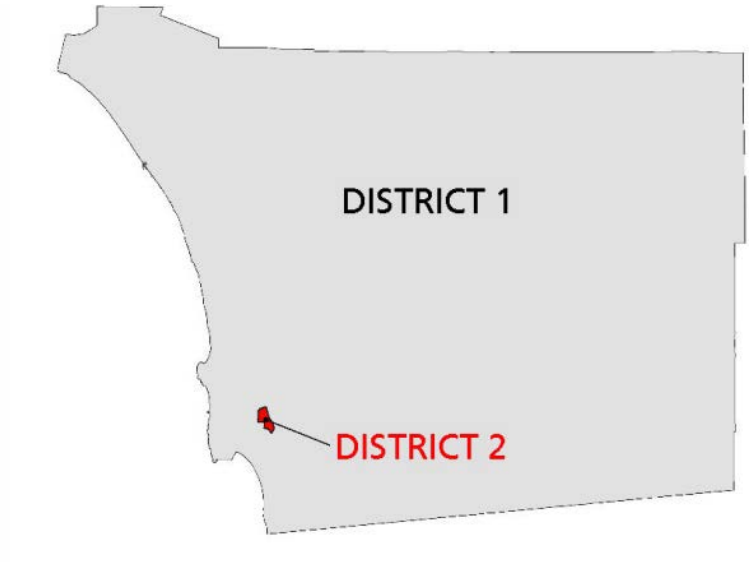


Figure 2–6
Actual Trip Table After Compression

		Destinations	
	District	1	2
Origins	1	0	92970
	2	89154	25319

Figure 2–7
Conceptual Trip Table After Compression

		Destinations	
	District	1	2
Origins	1	Both O&D OUTSIDE of North Park	O OUTSIDE of North Park, D INSIDE of North Park
	2	O INSIDE of North Park, D OUTSIDE of North Park	Both O&D INSIDE of North Park

In summary, this methodology includes creating a study area select zone assignment and compressing the select zone trip table to calculate the number of trips by district and determine the OD breakdown within those districts (I-I, E-I, I-E, and E-E).

The following defines the necessary steps to calculate intra-zonal trips.

Step 4. Extract intra-zonal trips and distance skims for each TAZ within the study area. While intra-zonal VMT will be a very small fraction of the overall region-wide VMT, it is still important to include and document. Intra-zonal trips and distances come from the diagonal rows of vehicular trip tables and distances skim files. Trip tables contain trip flows between TAZs. Skim files usually include travel time, travel distance, and/or travel cost between TAZs.

The distance skim is used to calculate intra-zonal trip distances. Intra-zonal trip distances are calculated by halving the average distance between the TAZ in question and its three nearest TAZ neighbor.

Intra Zonal Distance = $((D_{ij1} + D_{ij2} + D_{ij3}) / 3) / 2$

Where:

D = Distance (in miles)
ij1 = Origin Zone to the first nearest neighbor
ij2 = Origin Zone to the second nearest neighbor
ij3 = Origin Zone to the third nearest neighbor

Or

$0.23 = ((0.40 + 0.56 + 0.42) / 3) / 2$

Figures2–8 and ***2–9*** illustrate the intra-zonal data extracted in spreadsheet-format.

Figure 2–8
Intra-Zonal Cells Within the Base Year 2008 AM Trip Table

ORIGINS \ DESTINATIONS	3486	3487	3488	3489	3490	3491	3492	3493	3494	3495
3486	6	0	0	0	0	0	0	0	0	0
3487	4	2	0	0	1	3	0	0	0	0
3488	0	0	0	0	0	0	0	0	0	0
3489	0	0	0	3	0	0	2	1	0	0
3490	2	1	0	0	2	2	0	0	0	0
3491	6	4	0	0	1	3	0	0	0	0
3492	0	0	0	2	0	0	2	0	0	0
3493	0	0	0	0	0	0	0	101	0	0
3494	0	0	0	0	0	0	0	0	0	0
3495	0	0	0	0	0	0	0	0	0	4

Figure 2–9 Calculated Base Year 2008 Intra-Zonal VMT for North Park						
2008						
TAZ	INTRA DISTANCE	AM	PM	OP	INTRA TRIPS	INTRA VMT
3109	0.23	26	20	92	138	31.74
3143	0.20	17	20	94	131	26.20
3145	0.24	3	4	28	35	8.23
3180	0.25	32	50	302	384	94.08
3182	0.17	55	53	256	364	61.88
3225	0.19	38	50	263	351	64.94
3227	0.20	25	36	210	271	54.20
3277	0.22	124	141	712	977	214.94
3280	0.21	133	172	965	1270	266.70
3281	0.25	82	137	879	1098	269.01
3381	0.23	21	40	282	343	78.89
3385	0.24	13	24	154	191	44.89
3387	0.25	16	20	127	163	40.75
3415	0.19	7	9	49	65	12.35
3419	0.30	20	14	55	89	26.70
3430	0.22	18	14	56	88	18.92
3432	0.23	2	0	3	5	1.13
3487	0.18	2	3	14	19	6.42
3490	0.16	2	1	3	6	0.96
3491	0.14	3	3	17	23	3.22
3509	0.23	3	4	21	28	6.30
3519	0.24	1	2	6	9	2.12
3521	0.22	21	14	68	103	22.15
3535	0.19	2	2	11	15	2.85
3547	0.38	2	0	2	4	1.52
3550	0.26	2	3	11	16	4.16
3586	0.67	7	8	30	45	30.15
TOTAL NORTH PARK INTRA-ZONAL VMT						1392.37

Steps 5 and **6** explain the final steps in calculating the three trip types necessary for calculating total VMT.

Step 5. Use GIS to process the results and export files that can be read by a spread sheet. The main goal of this step is to produce a table with VMT split by jurisdiction and road functional classification. Note that the following process was designed using an AML (Arc Macro Language) script which can be found in ***Appendix C***. AML is the native scripting language of ESRI's Arc/INFO workstation software. This script could be duplicated using the scripting language Python for use in ESRI's ArcMap desktop

software. The results should be the same if AML is used in Arc/INFO or if Python is used in ArcMap. The following nine steps define the activities of the script:

a. Create a network layer with additional attributes for analysis

b. Create a lookup table to store the results of the select zone assignment

c. Join the lookup table with the network layer

d. Overlay the network layer with a polygon layer that represents jurisdictional boundaries

e. Calculate daily VMT (formula above)

f. Calculate select zone VMT using basically the same formula:

g. Select Zone VMT = (Select Zone Query volume * Link Length) / 5280

h. Perform a frequency function of the link attribute table. A frequency function returns the count of values that fall into a specific range. In this example, the values of the link Functional Classifications are used to summarize the daily and select zone query VMT.

i. Output a text or CSV file that can be imported into a spread sheet (This file should have a minimum of 4 columns):

    1. Jurisdiction name
    2. Functional Classification Code
    3. Daily 24-hour VMT
    4. Select zone query VMT

j. This file can have a variable number of rows (records) depending on the number of classifications defined in the network being analyzed as well as the granularity of the jurisdictions to analyze.

k. Clip the network layer with the study area boundary and calculate bi-directional lane miles with the following formula:

    Lane Miles = (Total Lanes * Length) / 5280

    Aggregate the total lane miles within the study area and export one number for use in calculating VMT per Lane Mile in the spread sheet analysis. This step is crucial for the ability to compare network scenarios equitably. ***Figure 2–10*** shows the summarized lanes miles for each alternative analyzed in this paper.

Figure 2–10 Study Area Lane Miles by Scenario	
ALTERNATIVE	LANE MILES
2008	104.0
2050 A	111.5
2050 B	111.5
2050 C	113.0

Step 6. Use a spread sheet to calculate the three categories of VMT.

a. Open the compressed select zone trip table and use it to calculate the internal capture percentage for the district that represents the city/community/ development being studied. The internal capture rate represents the percent of Internal-to-Internal trips relative to the total study area VMT. ***Figure 2–11*** displays the compressed trip table. The formula shown below illustrates the internal capture calculation for the base year.

Internal Capture Rate (%) = I-I VMT (district 2 to 2) ÷ Total VMT ($\sum$ all districts)

Or

25,319 ÷ 207,443 = <u>12.21%</u>

Figure 2–11
Compressed Trip Tables & Calculated Internal Capture Rate

Base Year 2008

Origins \ Destinations	District	1	2	Sum
Origins	1	0	92,970	92,970
	2	89,154	25,319	114,473
Sum		89,154	118,289	**207,443**
Internal Capture Rate				**12.21%**

2050 A

Origins \ Destinations	District	1	2	Sum
Origins	1	0	127,947	127,947
	2	121,689	30,051	151,740
Sum		121,689	157,998	**279,687**
Internal Capture Rate				**10.74%**

2050 B

Origins \ Destinations	District	1	2	Sum
Origins	1	0	131,176	131,176
	2	124,400	31,817	156,217
Sum		124,400	162,993	**287,393**
Internal Capture Rate				**11.07%**

2050 C

Origins \ Destinations	District	1	2	Sum
Origins	1	0	131,215	131,215
	2	124,429	31,799	156,228
Sum		124,429	163,014	**287,443**
Internal Capture Rate				**11.06%**

E-E (Zero Trip-Ends)
I-E and E-I (One Trip-End)
I-I (Two Trip-Ends)
Internal Capture Rate (I-I ÷ Sum)
District 1 = Everything BUT North Park
District 2 = North Park

A value other than zero in the District 1-to-District 1 cell indicates one of the following potential issues: 1) A miss-match between the list of TAZs used for the community-wide select zone assignment compared to the definition of the study area Districts; or 2) one or more of the study area TAZs straddle a community or city boundary.

Analyzing the 2050 No Build scenario (*Alternative A*), the result shows that the model predicts 10.74% of trips with an origin inside of Greater North Park will also have a destination within Greater North Park. This will become the factor to apply to total VMT within Greater North Park to calculate Internal-to-Internal VMT.

a. Open the text or CSV file created from GIS, which will become the main worksheet.

b. Add four columns, one for each of the three VMT categories noted above plus one for intra-zonal VMT. ***Figure 2–12*** shows the column headers for each VMT category.

Figure 2–12
Worksheet Headers

SCENARIO							
JURISDICTION	CLASSIFICATION	TOTAL VMT	TOTAL NORTH PARK VMT (I-I, I-E, E-I, & E-E)	TWO TRIP-ENDS NORTH PARK VMT (I-I)	ONE TRIP-END NORTH PARK VMT (I-E and E-I)	NON-NORTH PARK VMT (E-E)	NORTH PARK INTRA-ZONAL VMT (INTRA)

The post-SANDAG forecast process creates a standard report called "postlod2.pr" that summarizes many modeling metrics including VMT. The reports used to validate this methodology can be found in ***Appendix D***. The "Total VMT" column contains 24-hour daily VMT and the "Total North Park VMT" includes the study area select zone assignment VMT.

Calculate the "Two Trip-Ends" category with the following formula, but only for the city/community/development being analyzed as the rest of the two trip end records should all be null. ***Figure 2–13*** shows the spread sheet results.

I-I VMT = (select zone query VMT * internal capture % calculated in **Step 6a**)

Or

212,850 * 12.21% = <u>25,979 I-I VMT</u>

Figure 2–13 Two Trip-Ends VMT Calculations								
BASE YEAR 2008								
JURISDICTION	CLASSIFICATION		TOTAL VMT	TOTAL NORTH PARK VMT (I-I, I-E, E-I, & E-E)	TWO TRIP-ENDS NORTH PARK VMT (I-I)	ONE TRIP-END NORTH PARK VMT (I-E and E-I)	NON-NORTH PARK VMT (E-E)	NORTH PARK INTRA-ZONAL VMT (INTRA)
GNC	1	Freeway	327,268	36,989	4,515	32,474	290,279	
GNC	3	Major	67,085	49,701	6,066	43,635	17,384	
GNC	4	Collector	44,221	35,296	4,308	30,988	8,925	
GNC	5	Local Collector	52,603	42,254	5,157	37,097	10,349	
GNC	8	Freeway Ramp	35,242	4,325	528	3,797	30,917	
GNC	9	Local Ramp	8,697	5,837	712	5,125	2,860	
GNC	10	Zone Connector	38,447	38,448	4,693	33,755	(1)	
GNC	11	Intra-Zonal						1,392
GNC		Total	573,563	212,850	25,979	186,871	360,713	1,392

*GNC = Greater North Park

Calculate the "One Trip-End" category with the following formula for all records:

I-E & E-I VMT = (select zone query VMT – I-I VMT)

Or

212,850 – 25,979 = 186,871 I-E & E-I VMT

Figure 2–14 shows the spread sheet results.

Figure 2–14 One Trip-Ends VMT Calculations								
BASE YEAR 2008								
JURISDICTION	CLASSIFICATION		TOTAL VMT	TOTAL NORTH PARK VMT (I-I, I-E, E-I, & E-E)	TWO TRIP-ENDS NORTH PARK VMT (I-I)	ONE TRIP-END NORTH PARK VMT (I-E and E-I)	NON-NORTH PARK VMT (E-E)	NORTH PARK INTRA-ZONAL VMT (INTRA)
GNC	1	Freeway	327,268	36,989	4,515	32,474	290,279	
GNC	3	Major	67,085	49,701	6,066	43,635	17,384	
GNC	4	Collector	44,221	35,296	4,308	30,988	8,925	
GNC	5	Local Collector	52,603	42,254	5,157	37,097	10,349	
GNC	8	Freeway Ramp	35,242	4,325	528	3,797	30,917	
GNC	9	Local Ramp	8,697	5,837	712	5,125	2,860	
GNC	10	Zone Connector	38,447	38,448	4,693	33,755	(1)	
GNC	11	Intra-Zonal						1,392
GNC		Total	573,563	212,850	25,979	186,871	360,713	1,392

*GNC = Greater North Park

Calculate the "Zero Trip-End" or "through trips" category with the following formula for all records:

E-E VMT = (24-hour total VMT – select zone query VMT)

Or

573,563 – 212,850 = 360,713 E-E VMT

Figure 2–15 shows the spread sheet results.

Figure 2–15
Zero Trip-Ends VMT Calculations

BASE YEAR 2008

JURISDICTION	CLASSIFICATION	TOTAL VMT	TOTAL NORTH PARK VMT (I-I, I-E, E-I, & E-E)	TWO TRIP-ENDS NORTH PARK VMT (I-I)	ONE TRIP-END NORTH PARK VMT (I-E and E-I)	NON-NORTH PARK VMT (E-E)	NORTH PARK INTRA-ZONAL VMT (INTRA)
GNC	1 Freeway	327,268	36,989	4,515	32,474	290,279	
GNC	3 Major	67,085	49,701	6,066	43,635	17,384	
GNC	4 Collector	44,221	35,296	4,308	30,988	8,925	
GNC	5 Local Collector	52,603	42,254	5,157	37,097	10,349	
GNC	8 Freeway Ramp	35,242	4,325	528	3,797	30,917	
GNC	9 Local Ramp	8,697	5,837	712	5,125	2,860	
GNC	10 Zone Connector	38,447	38,448	4,693	33,755	(1)	
GNC	11 Intra-Zonal						1,392
GNC	Total	573,563	212,850	25,979	186,871	360,713	1,392

*GNC = Greater North Park

Cross check each of the last three calculations by comparing the study area total sums with the sum of each functional classification, as shown in ***Figure 2–16.***

Figure 2–16 Cross-Checking of VMT Calculations								
BASE YEAR 2008								
JURISDICTION	CLASSIFICATION		TOTAL VMT	TOTAL NORTH PARK VMT (I-I, I-E, E-I, & E-E)	TWO TRIP-ENDS NORTH PARK VMT (I-I)	ONE TRIP-END NORTH PARK VMT (I-E and E-I)	NON-NORTH PARK VMT (E-E)	NORTH PARK INTRA-ZONAL VMT (INTRA)
GNC	1	Freeway	327,268	36,989	4,515	32,474	290,279	
GNC	3	Major	67,085	49,701	6,066	43,635	17,384	
GNC	4	Collector	44,221	35,296	4,308	30,988	8,925	
GNC	5	Local Collector	52,603	42,254	5,157	37,097	10,349	
GNC	8	Freeway Ramp	35,242	4,325	528	3,797	30,917	
GNC	9	Local Ramp	8,697	5,837	712	5,125	2,860	
GNC	10	Zone Connector	38,447	38,448	4,693	33,755	(1)	
GNC	11	Intra-Zonal						1,392
GNC		Total	573,563	212,850	25,979	186,871	360,713	1,392

*GNC = Greater North Park

Incorporate the summary of intra-zonal VMT from **Step 4** as shown in ***Figure 2–17***.

