Santa Fe Project Center

Organizing and Visualizing Traffic Data in the Santa Fe Metropolitan Area

An Interdisciplinary Qualifying Project
Submitted to the faculty of
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ABSTRACT

Transportation organizations in Santa Fe, New Mexico do not currently have a centralized location for all of the traffic data they collected in the Santa Fe metropolitan area. To alleviate this problem, the team created a database to store the data from each organization. Visualizations representing the data were also created, and this process was also made automatic through Microsoft Excel. Then, a transportation platform was created to provide the organizations with easy access to the database and visualizations.

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EXECUTIVE SUMMARY

As eastern civilizations of the United States became more industrialized, many people became discontent and began moving west; Santa Fe, New Mexico was one of their main destinations. In the 19th century, traveling to Santa Fe became easier with the introduction of several trails, such as the Santa Fe Trail, Camino Real, and Old Spanish Trail. These trails became the primary routes into and out of Santa Fe. As more people became interested in Santa Fe, the population grew, leading to an increase in the need for different means of transportation.

With transportation becoming more developed, the need for improving the roadways and keeping them efficient became apparent. Transportation organizations, such as the Santa Fe Metropolitan Planning Organization (SFMPO), work to keep transportation in Santa Fe as efficient as possible. By collecting traffic data, they analyze traffic flow and road conditions. If need be, recommendations are made to improve the roadways, which could include adding signs or even a new lane on a road.

There are multiple traffic management organizations collecting traffic data in Santa Fe. There is a multitude of data; however, collaboration between each organization can be improved. Currently, there is no existing transportation platform that includes traffic data from all of these organizations. A platform such as this would create a centralized location for all traffic data collected in Santa Fe and improve the communication between organizations.

The main goal of this project was to help the SFMPO, as well as other traffic management organizations, in the development of a transportation platform, which would allow for the maintenance, organization, and modeling of traffic data in the Santa Fe metropolitan area. This goal was broken down into four major objectives:

1. Gathering, organizing, and maintaining traffic data.
2. Determining an appropriate approach to visualizing traffic data.
3. Designing and creating a transportation platform for traffic planning.

Figure 0.1 Flow of Data From Organizations to Platform

The first step in completing the first objective was to gather data from the different transportation organizations in the Santa Fe area. These organizations included the SFMPO, New Mexico Department of Transportation (NMDOT), City of Santa Fe, and Santa Fe County. This was done by contacting people in these organizations and asking them for any traffic data that they had available and was collected within the metropolitan area. The main focus was to collect traffic counts, which are the most useful type of data for the SFMPO and planning purposes. Once this data was received, it was organized according to different aspects, such as the type of data and the location it was collected. All of this data was then placed into Dropbox, an online database. This provided organizations easy access to the data that was collected. The last step in completing the first objective was to maintain data flow once this project was completed. Each person uploading data to the database was contacted once again and asked to continue uploading on a frequent basis.

A universal labeling system was also created, because each oragnization uses a different system and a universal one would make creating maps and other visualizations easier. Labels were made for each road segment and intersection that are used by the organizations. Using this system, a map was created using Google Maps, leading into the second objective. The points on this map show different data collection points. Information about the points are also provided when clicked on. This map, and an example of the data included, is shown in Figure 0.2.