Figure 2–17 Intra-Zonal Trips								
BASE YEAR 2008								
JURISDICTION	CLASSIFICATION		TOTAL VMT	TOTAL NORTH PARK VMT (I-I, I-E, E-I, & E-E)	TWO TRIP-ENDS NORTH PARK VMT (I-I)	ONE TRIP-END NORTH PARK VMT (I-E and E-I)	NON-NORTH PARK VMT (E-E)	NORTH PARK INTRA-ZONAL VMT (INTRA)
GNC	1	Freeway	327,268	36,989	4,515	32,474	290,279	
GNC	3	Major	67,085	49,701	6,066	43,635	17,384	
GNC	4	Collector	44,221	35,296	4,308	30,988	8,925	
GNC	5	Local Collector	52,603	42,254	5,157	37,097	10,349	
GNC	8	Freeway Ramp	35,242	4,325	528	3,797	30,917	
GNC	9	Local Ramp	8,697	5,837	712	5,125	2,860	
GNC	10	Zone Connector	38,447	38,448	4,693	33,755	(1)	
GNC	11	Intra-Zonal						1,392
GNC		Total	573,563	212,850	25,979	186,871	360,713	1,392

*GNC = Greater North Park

Create subtotals for each jurisdiction across all VMT categories and facility types, and compare the region-wide totals, as shown in ***Figure 2–18***.

Figure 2–18
Jurisdictional VMT Summaries

Scenario					
Jurisdiction	Total VMT	Total North Park VMT	Two Trip-Ends North Park VMT	One Trip-End North Park VMT	Non-North Park VMT
CARLSBAD TOTAL	3,344,783	6,864	-	6,864	3,337,919
CHULA VISTA TOTAL	3,944,329	26,635	-	26,635	3,917,694
CORONADO TOTAL	425,415	7,511	-	7,511	417,904
DEL MAR TOTAL	97,997	151	-	151	97,846
EL CAJON TOTAL	2,170,595	13,539	-	13,539	2,157,056
ENCINITAS TOTAL	2,072,646	8,464	-	8,464	2,064,182
ESCONDIDO TOTAL	2,804,158	6,095	-	6,095	2,798,063
External TOTAL	348,011	1,233	-	1,233	346,778
IMPERIAL BEACH TOTAL	118,284	215	-	215	118,069
LA MESA TOTAL	1,816,617	22,479	-	22,479	1,794,138
LEMON GROVE TOTAL	824,528	9,186	-	9,186	815,342
NATIONAL CITY TOTAL	1,637,674	23,317	-	23,317	1,614,357
OCEANSIDE TOTAL	3,187,796	2,198	-	2,198	3,185,598
POWAY TOTAL	1,107,444	2,234	-	2,234	1,105,210
SAN DIEGO TOTAL	38,508,241	983,410	25,979	957,385	37,488,977
SAN MARCOS TOTAL	2,058,102	1,890	-	1,890	2,056,212
SANTEE TOTAL	855,495	2,757	-	2,757	852,738
SOLANA BEACH TOTAL	567,459	3,108	-	3,108	564,351
Unincorporated TOTAL	17,470,189	44,274	-	44,274	17,425,915
VISTA TOTAL	1,712,782	279	-	279	1,712,503
Summary	85,072,545	1,165,839	25,979	1,139,814	83,870,852

Validate the VMT data by summarizing and cross-checking it via other sources such as the post-forecast report "postlod2.pr", previously discussed. ***Figure 2–19*** shows this comparison.

Figure 2–19
Validation by Summary Cross-Check

REGIONAL VALIDATION BY SUMMARY BASE YEAR 2008		
Reported:	Post-forecast VMT report (postlo2.pr)	85,057,878
Assigned:	Assigned sum of all VMT	85,072,545
Disaggregated:	Sum of all VMT using this method	85,036,645
SUMMARY 1: (ASSIGNED – REPORTED)		
Absolute VMT Difference		(15,333)
Percent VMT Difference		-0.01802%
SUMMARY 2: (DISAGGREGATED – REPORTED)		
Absolute VMT Difference		(51,233)
Percent VMT Difference		-0.06021
SUMMARY 3: (DISAGGREGATED – ASSIGNED)		
Absolute VMT Difference		35,900
Percent VMT Difference		-0.04222%

Compare the calculated 24-hour VMT with reports or some metric from the travel demand model. This table, shown above in *Figure 2–19*, compares three levels of VMT calculations: "Reported" VMT is generated after each model scenario and is included in the "postload2.pr" reports provided in *Appendix D*. "Assigned" includes calculating total VMT via a travel demand model, a GIS or a spread sheet. "Disaggregated" is the result of the methodology described in this white paper. If any of these three comparisons result in more than a 0.1% difference, it indicates a typo or an error during this analysis.

Complete statistical results of this methodology shown in graphical format are documented in ***Appendix E.***

Figures 2–20 through ***2–26*** show a summary of the final results of the VMT calculations normalized by different factors: population, employment, dwelling units, person trips, lane miles, and acreage.

Figure 2–20 Final VMT, Population, Employment, Dwelling Units and Person Trips Generated						
Alternative	Total VMT	Total North Park VMT	North Park Population	North Park Jobs	North Park Total Units	North Park Person Trips Generation
2008	573,563	212,850	47,548	8,697	24,795	375,074
2050 A	768,798	282,006	71,777	11,346	35,258	496,800
2050 B	775,137	290,202	73,475	11,614	36,092	519,036
2050 C	775,972	290,707	73,475	11,614	36,092	519,036

Figure 2–21 Final Results of the Methodology Normalized by Population		
Alternative	Total VMT Per Capita	North Park Total VMT Per Capita
2008	12.06	4.48
2050 A	10.71	3.93
2050 B	10.55	3.95
2050 C	10.56	3.96

Figure 2–22 Final Results of the Methodology Normalized by Employment		
Alternative	Total VMT Per Job	North Park Total VMT Per Job
2008	65.95	24.47
2050 A	67.76	24.86
2050 B	66.74	24.99
2050 C	66.81	25.03

Figure 2–23 Final Results of the Methodology Normalized by Dwelling Units		
Alternative	Total VMT Per Dwelling Unit	North Park Total VMT Per Dwelling Unit
2008	23.13	8.58
2050 A	21.80	8.00
2050 B	21.48	8.04
2050 C	21.50	8.05

Figure 2–24 Final Results of the Methodology Normalized by Person Trips Generated		
Alternative	Total VMT Per Person Trips Generated	North Park Total VMT Per Person Trips Generated
2008	1.53	0.57
2050 A	1.55	0.57
2050 B	1.49	0.56
2050 C	1.50	0.56

Figure 2–25 Final Results of the Methodology Normalized by Lane Miles					
Alternative	Lane Miles	Total VMT	Total VMT per Lane Mile	North Park Total VMT	Total North Park VMT per Lane Mile
2008	104.0	573,563	5,515.0	212,850	2,046.6
2050 A	111.5	768,798	6,895.0	282,006	2,529.2
2050 B	111.5	775,137	6,951.9	290,202	2,602.7
2050 C	113.0	775,972	6,867.0	290,707	2,572.6

Figure 2–26 Final Results of the Methodology Normalized by Acreage					
Alternative	Study Area Acreage	Total VMT	Total VMT per Acre	North Park Total VMT	Total North Park VMT per Acre
2008	2257.4	573,563	254.1	212,850	94.3
2050 A	2257.4	768,798	340.6	282,006	124.9
2050 B	2257.4	775,137	343.4	290,202	128.6
2050 C	2257.4	775,972	343.7	290,707	128.8

3.0 APPLICATION

Once all modeling work has been completed to generate disaggregated VMT for the study area, the information produced is then applied to the significance findings of the Environmental Impact Report (EIR) Climate Action Plan (CAP). The CAP focuses on the greenhouse gas (GHG) emissions on a pre- and post-project basis. VMT is a primary factor in measuring GHG as it relates to carbon dioxide emissions and the associated significant environmental impacts. As previously mentioned in the introduction to this paper, VMT is disaggregated in three categories:

- Internal-Internal (I-I): all VMT should be included in the analysis
- Internal-External (I-E) or External-Internal (E-I): 50% of VMT should be included in the analysis
- External-External (E-E): all VMT should be excluded in the analysis

The Methodology section describes the regional traffic modeling software's ability to derive the needed VMT information for a specific study area. The application of the VMT modeling output is covered in this section, with the continued use of North Park as the study area.

The key reasoning for disaggregating VMT into three separate types is to accurately evaluate North Park's estimated VMT, excluding the effect of other nearby jurisdictions. The community-wide inventory includes the VMT for all trips that begin and/or end within the Community limits of which are then split into the three categories. North Park would only be accountable for all trips within the Community limits (I-I), while it would share accountability with other jurisdictions for trips that have only one end point in the Community (I-E & E-I). All pass-through trips (E-E), would be excluded from the VMT results as the trips are not generated by land uses within the Community. This methodology is supported by the SB 375 Regional Targets Advisory Committee and ICLEI-Local Governments for Sustainability.

The current way the I-E and E-I trips are included in the CAP evaluation is by halving the results; North Park would be responsible for generating approximately 50% of the I-E and E-I trips. While this approach may over or under estimate North Park's contribution to Community VMT, it is presently the only viable approach given the difficulty in determining the origin or destination for an externally-oriented trip.

The data results of the I-I trips and half of the I-E and E-I trips are then input into the Urban Emissions Model (URBEMIS) or similar software, along with other determining factors, to estimate the projected emissions generated by North Park VMT. The thresholds set forth by AB 32 are used to measure the significance of emission levels between pre- and post-project conditions.

4.0 CONCLUSION

This paper provides an introduction discussing the recently adopted State legislation to reduce greenhouse gas (GHG) emissions to 1990 levels. As a result of these acts, environmental documents are required to evaluate the GHG levels proposed by projects (large-scale projects such as general plans and specific plans) as part of the CEQA process. As recommended to calculated GHG by the September 2009 Report to CARB by the SB 375 Regional Targets Advisory Committee and ICLEI's Community Protocol, VMT is defined as a unit to measure vehicle travel made by any individual vehicle, as classified by the three types of trips: Internal-Internal, Internal-External or External-Internal, and External-External. In order to disaggregate VMT into such classes, SANDAG has developed a modeling process to generate these results.

The Methodology section of this white paper discusses the technical approach to using the traffic model to generate the three types of VMT trips. Listing of the tools needed, the data input, general assumptions, and the steps required are discussed in detail in this section. The methodology used generates the three VMT trip categories using a select-zone assignment approach to separate out, as accurately as possible, the trips produced by North Park land uses and the trips produced by outside jurisdictions. Observed VMT from the field is extremely difficult to calculate accurately, thus the method outlined in this white paper is compared to other computational methods of calculating VMT. To measure the margin of error for this type of data analysis, comparisons can be drawn between the calculated 24-hour VMT from the assignment, the select-zone assignment and the post-modeling report from the travel demand model. As shown in this paper, the methodology developed by SANDAG results in a 0.06% margin of error, which is well below the 0.1% margin of error threshold set by SANDAG.

The data produced through the SANDAG modeling process are then input into the Urban Emissions Model to conclude whether the project will result in a significant GHG impact.

Environmental documents prepared for the cities of La Mesa and Escondido have found success in implementing the methodology applied by SANDAG through the use of the travel demand model. The Final Environmental Impact Analysis (FEIR) for the Escondido General Plan Update, certified December 2011, utilized this technique for calculating GHG for the entire jurisdiction.

This paper has provided a quantitative approach for disaggregating VMT. The use of this information can be applied toward community-wide GHG inventories as well as at the large- to medium-scale project level (Initial Studies, Mitigated Declarations, Negative-Mitigated Declarations, Environmental Impacts Reports, and Environmental Impact Studies). However, it is recognized that other approaches to VMT calculations are in existence. The goal of this technical paper is to provide a more accurate approach for calculating VMT which would set the standard for VMT analyses in the San Diego Region as well as to influence other State and National agencies and institutions to adopt and utilize this methodology in their long-term VMT/GHG planning efforts.

5.0 NEXT STEPS

1. Validation and refinement: This white paper shall continue to be refined and validated on an as-needed basis in terms of methodology and application. The document shall be updated with data developed in support of General Plan and Community Plan updates for jurisdictions in genuine applications.
2. Travel demand model migration: This method shall remain valid for both a traditional 4-step travel demand model (trip-based) and for an Activity Based Model (tour-based). The primary reason for this methodology being portable is that it utilizes trip tables input into the traffic assignment stage as well as assigned traffic as an output of the traffic assignment stage. Since trip tables and traffic assignment are required steps for either model paradigm, this methodology will remain valid for either generation of travel demand models.
3. GIS migration: The AML script developed for this analysis using Arc/INFO workstation shall be ported to the ArcPy (Python) script language for use in ArcGIS.
4. Publication: This white paper shall continue to be vetted through the ITE Task Force for publication. It shall also be vetted through several of SANDAG's working committees including SANTEC (San Diego Traffic Engineers' Council) and TWG (Regional Planning Technical Working Group). If accepted, it shall be presented at a TRB conference and forwarded to ICLEI for inclusion in the U.S. Community Protocol for Accounting and Reporting GHG Emissions.
5. Directional VMT: This method shall be further developed to allow for the analysis of directional VMT.
6. Trip Purpose VMT: This method shall also be further developed to factor VMT by trip purpose (i.e. home-to-work, home-to-school, etc).

APPENDICES

VEHICLE MILES TRAVELED CALCULATIONS USING THE SANDAG REGIONAL TRAVEL DEMAND MODEL

San Diego, California
May 2013

APPENDIX A

GLOSSARY OF ACRONYMS & TERMS

AB	**Assembly Bill**
ADT	**Average Daily Traffic**
AML	**Arc Macro Language**
ATL	**Average Trip Length**
Caltrans	**California Department of Transportation**
CAP	**Climate Action Plan**
CARB	**California Air Resources Board**
CEQA	**California Environmental Quality Act**
CMP	**Congestion Management Plan**
CPA	**Community Planning Area**
CSV	**Comma Separated Variable**
E-E	**External-to-External Trip Category**
E-I	**External-to-Internal Trip Category**
EIR	**Environmental Impact Report**
GHG	**Green House Gas**
GIS	**Geographic Information Systems**
HHDT	**Heavy-Heavy Duty Truck**
HOV	**High Occupant Vehicle**
I-E	**Internal-to-External Trip Category**
I-I	**Internal-to-Internal Trip Category**
ICLEI	**International Council for Local Environmental Initiatives**
Internal Capture	**Trips with an Origin and Destination within the same study area**
Intra-zonal	**Trips with an Origin and Destination within the same TAZ**
ITE	**Institute of Traffic Engineers**
LHDT	**Light-Heavy Duty Truck**
LOS	**Level of Service**
MHDT	**Medium-Heavy Duty Truck**
MPO	**Metropolitan Planning Organization**
OD	**Origin Destination**
PHT	**Person Hours of Travel**
PMT	**Person Miles of Travel**
RC	**Revenue Constrained**
RTIP	**Regional Transportation Improvement Plan**
RTP	**Regional Transportation Plan**
SANTEC	**San Diego Traffic Engineers' Council**
SB	**Senate Bill**
SOV	**Single Occupant Vehicle**
TAZ	**Traffic Analysis Zone**
TDM	**Travel Demand Management**
TRB	**Transportation Research Board**
TWG	**Regional Planning Technical Working Group**
VHT	**Vehicle Hours of Travel**
VMT	**Vehicle Miles of Travel**

APPENDIX B

SCENARIO TRIP GENERATION REPORTS (TAZ 3491)

Base Year 2008
Trip Generation and land use by zone

Land Use					Trips	
Zone	Code	Name	Type	Amount	Person	Vehicle
3491	101	SINGLE FAMILY	du	342.0	3409	2460
3491	102	MULTI-FAMILY	du	189.0	1590	1113
3491	1409	GROUP QUARTERS	acre	0.2	1	1
3491	4112	RIGHT-OF-WAY	acre	12.8	0	0
3491	5007	STREETFRONT COMM	acre	0.6	759	550
3491	5009	OTHER COMMERCIAL	acre	0.5	59	43
3491	6102	CHURCH	acre	0.4	21	17
3491	9101	INACTIVE USE	acre	5.4	0	0
3491	**TOTAL**				**5839**	**4184**