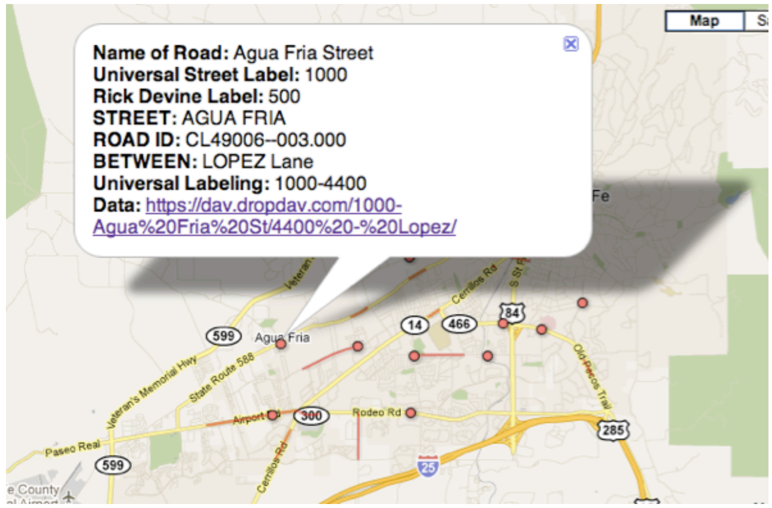

Figure 0.2 Map of Labeled Intersections and Road Segments

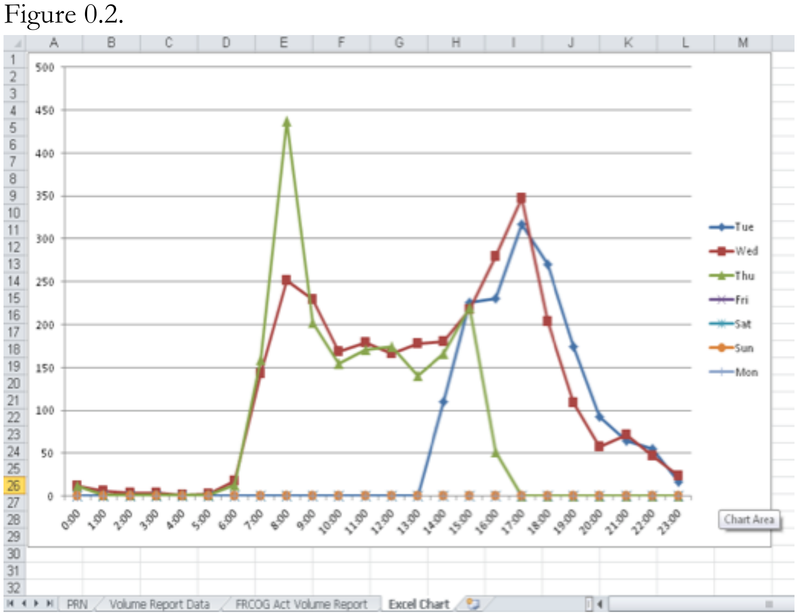

Figure 0.3 Line Graph of Traffic Data Created in Excel

The second objective also consisted of creating other visualizations, such as graphs, of the traffic data collected in the first objective. The data being uploaded into Dropbox was in Printer Text (PRN) file format; it was then converted into spreadsheets using a macro in Excel. Graphs were then automatically created using this data. These graphs contain information about certain traffic counts over a 48-hour period and are able to show traffic flow and peak hours for that time period. An example of such a graph can be found in Figure 0.3. Three peak hours for this count can be seen clearly; they occur where the volumes are highest, at about 75 vehicles, during these times.

The third and final objective of this project was to design and create a transportation platform. This platform is a combination of the first two objectives, containing a database and mapping applications. It is Internet based, so Dreamweaver, a webpage creation tool, was chosen to create the website. The website includes several applications, including Google Docs, Google Maps, Dropbox, and GIS Cloud. The labeling system created in the first objective is also included on the website to give organizations easy access to it. Tutorials for using each application were then created, as well as the website in general. Using Dreamweaver, tabs were created for each application and features. A split screen viewing option was also added, giving users the ability to view two applications or other features at once. The platform contains data from several organizations in Santa Fe, and provides users with easy access to this data.

The transportation platform created during this project has the potential to be a great asset to the SFMPO, as well as other transportation organizations. It bridges the gap between the different organizations in Santa Fe, creating a centralized location for the traffic data collected by them. By providing visualizations for this data, transportation planners, such as the SFMPO, are able to analyze data easily and make recommendations for improving the city's transportation and roadways. The team recommends that several of the results be expanded on to make uploading and visualizing data easier and more useful to the organizations, especially the SFMPO. In the future, these and other recommendations will prove to be very useful to the planning process.

1. INTRODUCTION

According to the United States Census Bureau, America's population grew from 281.4 to 308.7 million people from 2000 to 2010; which means a 9.7 percent increase in only 10 years.[1] With this ever-increasing population growth in the United States, the vehicle transportation network becomes overcrowded and complicated, which gives way to many setbacks and time conflicts for those on the roads. Transportation is "the act of moving something [or someone] from one location to another."[2] There has been a significant rise in the number of passenger cars, 128 million in 1985 to 137 million in 2008,[3] which has influenced the swell in the number of hours wasted in the average commute, from roughly 19 to 34 hours.[4] Of the approximately 86% of commuters who traveled by car in 2008, only 10% carpooled to work. Additionally, only 5% used public transportation, and the remaining 9% utilized other means of travel or worked from home.[5] A chart of these numbers is shown in Figure 1.1 below. Consequently, in 2009, an estimated $87 billion, 4.2 billion hours, and 2.8 billion gallons of fuel were wasted due to matters of congestion.[6] Although, congestion has a significant impact on commuters, only 24% are being proactive to help reduce this issue.