2050 A
Trip Generation and land use by zone

Land Use					Trips	
Zone	Code	Name	Type	Amount	Person	Vehicle
3491	101	SINGLE FAMILY	du	335.0	3529	2549
3491	102	MULTI-FAMILY	du	231.0	2039	1425
3491	1409	GROUP QUARTERS	acre	0.2	1	0
3491	4112	RIGHT-OF-WAY	acre	12.8	0	0
3491	6102	CHURCH	acre	0.4	23	18
3491	9101	INACTIVE USE	acre	4.9	0	0
3491	9702	MIXED USE (67% COM)	acre	1.8	1647	1194
3491	**TOTAL**				**7239**	**5186**

2050 B
Trip Generation and land use by zone

Land Use					Trips	
Zone	Code	Name	Type	Amount	Person	Vehicle
3491	101	SINGLE FAMILY	du	200.0	2440	1703
3491	102	MULTI-FAMILY	du	1200.0	10440	7329
3491	4112	RIGHT-OF-WAY	acre	12.8	0	0
3491	6002	LOW RISE OFFICE	acre	6.0	1753	1350
3491	6102	CHURCH	acre	0.4	21	16
3491	9101	INACTIVE USE	acre	4.9	0	0
3491	9702	MIXED USE (67% COM)	acre	8.8	7582	5504
3491	**TOTAL**				**22236**	**15903**

2050 C
Trip Generation and land use by zone

Land Use					Trips	
Zone	Code	Name	Type	Amount	Person	Vehicle
3491	101	SINGLE FAMILY	du	200.0	2440	1703
3491	102	MULTI-FAMILY	du	1200.0	10440	7329
3491	4112	RIGHT-OF-WAY	acre	12.8	0	0
3491	6002	LOW RISE OFFICE	acre	6.0	1753	1350
3491	6102	CHURCH	acre	0.4	21	16
3491	9101	INACTIVE USE	acre	4.9	0	0
3491	9702	MIXED USE (67% COM)	acre	8.8	7582	5504
3491	**TOTAL**				**22236**	**15903**

APPENDIX C

GIS SCRIPT (AML)

```
/* VMT.AML FOR SERIES 12
/* MCA 08/05/11 FOR USE WITH ARC Workstation 9.X on the PC
/*
/* RUN THIS AML AFTER A SELECT ZONE ASSIGNMENT TO PRODUCE VMT.TXT
/* MODIFIED TO INCLUDE CITY CPA's
/* REQUIRED LIST OF GIS LAYERS:
/*    A Loaded network (line)layer:  HWYCOV2
/*    A jurisdiction/City Boundary (polygon)layer:  JURCOV

/*
/* CREATE HWVMT
/*
&if [exists hwyvmt -cover] &then kill hwyvmt all
copy hwycov2 hwyvmt
additem hwyvmt.aat hwyvmt.aat avmt 12 12 i
additem hwyvmt.aat hwyvmt.aat uvmt 12 12 i
additem hwyvmt.aat hwyvmt.aat szvmt 12 12 i
&data arc info
ARC
SEL HWYVMT.AAT
CALC TMP1 = 0
Q STOP
&end

/*
/* CREATE INFO LOOKUP TABLE FOR SELECT LINK VOLUMES
/*
&if [exists info.slk -info] &then &s x = [delete info.slk -info]
&data arc info
ARC
DEFINE INFO.SLK
HWYVMT-ID,6,6,I
LENGTHX,10,10,N,3
Q1,10,10,N,3
PCT1,9,9,N,2
PCT2,1,1,C

GET ../lodselk.prn COPY ASCII
Q STOP
&end

/*
/* JOIN INFO TABLE TO HWYVMT
/*
&if [exists hwyvmt2 -cover] &then kill hwyvmt2 all
joinitem hwyvmt.aat INFO.SLK hwyvmt.aat hwyvmt-id # ordered

/*
/* OVERLAY WITH JURCOV
/*
```

```
identity hwyvmt T:\data\GIS\covs\admin\jurcov hwyvmt2 line

/*
/* CALC VMT
/*
&data arc info
ARC
SEL HWYVMT2.AAT
CALC TMP1 = 0
CALC AVMT = ( AVOL * LENGTH ) / 5280
CALC UVMT = ( UVOL * LENGTH ) / 5280
CALC SZVMT = ( Q1 * LENGTH ) / 5280
RESEL JUR1 = 0
MOVEIT 'External' TO NAME1
ASEL
RESEL JUR1 = 14
CALC JUR1 = JUR2
MOVEIT NAME2 TO NAME1
Q STOP
&end

/*
/* CREATE REPORT
/*
frequency hwyvmt2.aat hwyvmt2.tab
name1
ifc
end
avmt
uvmt
szvmt
end
&if [exists vmt.txt -file] &then &s x = [delete vmt.txt -file]
&data ARC INFO
ARC
SEL HWYVMT2.TAB
OUTPUT ../vmt.txt INIT
PRINT NAME1,IFC,AVMT,UVMT,SZVMT
Q STOP
&end

/*
/* CALC STUDY AREA LANE MILES
/*
&if [exists hwyvmtlm -cover] &then kill hwyvmtlm all
&if [exists hwyvmtlm.tab -info] &then &s x = [delete hwyvmtlm.tab -
info]
clip hwyvmt ../covs/sacov hwyvmtlm line
additem hwyvmtlm.aat hwyvmtlm.aat lanes 3 3 i
additem hwyvmtlm.aat hwyvmtlm.aat lm 12 12 n 1
&data arc info
ARC
```

```
SEL HWYVMTLM.AAT
CALC TMP2 = 1
CALC LANES = ABLNA + BALNA
CALC LM = ( LANES * LENGTH ) / 5280
Q STOP
&end
frequency hwyvmtlm.aat hwyvmtlm.tab
tmp2
end
lm
end
&if [exists lm.txt -file] &then &s x = [delete lm.txt -file]
&data ARC INFO
ARC
SEL HWYVMTLM.TAB
OUTPUT ../lm.txt INIT
PRINT LM
Q STOP
&end
&ret
```

APPENDIX D

VALIDATION FILE
POSTLOD2.PR

Base Year 2008

regionwide vehicle miles of travel

unadjusted daily vmt summary

functional class	vmt	vht	speed
freeway	42208325.	696965.	60.6
prime	7140439.	252908.	28.2
major	14410458.	530715.	27.2
collector	6127093.	216715.	28.3
local collector	4125602.	169530.	24.3
rural collector	1369462.	38736.	35.4
local	1267527.	53968.	23.5
fwy-fwy ramp	1675286.	41245.	40.6
ramp	2364372.	132575.	17.8
access	4399313.	188322.	23.4
total	85087878.	2321678.	36.6

11may12/07:11:25/postlod.pr

2050 A

regionwide vehicle miles of travel

unadjusted daily vmt summary

functional class	vmt	vht	speed
freeway	62128817.	1128115.	55.1
prime	9690714.	354408.	27.3
major	20762024.	776996.	26.7
collector	7547287.	283855.	26.6
local collector	7063388.	273276.	25.8
rural collector	786225.	20439.	38.5
local	1855548.	80234.	23.1
fwy-fwy ramp	2446217.	65814.	37.2
ramp	3175523.	204872.	15.5
access	6086573.	258336.	23.6
total	121542317.	3446344.	35.3

23mar12/14:22:53/postlod.pr

2050 B

regionwide vehicle miles of travel

unadjusted daily vmt summary

functional class	vmt	vht	speed
freeway	62107542.	1128811.	55.0
prime	9691910.	354366.	27.4
major	20764961.	777157.	26.7
collector	7541346.	283810.	26.6
local collector	7079767.	273990.	25.8
rural collector	785301.	20423.	38.5
local	1855127.	80239.	23.1
fwy-fwy ramp	2445554.	65740.	37.2
ramp	3177989.	205365.	15.5
access	6088362.	258414.	23.6
total	121537859.	3448315.	35.2

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regionwide vehicle miles of travel

unadjusted daily vmt summary

functional class	vmt	vht	speed
freeway	62111222.	1127726.	55.1
prime	9694188.	354474.	27.3
major	20761508.	776979.	26.7
collector	7557465.	284332.	26.6
local collector	7064862.	273231.	25.9
rural collector	786022.	20431.	38.5
local	1853098.	80104.	23.1
fwy-fwy ramp	2447395.	65877.	37.2
ramp	3176285.	205169.	15.5
access	6087108.	258359.	23.6
total	121539153.	3446684.	35.3

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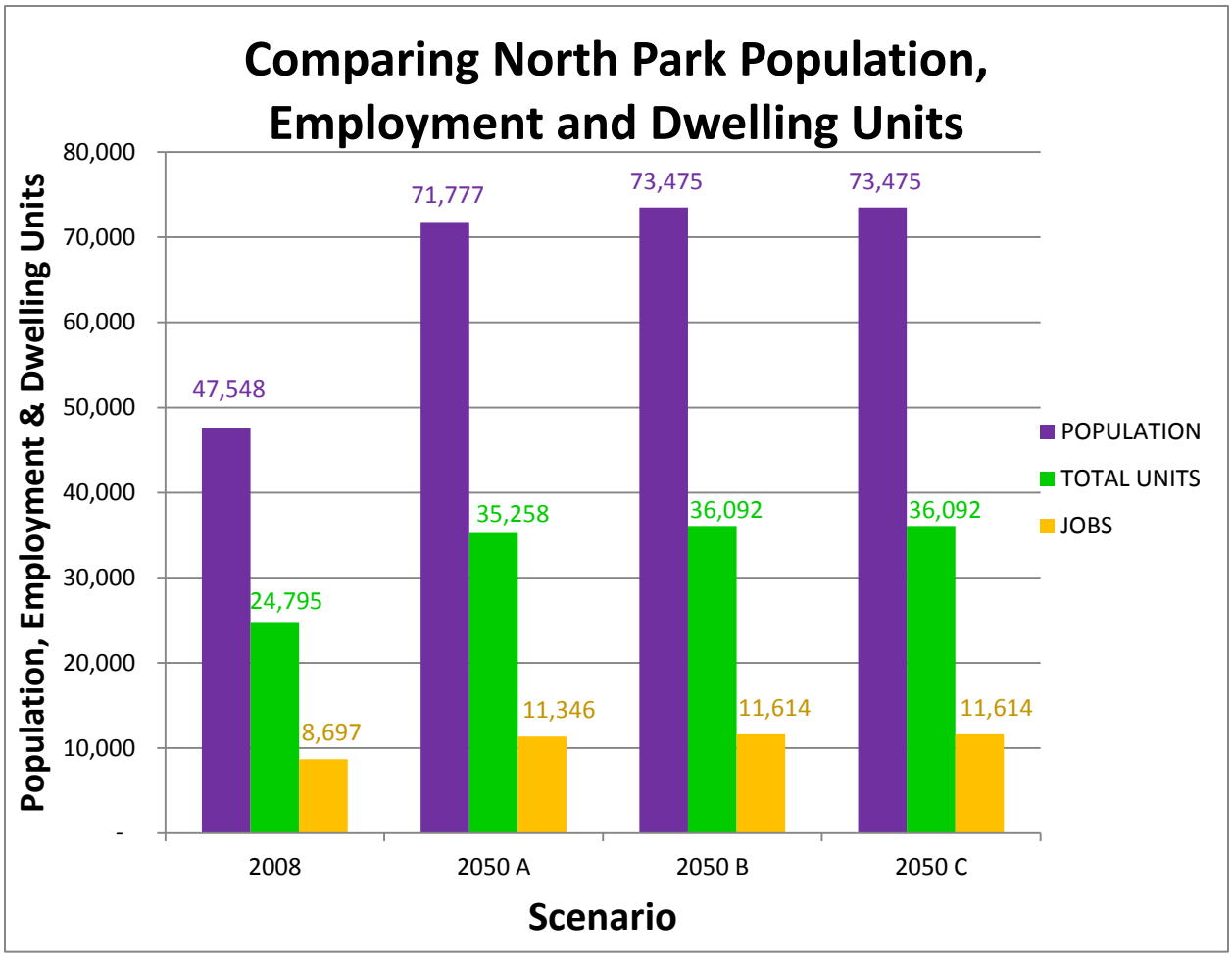
APPENDIX E

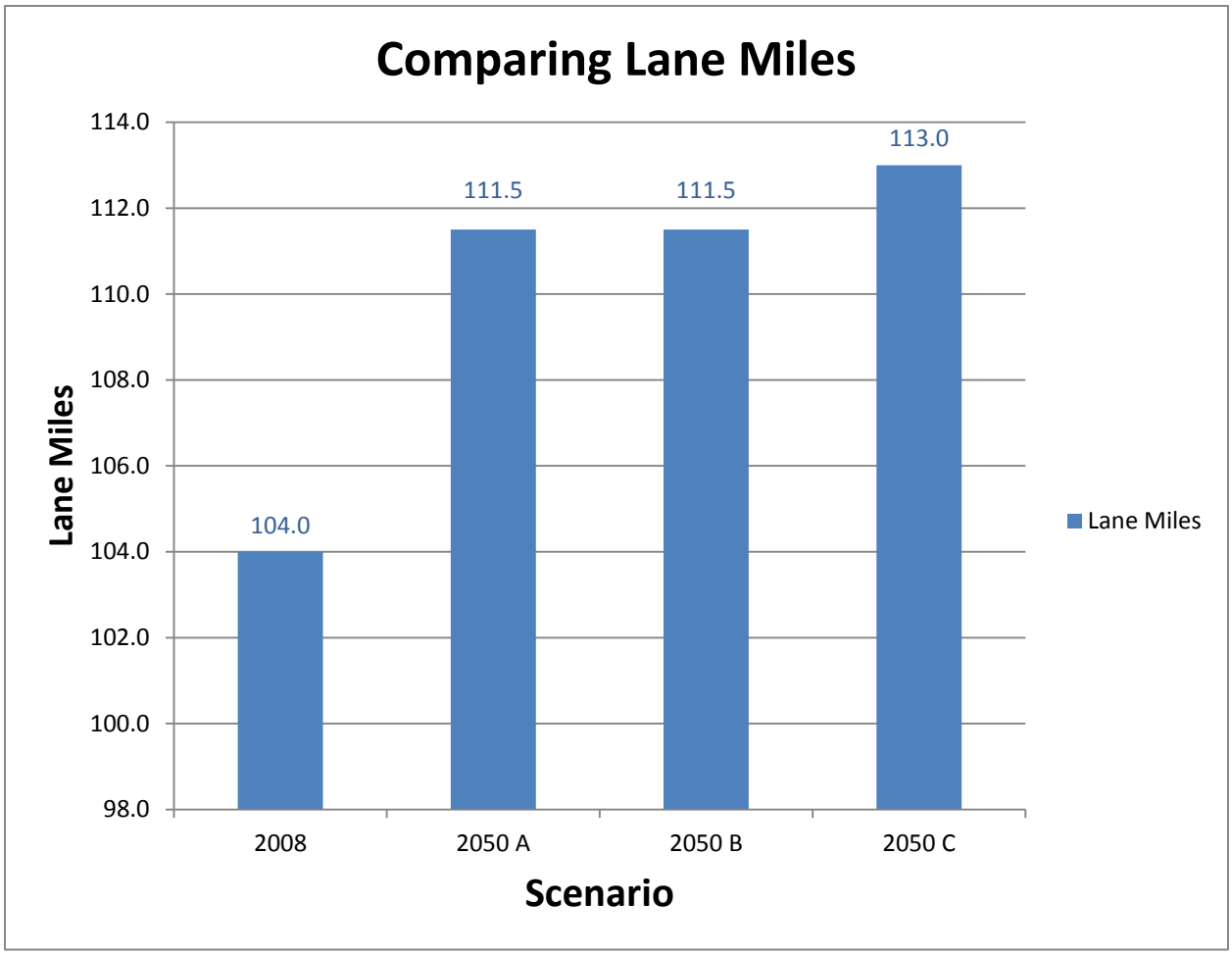
STATISTICAL RESULTS IN GRAPHICAL FORMAT

1) **Demographics**



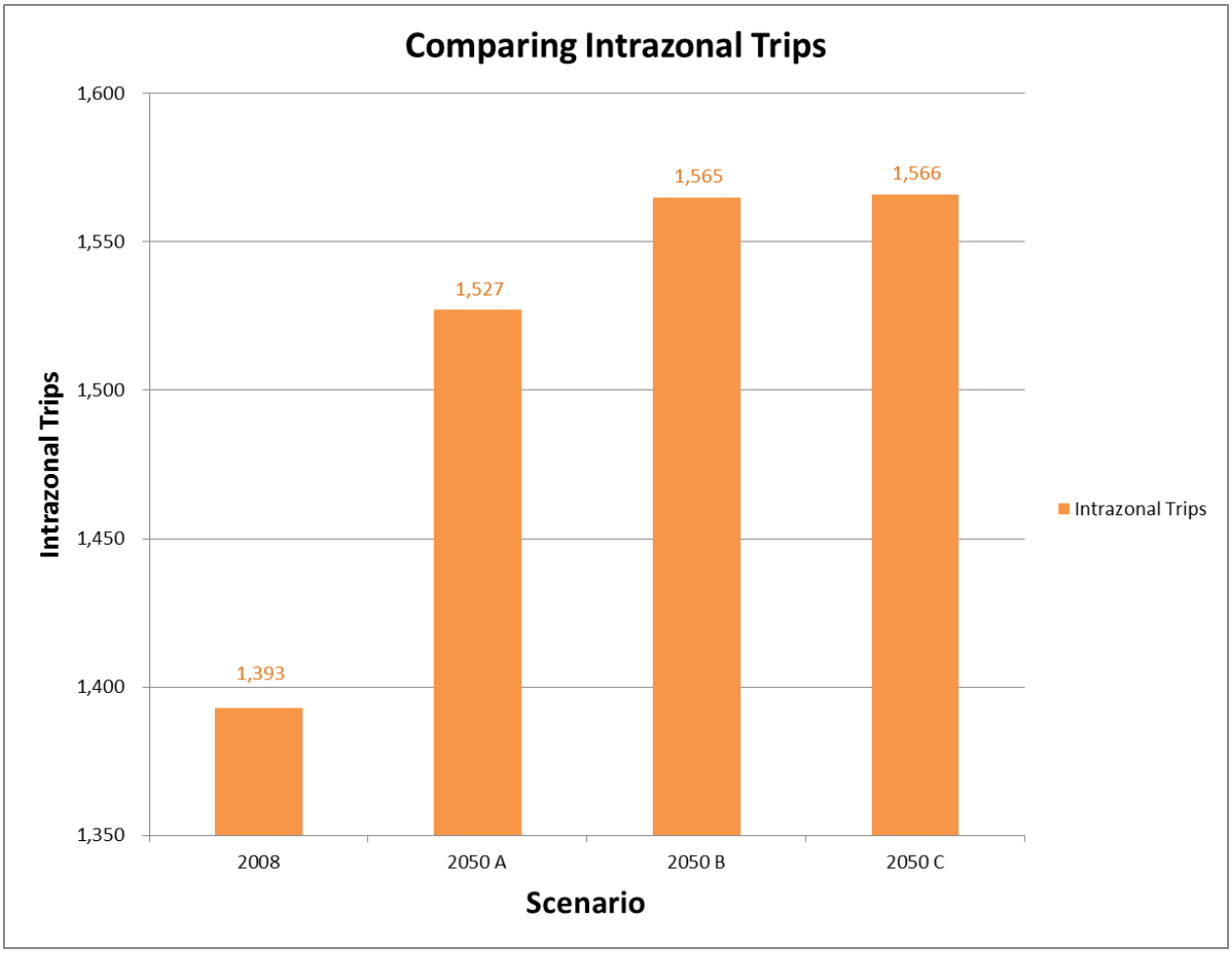
This chart displays the Population, Employment and total Dwelling Units for the four scenarios.

2) **Lane Miles**



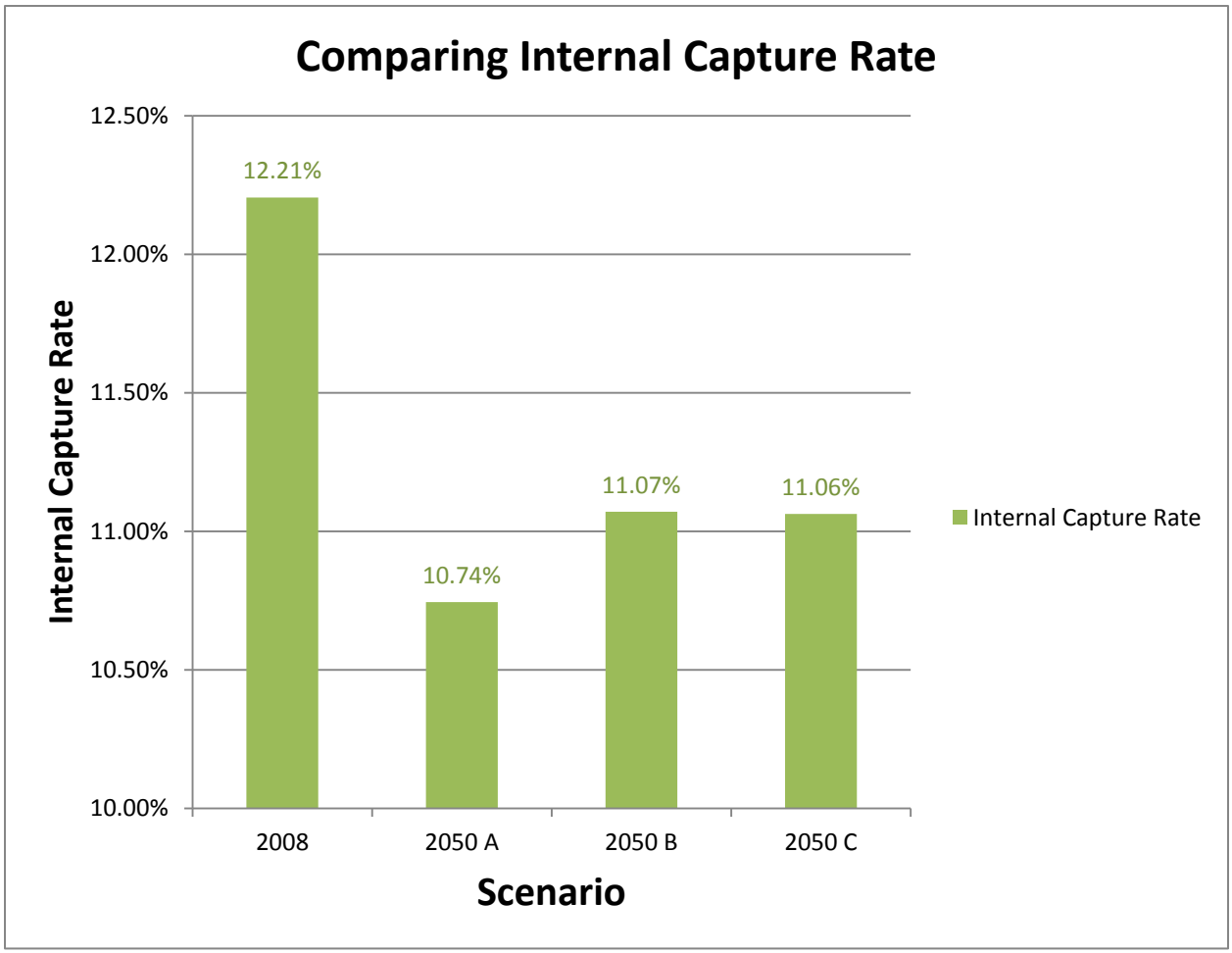
This chart shows the calculated Lane Miles for the four scenarios.

3) **Intra-Zonal Trips**



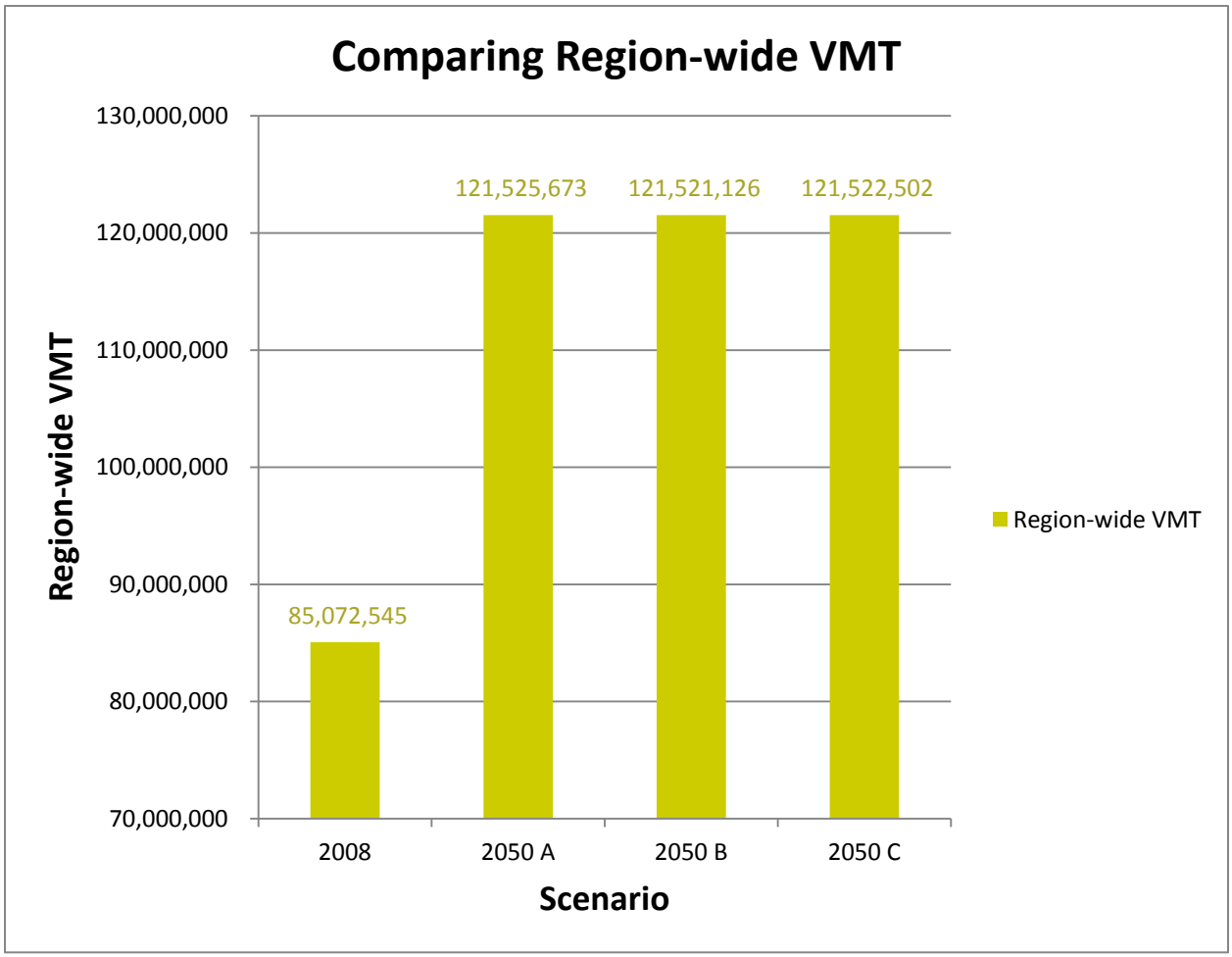
This chart compares the Intra-Zonal trips for the four scenarios.

4) **Internal Capture Rate**



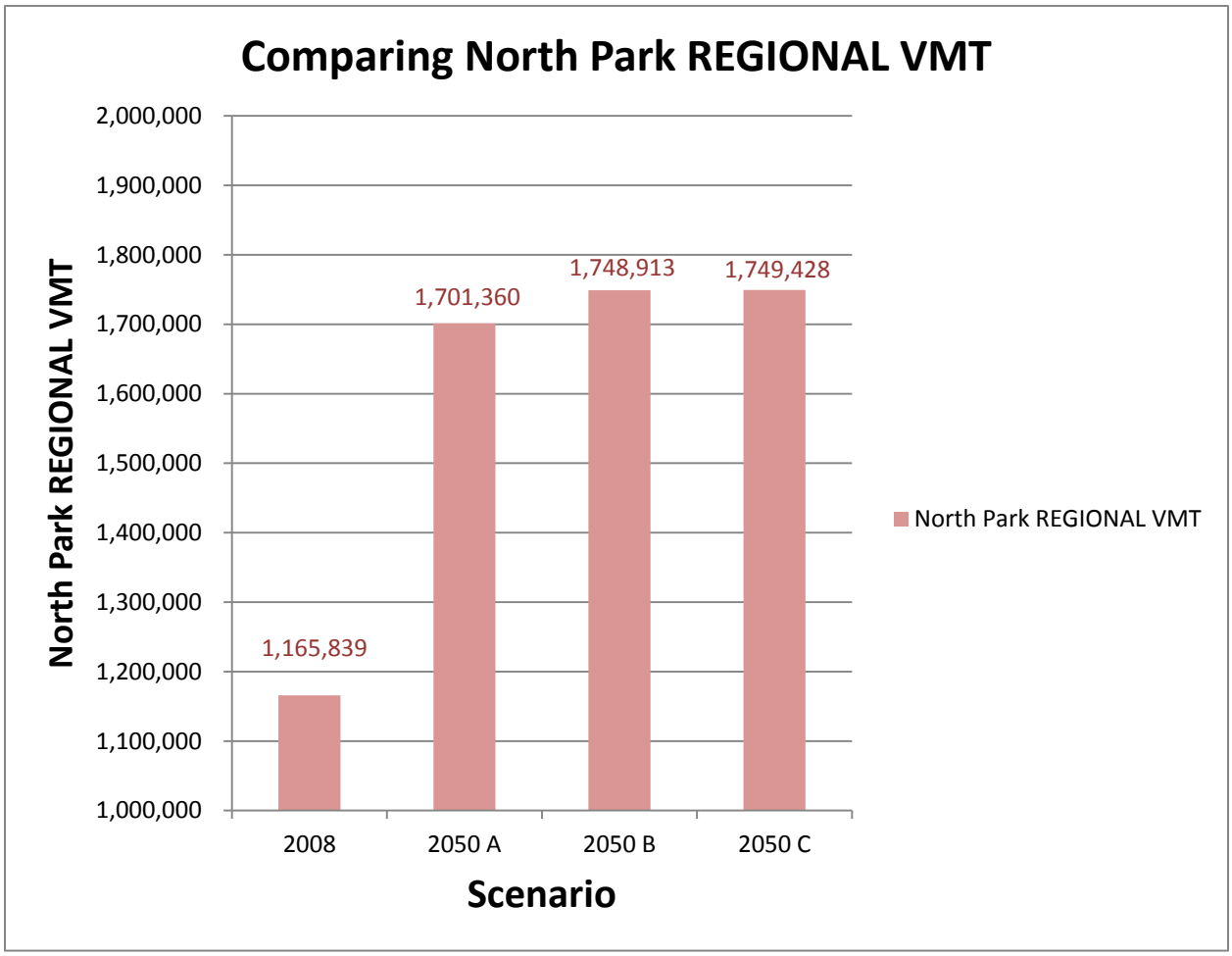
This chart relates the derived Internal Capture Rate for the four scenarios.