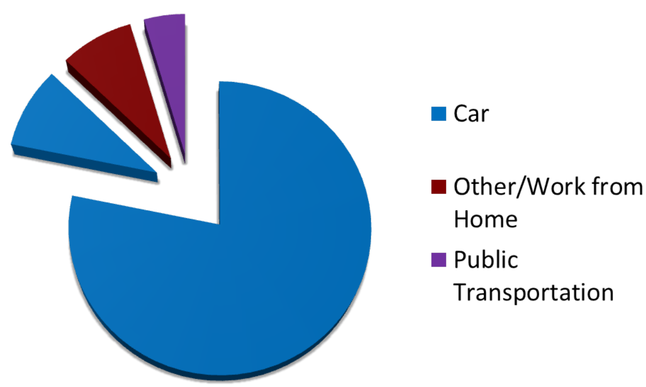

Figure 1.1 Commuting in the United States in 2008

The state of New Mexico is no exception to the congestion concerns caused by transportation growth. It is populated by approximately 2 million people and 676 thousand passenger cars, yielding a significant contribution to the 26 billion miles travelled and 1.4 billion gallons of fuel used in 2008.[7] More specifically, 7 million gallons of gasoline were wasted due to congestion in

1 Paul Mackun and Steven Wilson, Population Distribution and Change: 2000 to 2010U.S. Census Bureau,[2011]), http://www.census.gov/prod/cen2010/briefs/c2010br-01.pdf.

2 "WordNet: A Lexical Database for English," Princeton University, http://wordnet.princeton.edu/ (accessed 3/6, 2011).

3 "National Transportation Statistics," Bureau of Transportation Statistics, http://www.bts.gov/publications/national_transportation_statistics/ (accessed 1/29, 2011).

4 David Schrank, Tim Lomax and Shawn Turner, Urban Mobility Report 2010Texas Transportation Institute,[2010]), http://tti.tamu.edu/documents/mobility_report_2010.pdf.

5 National Transportation Statistics

6 "ITS Strategic Research Plan, 2010-2014," Research and Innovative Technology Administration, http://www.its.dot.gov/strat_plan/2010_factsheet.htm (accessed 2/4, 2011).

7 "State Transportation Statistics," Bureau of Transportation Statistics, http://www.bts.gov/publications/state_transportation_statistics/new_mexico/index.html (accessed 1/29, 2011).

Albuquerque during 2007. Using the average U.S. gas price in 2007,[8] this was a loss of approximately $20 million. With all of these problems, the different transportation organizations in New Mexico work towards improving traffic concerns.

One association currently working on improving transportation in New Mexico, specifically Santa Fe, is the Santa Fe Metropolitan Planning Organization (SFMPO). The SFMPO is an organization involved in the progression and development of the city of Santa Fe's transportation network. The SFMPO is responsible for producing the Unified Planning Work Program (UPWP), which is a document outlining the tasks and projects required to improve transportation in the city of Santa Fe, as well as the cost and expenditures of each plan. The 2010-2012 UPWP details the work previously done by the SFMPO, such as traffic count maps, traffic modeling programs, and proposed developments of intelligent transportations systems.[9] With traffic planning as their main objective in Santa Fe, the reliability and efficiency of the traffic data collected is very significant. Although there are various sources of traffic data, there is no platform to easily access and update with current data. Due to this the lack of a centralized platform, there is somewhat of a deficiency in communication between the organizations that collect traffic data in Santa Fe.

This project is intended to help the Santa Fe Metropolitan Planning Organization, as well as other traffic management organizations, in the development of a transportation platform, which would allow for the maintenance, organization, and modeling of traffic data in the Santa Fe metropolitan area. The team plans on gathering, organizing, and maintaining existing traffic data to use as a means of developing approaches of visualization. The team will then design and create a transportation platform for traffic planning to store data and these visualizations. Moreover, different forms of modeling this information, such as agent-based modeling, will be investigated. Ideally, this project will help assist the SFMPO, and other organizations in Santa Fe, to better plan the city's transportation network, as well as keeping the citizens of Santa Fe informed of current traffic issues.

8 Dan Wilchins, "U.S. Gasoline Prices Rosein 2007: Survey," Reuters (2007), http://www.reuters.com/article/2007/12/23/us-energy-gasoline-retail-idUSN0612178120071223.

9 Unified Planning Work ProgramSanta Fe Metropolitan Planning Organization,[2010]), http://santafempo.org/wp-content/uploads/2011/01/UPWP-2010-2012-Approved-04-08-10-Amendment-07-08-10-Am….pdf.