5) **Region-wide VMT**



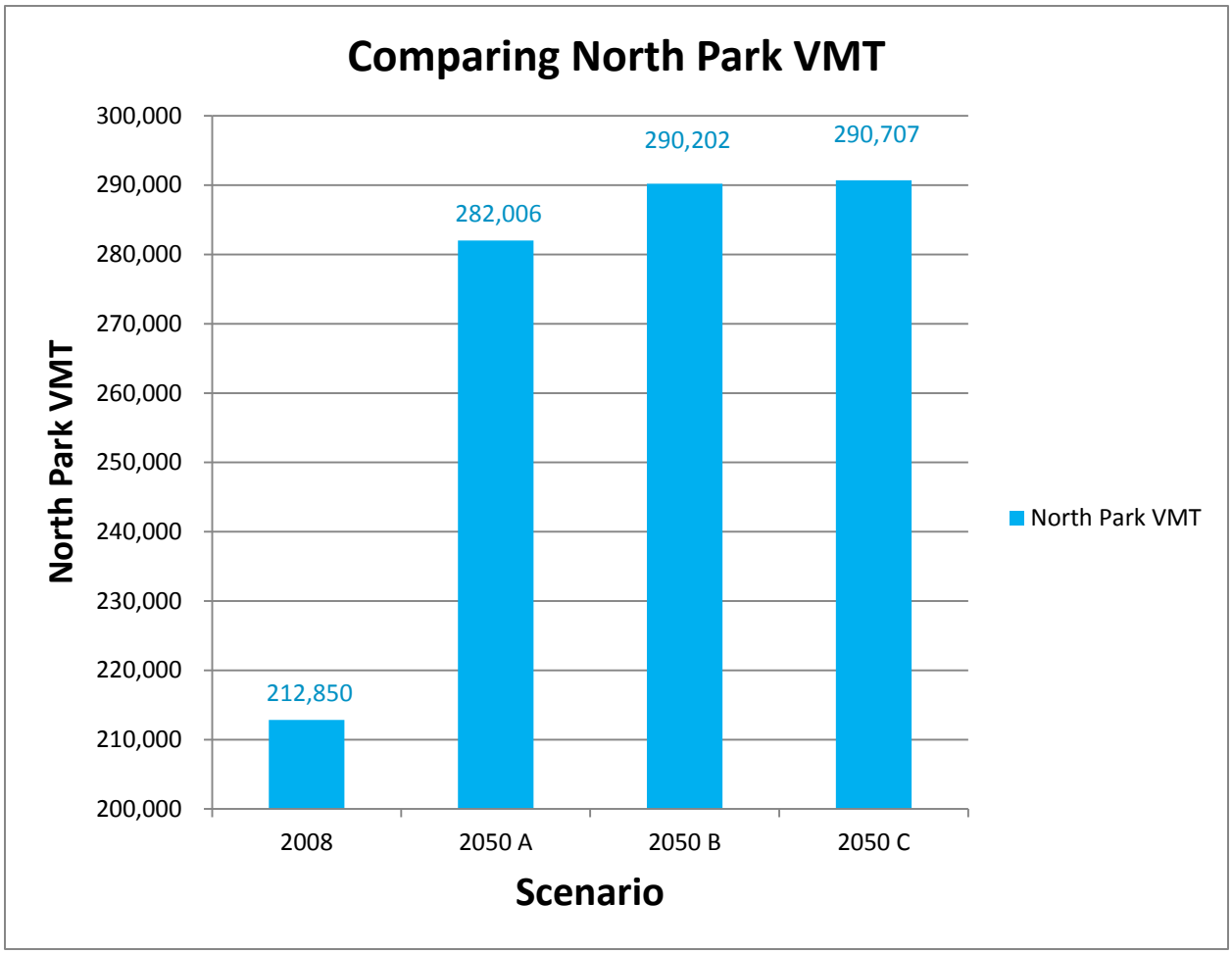
This chart compares the Vehicle Miles of Travel for the four scenarios for the whole San Diego region.

6) **North Park Regional VMT**



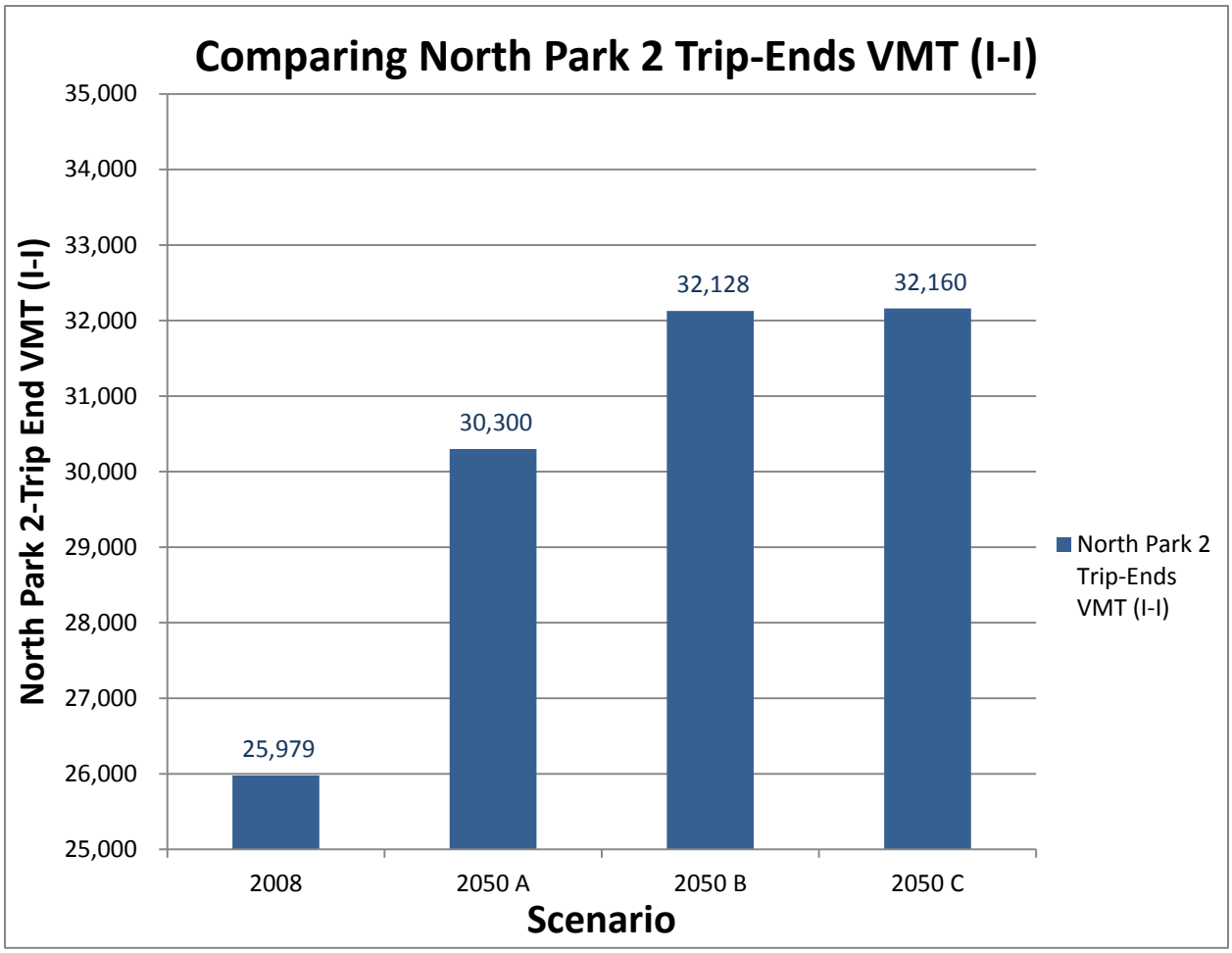
This chart tracks the North Park 1 trip-end Vehicle Miles of Travel throughout the whole San Diego region for the four scenarios.

7) **North Park VMT**



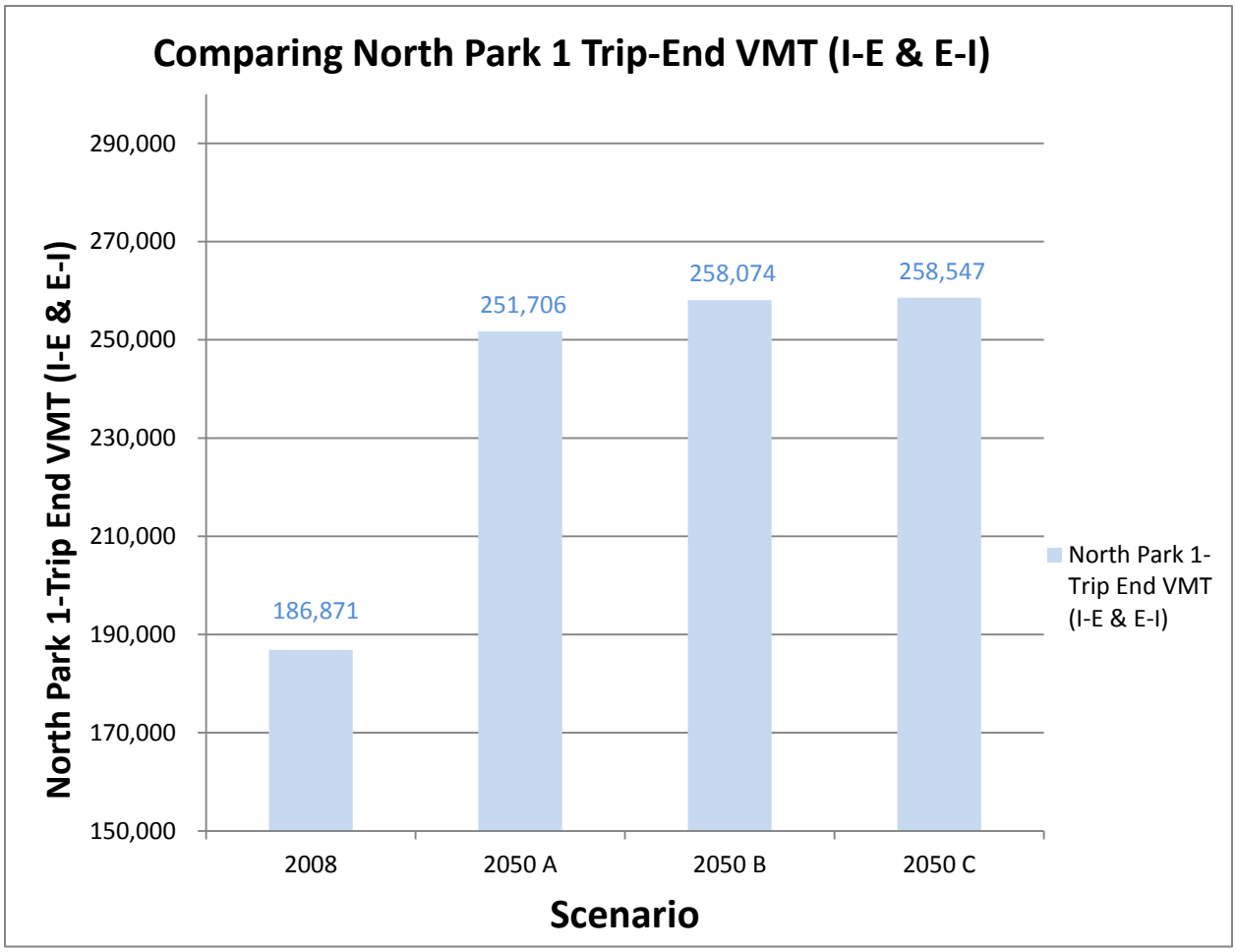
This chart compares all North Park Vehicle Miles of Travel in North Park only for the four scenarios.

8) **North Park Two (2) Trip-Ends VMT (I-I)**



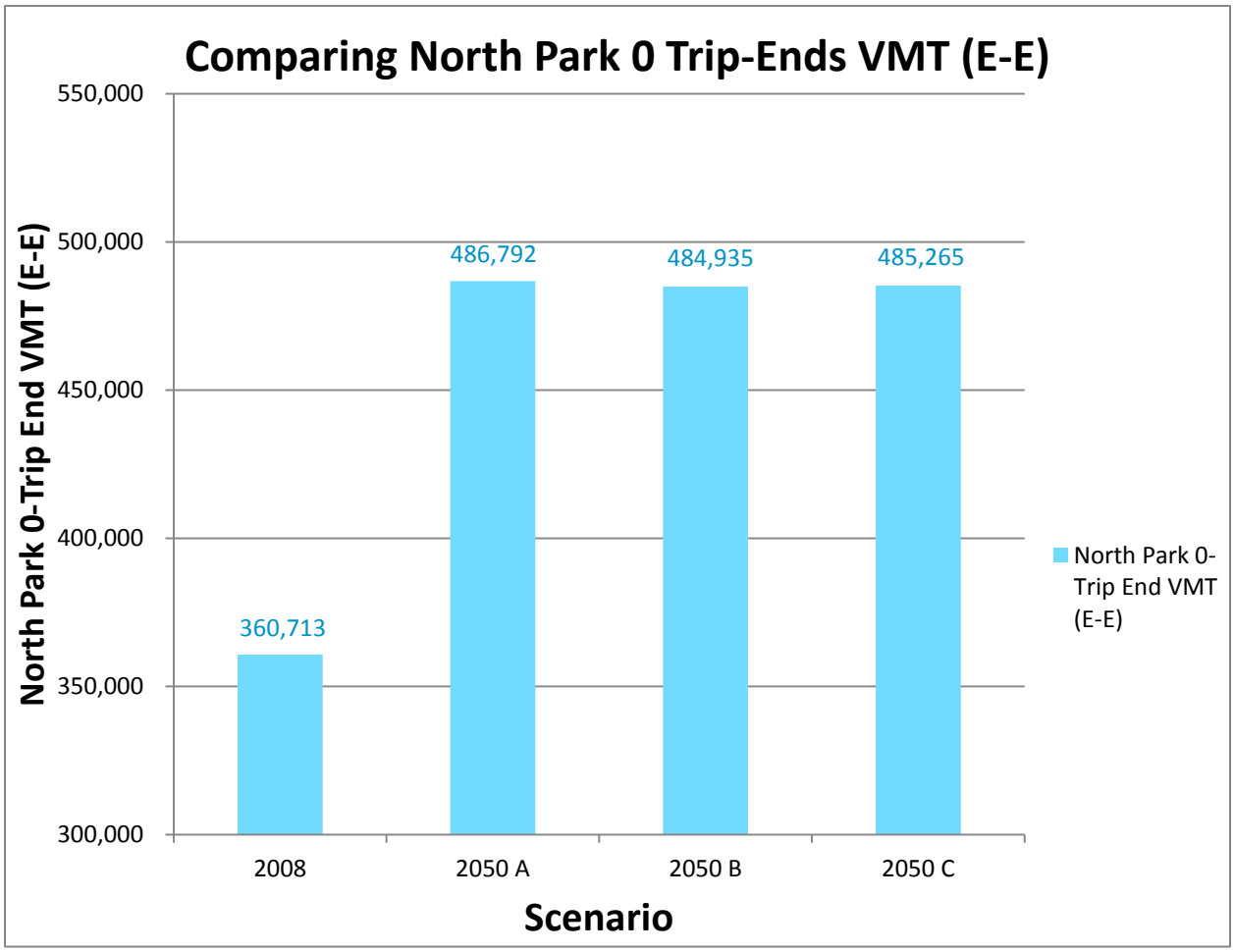
This chart compares North Park Vehicle Miles for trips where both the Origin and Destination are within North Park for the four scenarios.

9) **North Park One (1) Trip-End VMT (I-E & E-I)**



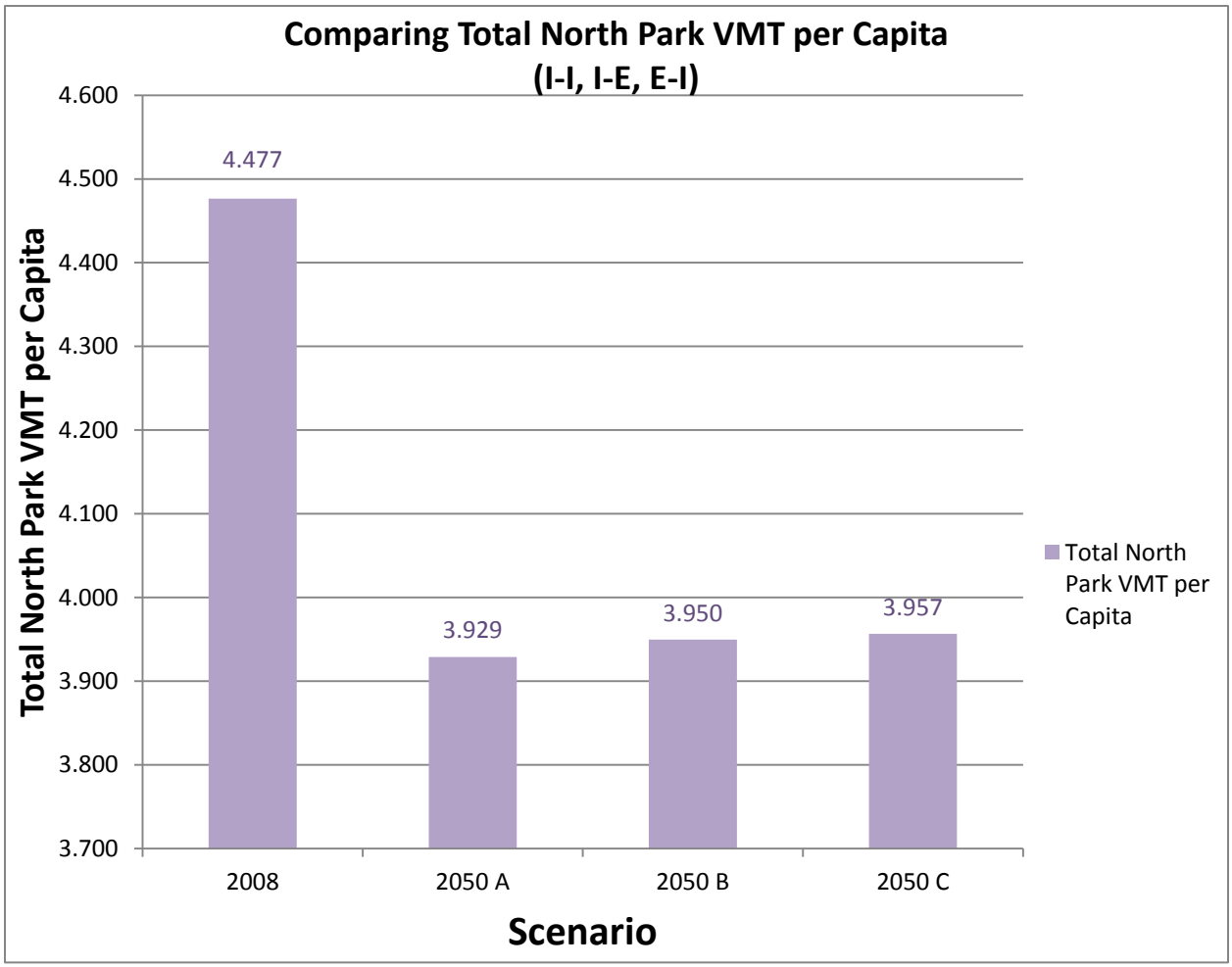
This chart compares North Park Vehicle Miles for trips where either the Origin or the Destination is within North Park for the four scenarios.

10) **North Park Zero(0) Trip-Ends VMT (E-E)**



This chart compares North Park Vehicle Miles for through trips where neither the Origin nor the Destination is within North Park for the four scenarios.

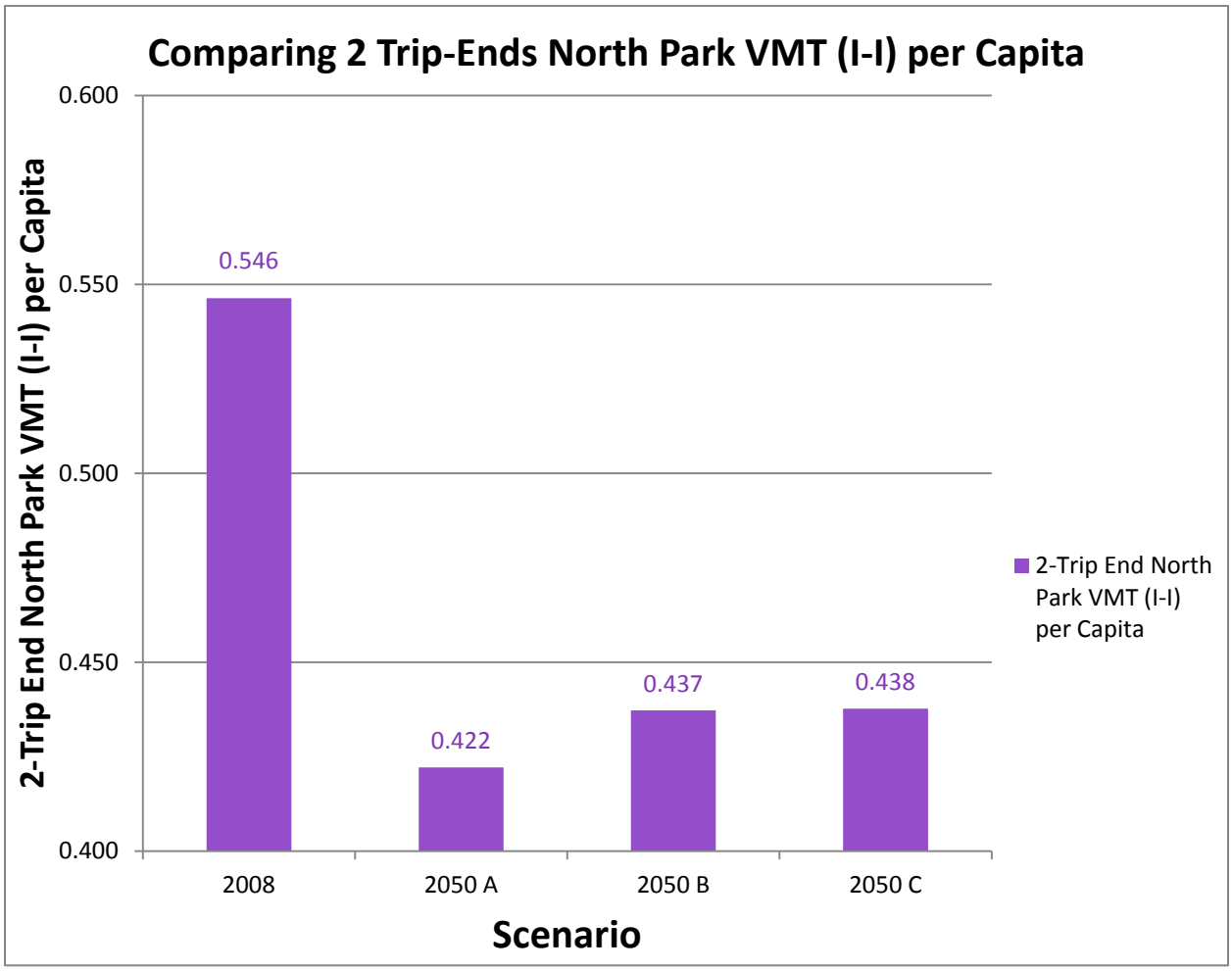
11) **Total North Park VMT per Capita**



This chart displays total North Park Vehicle Miles per Capita for the four scenarios by dividing the total North Park VMT by the North Park population.

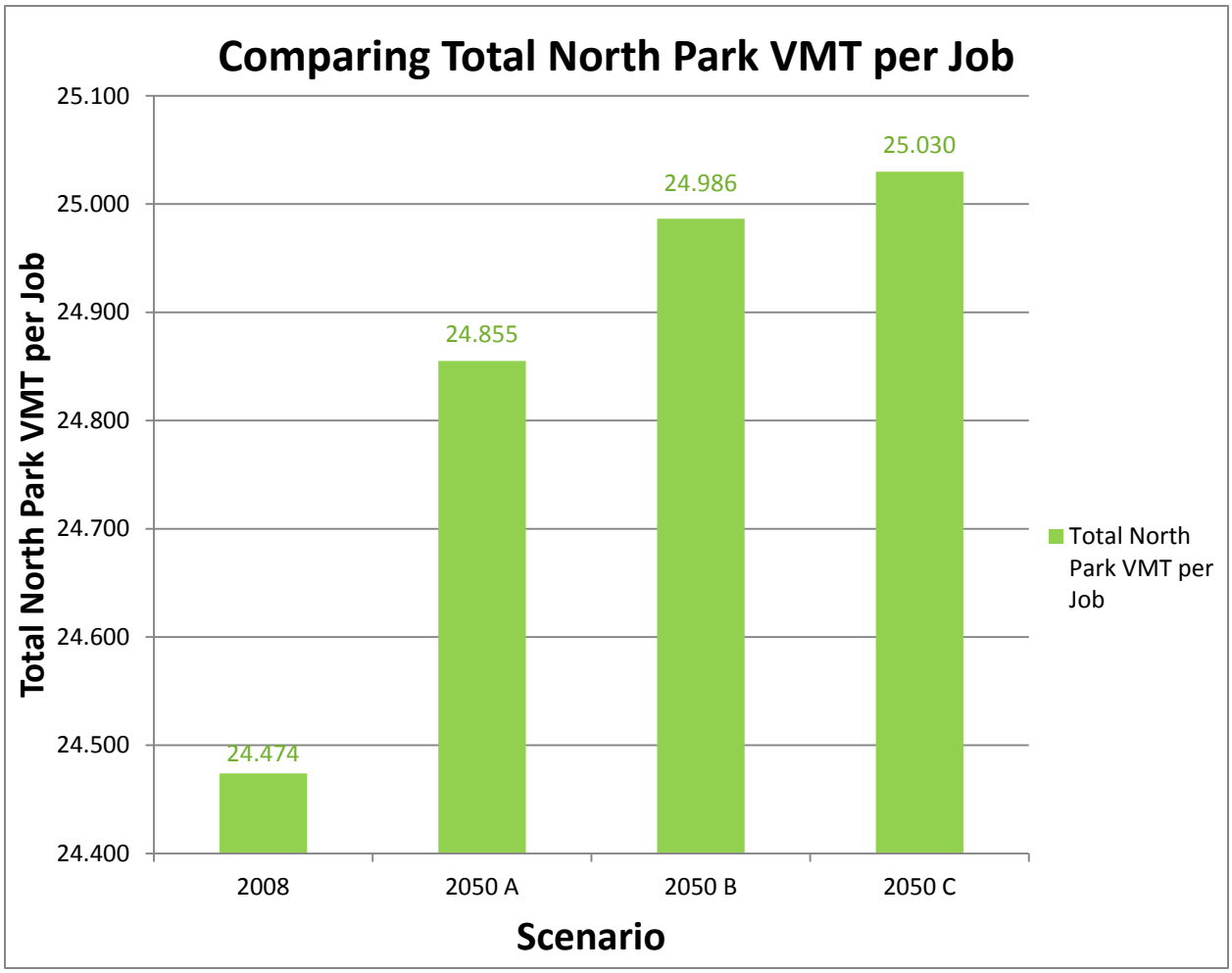
*Total North Park VMT = I-I, I-E, E-I trips

12)**2 Trip-Ends North Park VMT (I-I) per Capita**



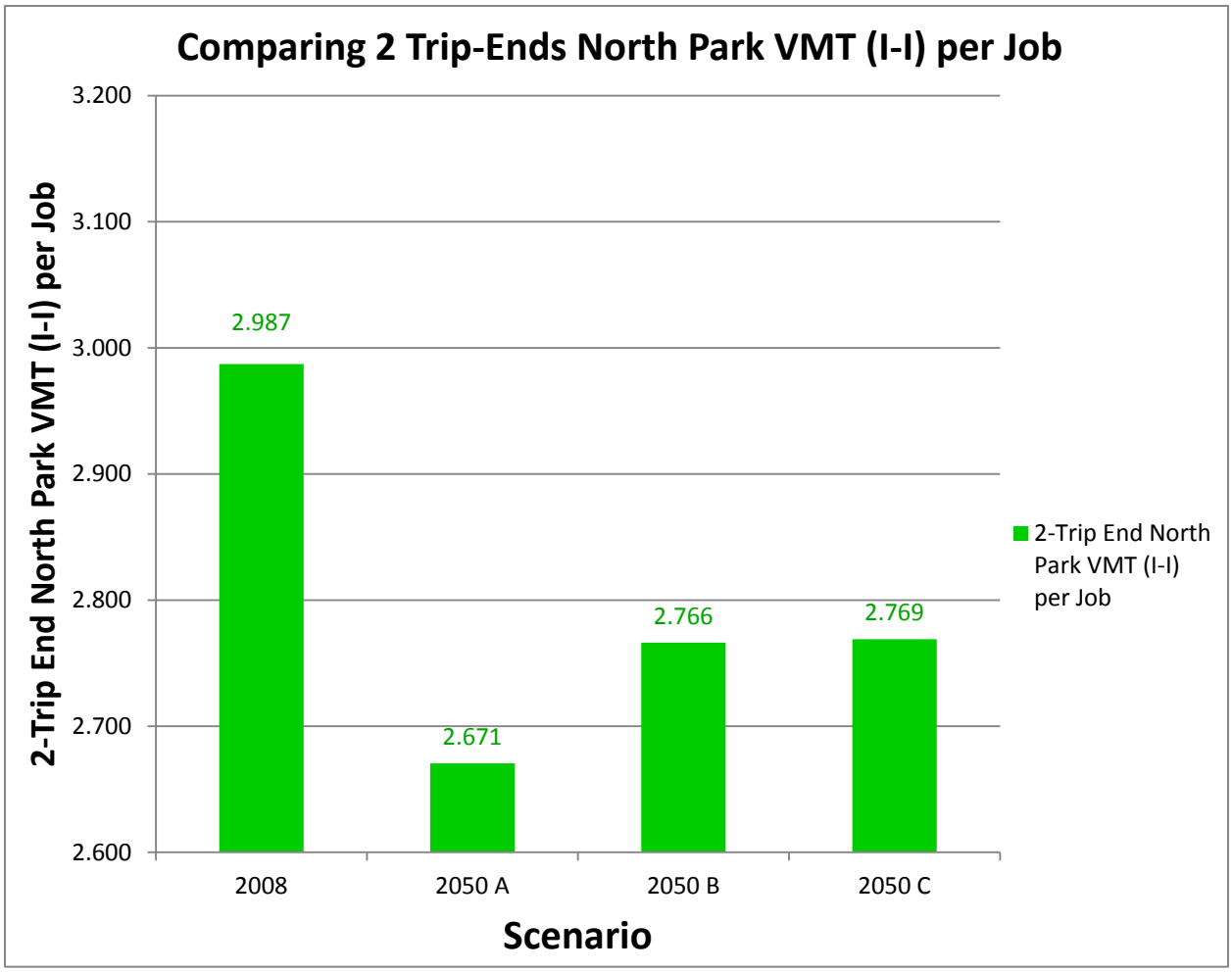
This chart reveals 2 trip-ends in North Park Vehicle Miles per Capita for the four scenarios by dividing the 2 trip-ends North Park VMT by the North Park population.

13) **Total North Park VMT per Employee**



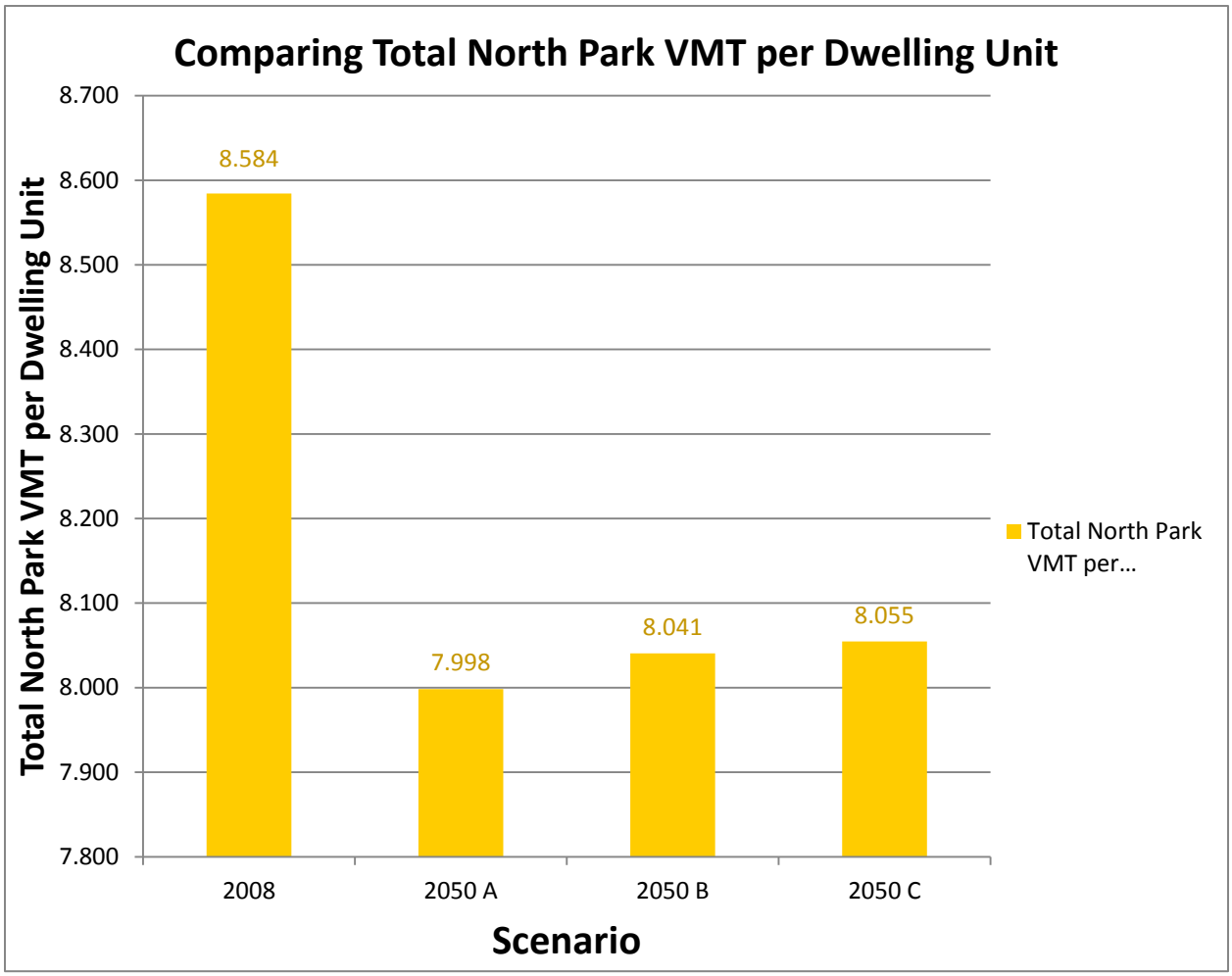
This chart displays total North Park Vehicle Miles per job for the four scenarios by dividing the total North Park VMT by the North Park employment.