2. BACKGROUND

In order to complete this project, a wide array of knowledge was needed. The project was broken into four main categories: traffic engineering, transportation planning, various software, and traffic data modeling. Traffic engineering is important to this project in order to understand the sources of the data that will be used in the platform. Ultimately, the platform will be used for traffic development purposes. Therefore, transportation planning was needed to understand this aspect. The platform will be comprised of numerous technologies and software, thus an understanding of different software was necessary. Finally, knowledge of traffic data modeling was required in order to assess its potential usage for filling in any gaps of missing information. Each of these topics will be explained in further detail in the following sections.

2.1. TRAFFIC ENGINEERING

A traffic engineer's main objective is to design and maintain roadways so that they are safe and efficient for travel. In order to account for the large number of cars on the road, and to improve roadways, traffic engineers must first analyze traffic data, which includes traffic counts and road conditions. This can be done with various traffic counting tools and analysis techniques such as traffic signal timing. Once traffic flow is evaluated using this information, installments such as traffic light sensors and signs can be put in place to improve traffic conditions.

2.1.1. TRAFFIC DATA

First, traffic engineers must collect different types of data to be analyzed for evaluation purposes. There are several main types of traffic data used by engineers: traffic counts, vehicle presence, vehicle speed, vehicle occupancy, turning movement counts, and vehicle classification. Traffic counts record the number of cars on the road during a specific time and travelling in a specific direction. They are used for several calculations, including the determination of how many vehicles are on the road at a given time. Generally, this data can be used to calculate Average Daily Traffic (ADT), Average Annual Daily Traffic (AADT), and volume. ADT provides the average number of vehicles that pass through a specific point in a twenty-four hour period. On the other hand, AADT provides the average number of vehicles that pass through a specific point in a year. Volume counts measure the total amount of vehicles on the road during a particular count. The intervals of the day with the highest recorded traffic volumes are known as the peak hours, and these periods can be calculated using traffic count data. Vehicle presence is the detection of a vehicle, or its axles, passing over a certain point in order to influence signal timing. Similarly, vehicle speed determines the rate of travel of each vehicle, and vehicle occupancy ascertains how long a vehicle has been in a certain area, as well as the number of vehicles in that area. Turning movement counts specify the actions of vehicles at intersections, whether they be turning left, right, or continuing straight. These are often taken manually and provide crucial information on traffic volume and traffic flow at specific intersections. Lastly, classification refers to the types of vehicles on the road. Vehicles can be classified using the Federal Highway Administration's classification chart, located in Appendix A.

2.1.2. TRAFFIC DATA COLLECTION

There are several tools used to count and collect the various forms of traffic data mentioned in the previous section. The most common means of counting are pneumatic road tubes, inductive loop detectors, video image detectors, and manual counts. The types of data collected by each device are displayed in Table 2.1 below.

Table 2.1Comparison of Traffic Counting Tools in Santa Fe

	Pneumatic Road Tubes	Inductive Loop Detectors	Video Image Detectors	Manual Count
Count	✔	✔	✔	✔
Presence		✔	✔	
Speed	✔	✔	✔	
Occupancy		✔	✔	✔
Classification	✔	✔	✔	✔
Turning Movement			✔	✔

The data collected from these devices is sent to numerous transportation organizations on the city, county, and state levels. This can include the state's department of transportation and/or the city's metropolitan planning organization. Then, this data is then analyzed and used by traffic engineers, as well as planners, to assess and improve traffic and road conditions.

Figure 2.1 Pneumatic Road Tubes

Pneumatic road tubes are rubber tubes with a diameter of one centimeter, and a length that can span multiple lanes. The tubes are placed on roadway surfaces, perpendicular to the direction of traffic flow. As a vehicle's tires pass over the tube, air is pushed through creating a burst of pressure. This pressure is sent to a box on the side of the road, closing a switch inside the box, in turn producing an electrical signal, which is collected as data. This signal contains a great deal of information about the vehicle, but must be interpreted by software before it is useful.