14)**2 Trip-Ends North Park VMT (I-I) per Employee**



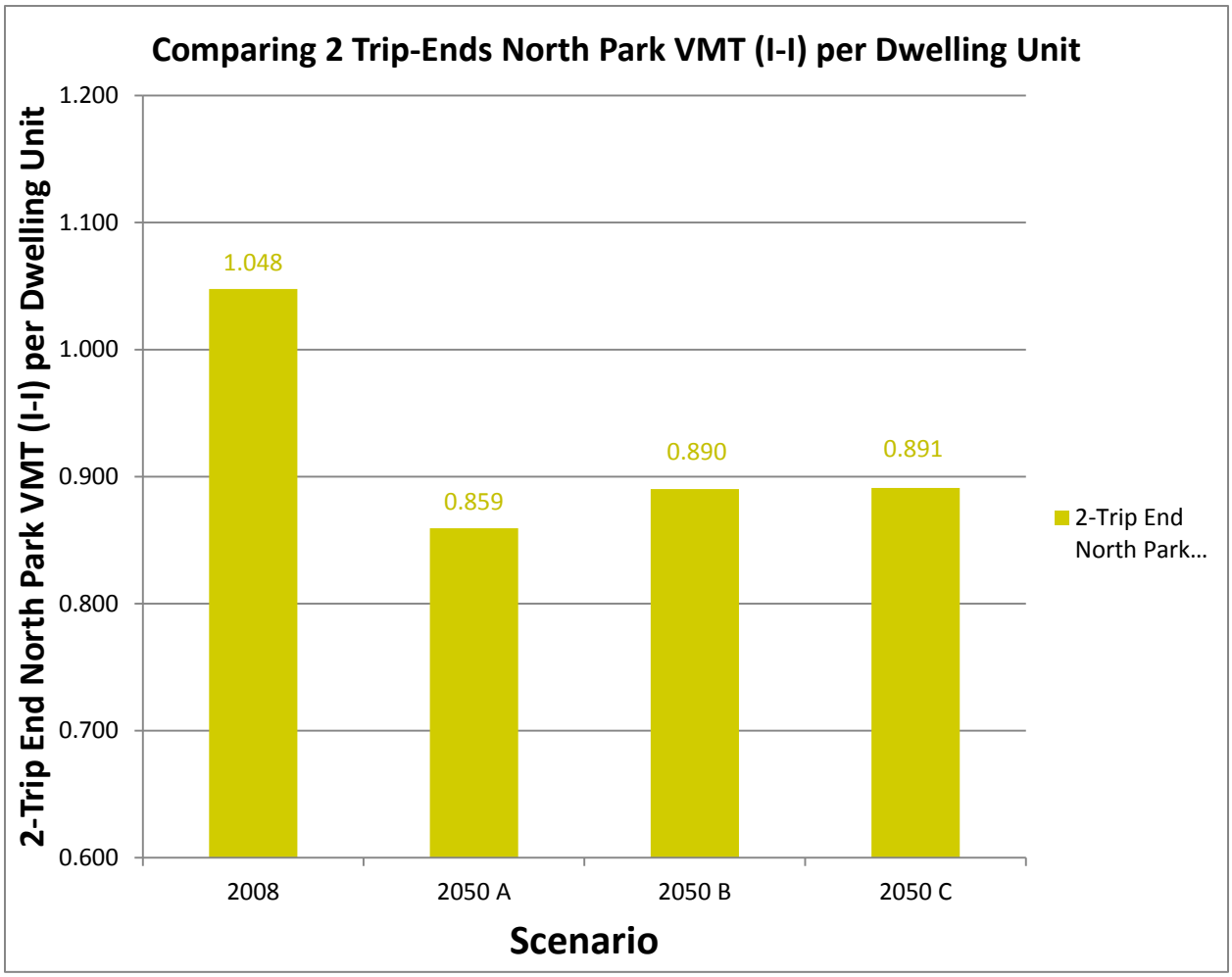
This chart reveals 2 trip-ends North Park Vehicle Miles per job for the four scenarios by dividing the 2 trip-ends North Park VMT by the North Park employment.

15) **Total North Park VMT per Dwelling Unit**



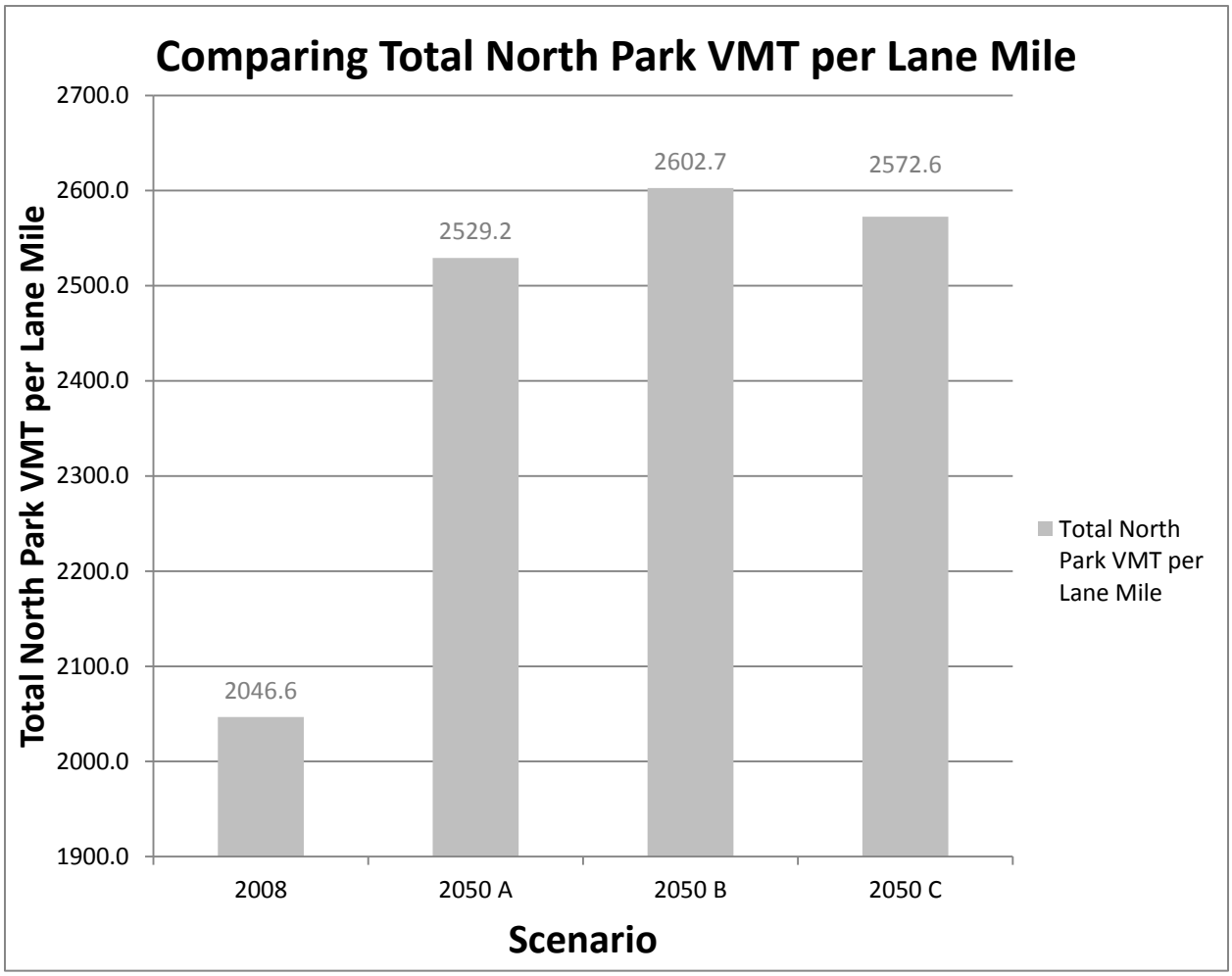
This chart shows total North Park Vehicle Miles per dwelling unit for the four scenarios by dividing the total North Park VMT by the number of dwelling units in North Park.

16)**2 Trip-Ends North Park VMT (I-I) per Dwelling Unit**



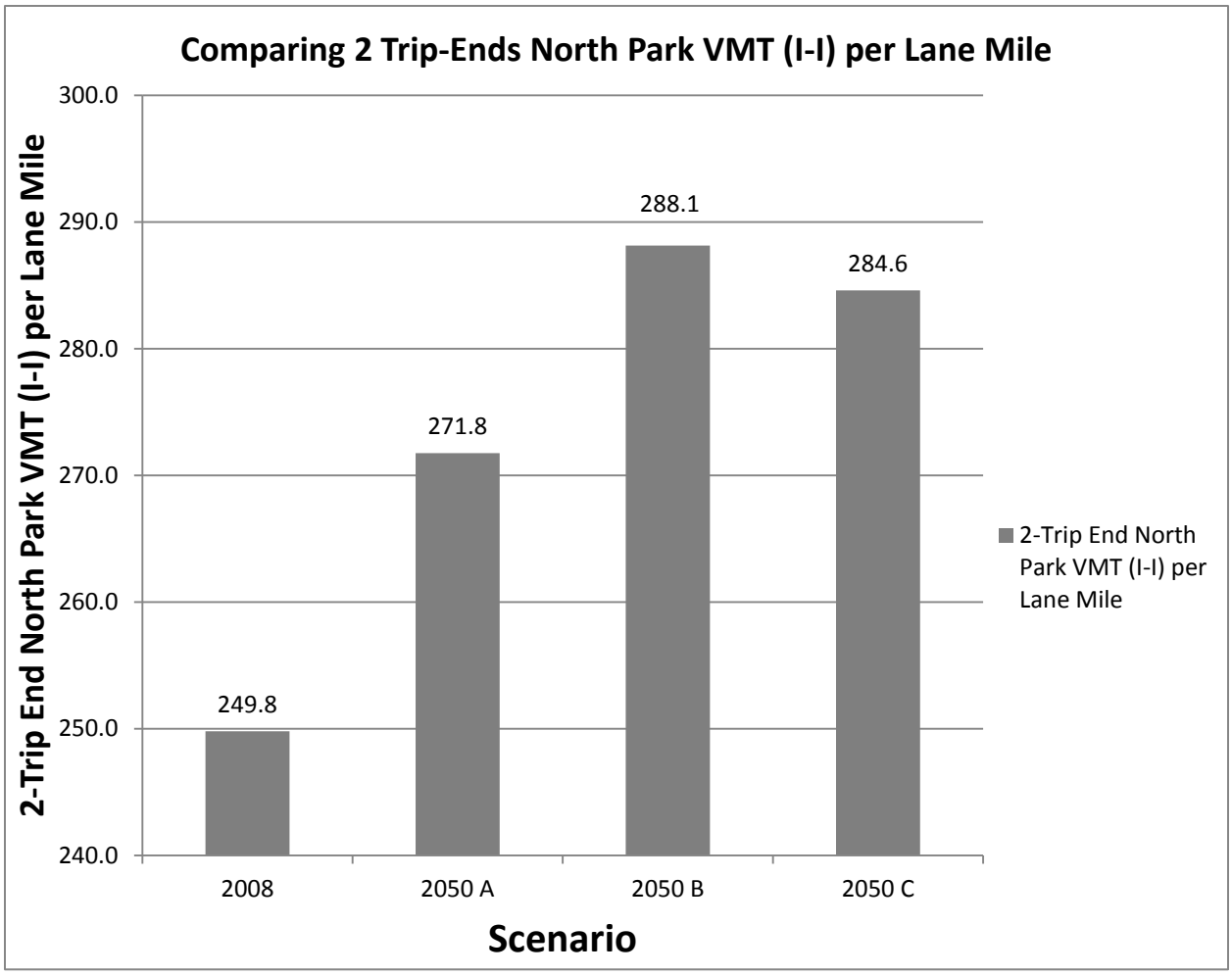
This chart displays 2 trip-ends North Park Vehicle Miles per dwelling unit for the four scenarios by dividing the 2 trip-ends North Park VMT by the number of dwelling units in North Park.

17) **Total North Park VMT per Lane Mile**



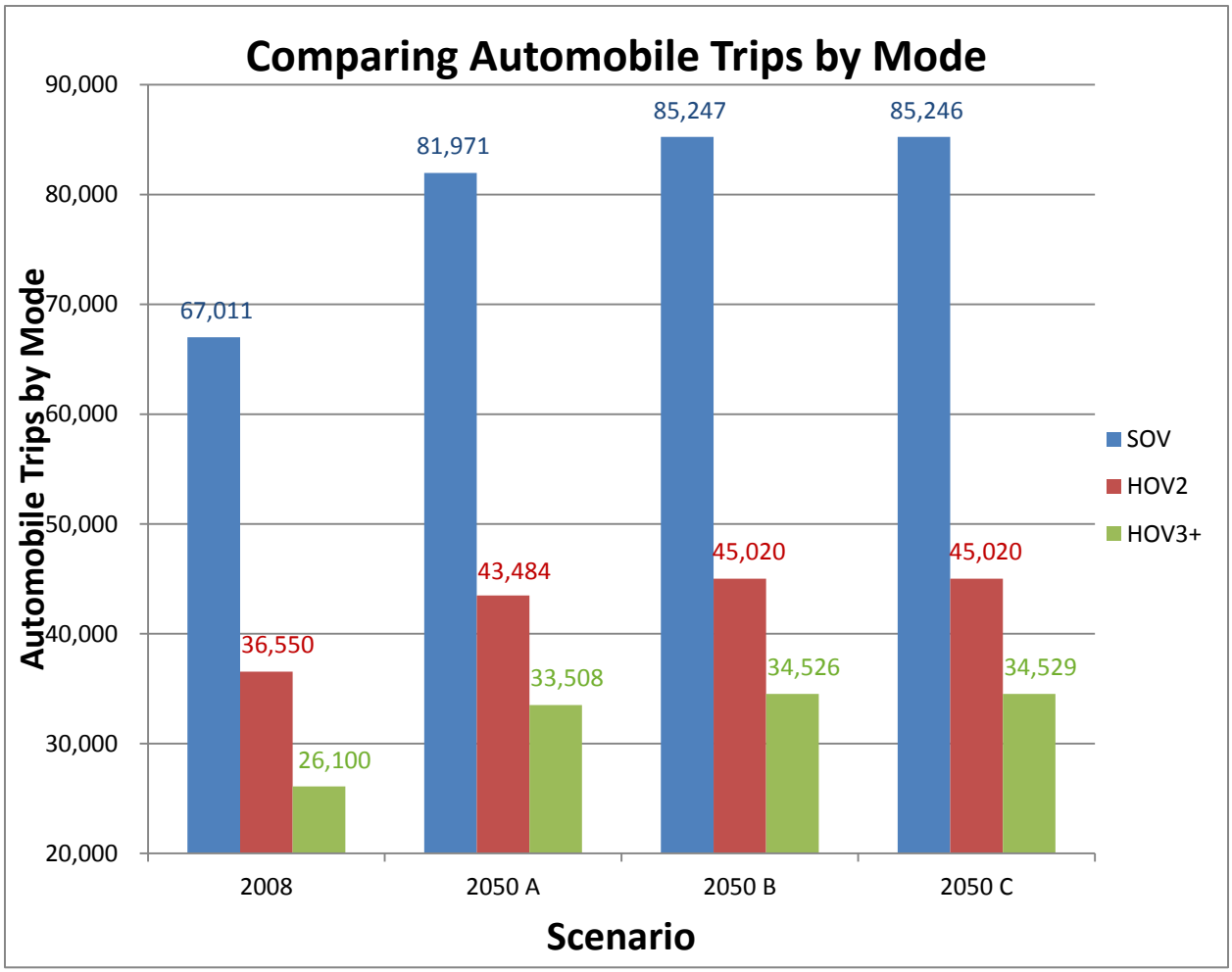
This chart demonstrates total North Park Vehicle Miles per lane mile for the four scenarios by dividing the total North Park VMT by the number of lane miles in North Park.

18)**2 Trip-Ends North Park VMT (I-I) per Lane Mile**



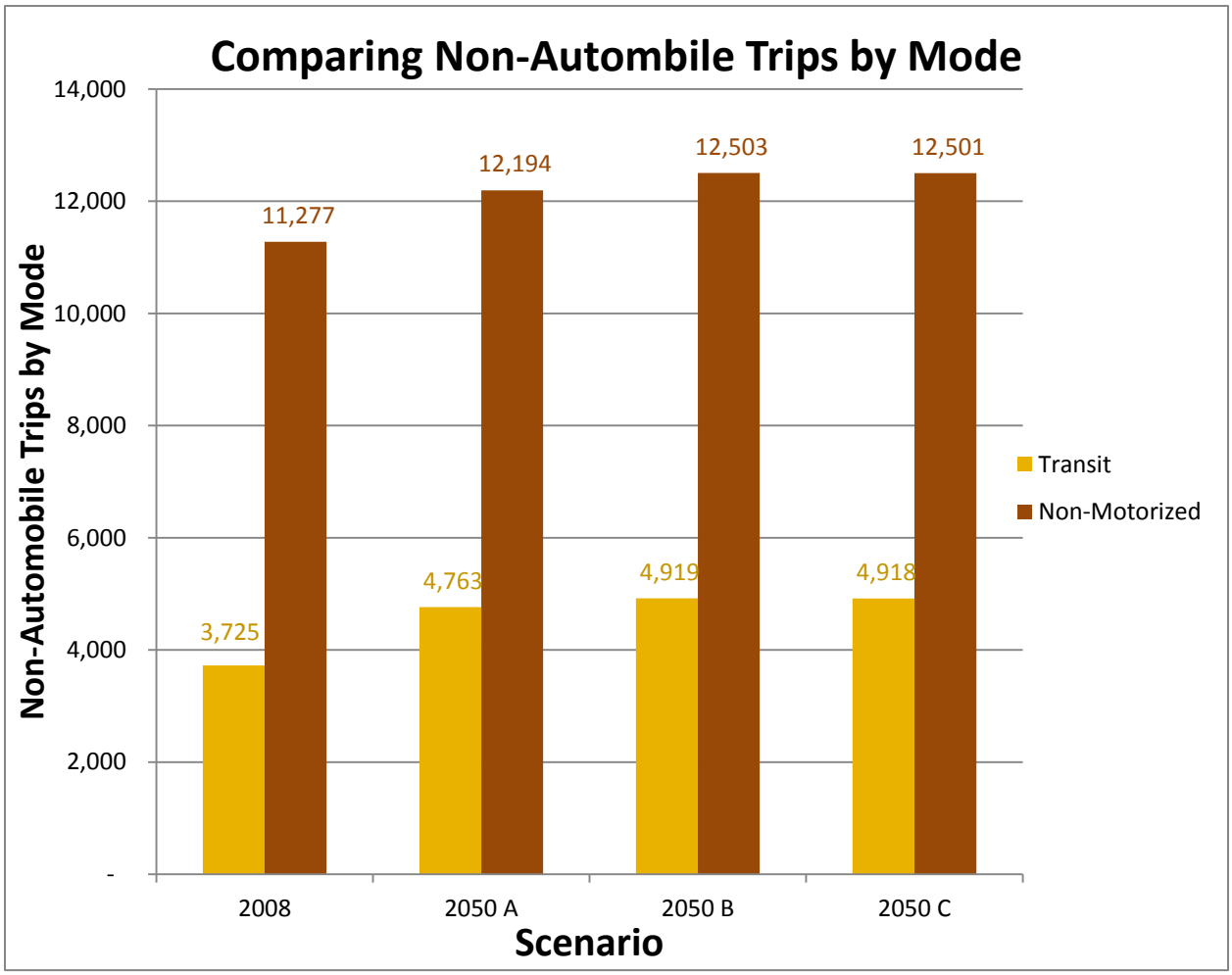
This chart illustrates 2 trip-ends North Park Vehicle Miles per lane mile for the four scenarios by dividing the 2 trip-ends North Park VMT by the number of lane miles in North Park.

19) **Automobile Trips by Mode**



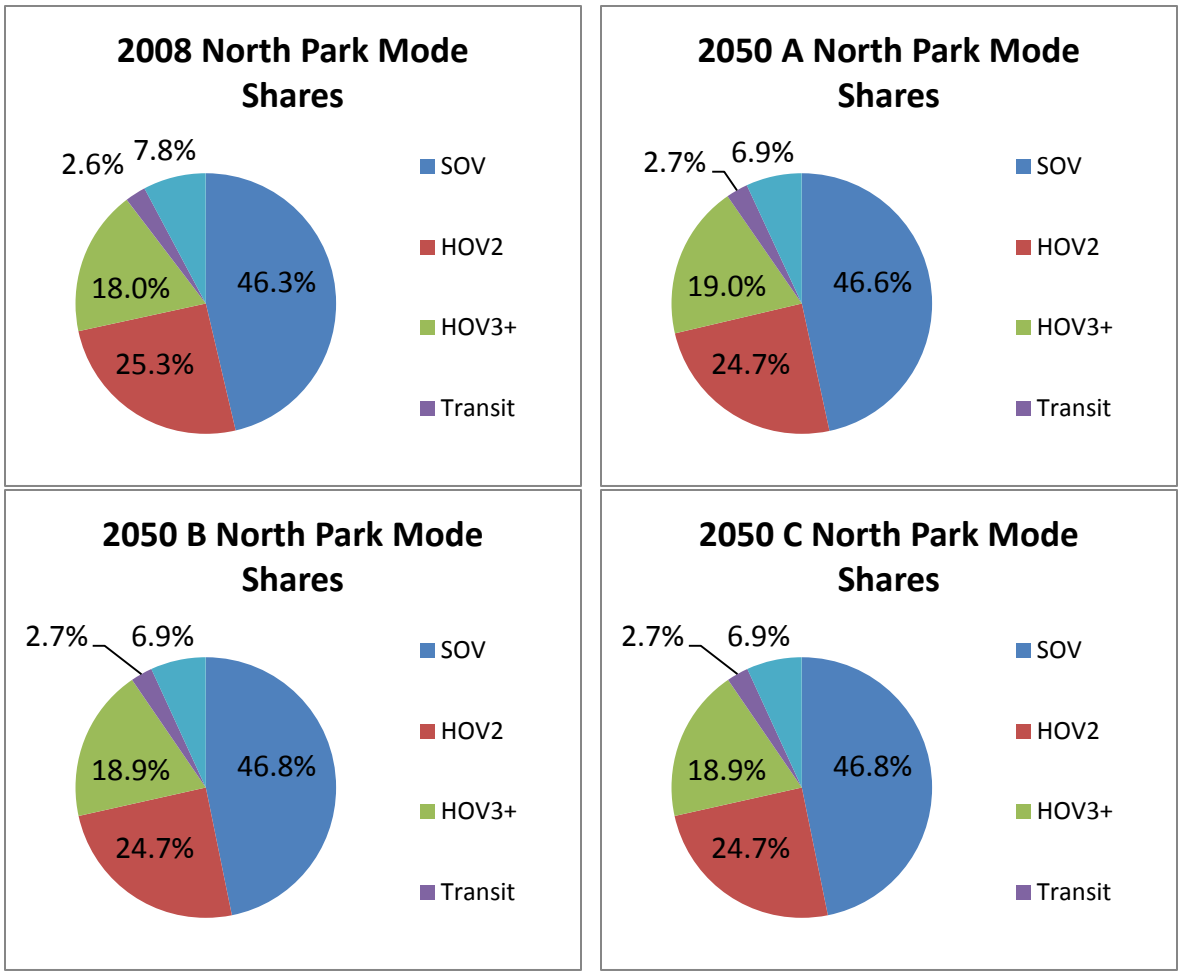
This chart displays the total number of automobile trips generated in North Park the four scenarios.

20) **Non-Automobile Trips by Mode**



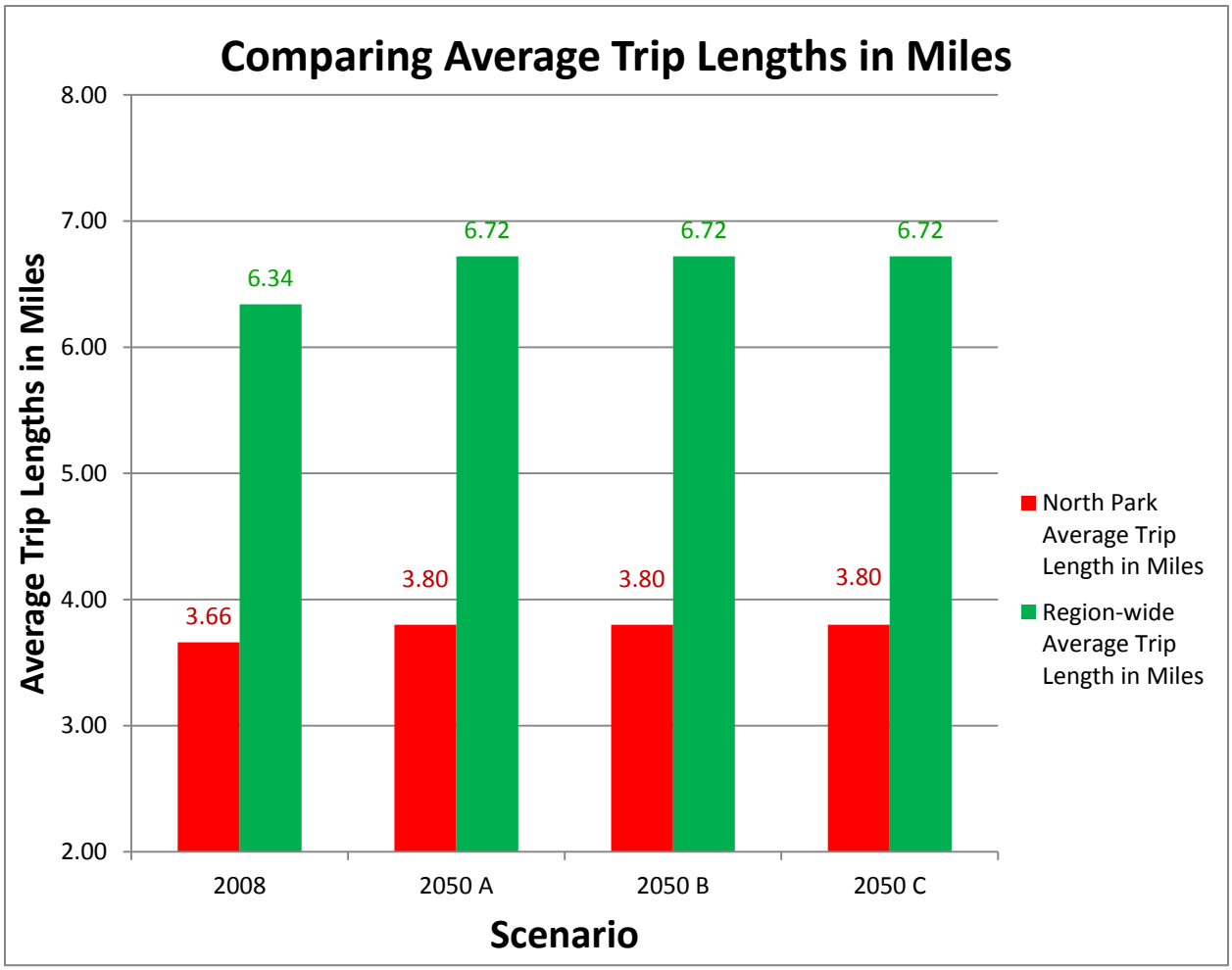
This chart displays the total number of non-automobile trips generated in North Park the four scenarios.

21) **Mode Shares**



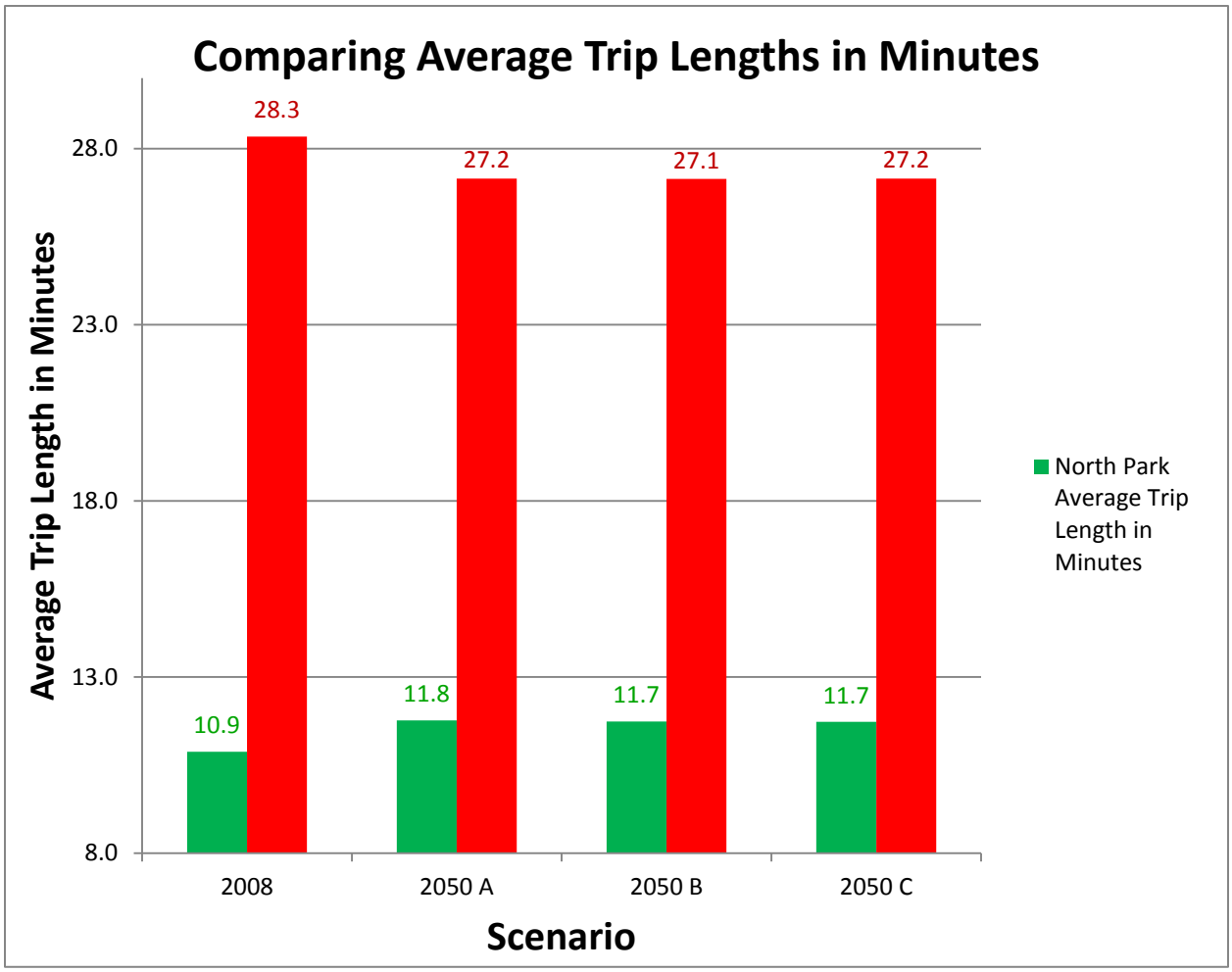
These charts depict the mode shares of all trips generated in North Park the four scenarios.

22) **Average Trip Lengths in Distance**



This chart displays average trip lengths in distance for the Region and for North Park for the four scenarios.

23) **Average Trip Lengths in Time**



This chart displays average trip lengths in time for the Region and for North Park for the four scenarios.