Although one pneumatic tube can collect general traffic count data, the use of two tubes allows for the collection of vehicle speed. The two tubes are placed a short, predetermined, distance apart and the time difference between when the vehicle's axles pass over each tube determines speed.[10] Axle count and spacing are also gathered and are used to classify the type of vehicle. Although the data collected is valuable when analyzing traffic conditions, it is generally collected during a 48-hour time period, making it difficult to determine flow patterns for extended periods of time. However, pneumatics tubes can be inaccurate because vehicles with multiple axles can be confused for multiple vehicles. This problem

10 Han Reijmers, Detectors, Loop Detector, 2006)

can be corrected by using vehicle pressure to determine the weight of the vehicle, therefore classifying the vehicles by not only axle count but also weight. Pneumatic road tubes are cost effective and simple to maintain,[11] however they are vulnerable to weather, temperature, traffic conditions, and even vandalism, causing the need for frequent replacement.[12]

Inductive loop detectors are commonly located in roadways in the vicinity of intersections. They are wires embedded in the pavement in a square or rectangular formation. The wires create a magnetic field and maintain a constant frequency, which is disrupted as vehicles stop on or pass over the loop.[13] The inductance of the loop then decreases, in turn, increasing the oscillation frequency. This causes the attached electronics unit to send a pulse to the box on the side of the road where the data is stored.[14] With one loop, data such as vehicle count, presence, occupancy, and classification can be determined. The length of the vehicle, which is recorded as the vehicle passes over the loop, can determine classification. If two loops are installed several meters apart, speed and queue length can also be calculated. Unlike pneumatic roads tubes, loop detectors are constantly collecting information. However, they are not always as precise as necessary because low traffic levels and varying temperatures can cause errors in the data.[15]

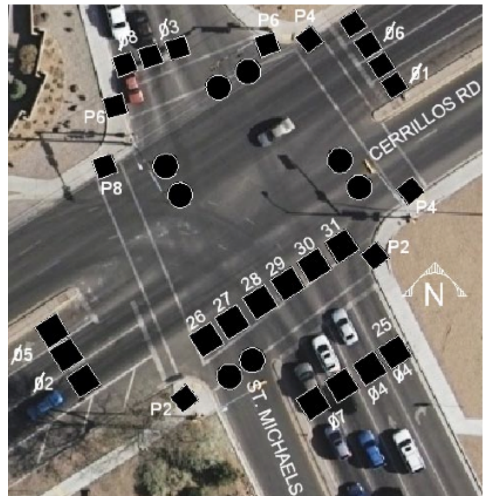

Figure 2.2 Aerial Image of Loop Detector Locations at Intersection of St. Michael's Drive and Cerrillos Road


Figure 2.3 Video Image Detector

Video image detectors are cameras placed above roadways, generally on traffic signals, that have the ability to scan a wide area.[16] The cameras provide a live video feed that is sent to a controller who determines the traffic conditions. Video image detectors allow for the calculation of other traffic data including density, queue length, speed profiles, count, and

11 Ibid.

12 Guillaume Leduc, Road Traffic Data: Collection Methods and Applications (Spain: European Commuinites,[2008]), http://ftp.jrc.es/EURdoc/JRC47967.TN.pdf.

13 Jean-Paul Rodrigue, Claude Comtois and Brian Slack, The Geography of Transport Systems, 2nd ed. (New York: Routledge, 2009), http://www.people.hofstra.edu/geotrans/index.html.

14 Leduc, Road Traffic Data: Collection Methods and Applications

15 Joy Dahlgren, Shawn Turner and Reinaldo Garcia, "Collecting, Processing, Archiving and Disseminating Traffic Data to Measure and Improve Traffic Performance," (2002), http://tmcpfs.ops.fhwa.dot.gov/cfprojects/uploaded_files/TRB%20Paper%2000569.pdf.

16 Reijmers, Detectors, Loop Detector

presence.[17] However, the cameras are vulnerable to various road and weather obstructions. Glare, day to night transitions, and reflections from wet roads can cause the camera to produce unreliable data.[18]

Manual counting is the process in which a person is physically observing vehicle movements, and is performed using either mechanical or electronic counting boards. Mechanical counting boards contain buttons for each direction of travel, left, right, and straight. The person operating the counting board stands at a specific intersection and observes and records the number of vehicles that pass by, as well as recording their direction. Electronic counting boards collect the same data, but have internal clocks for time stamping the data. One downfall is that manual counting can be very time consuming as the counter is often outside for long periods of time.[19]

2.1.3. TRAFFIC SIGNAL TIMING

Once traffic data has been acquired, traffic engineers use the information to reduce traffic problems, such as congestion. A method of alleviating this congestion is through the use of inductive loop detectors to control traffic signals. As a vehicle approaches a red light, a signal is sent from the loop sensor, making it aware of the vehicles presence. This information is used to determine the timing of the lights. Video image detectors can also be used to change traffic lights. When the cameras become aware of a vehicle's movement, a signal is sent in order to change the light from red to green. During the night, the cameras pick up the glare from headlights to detect movement. This becomes troublesome during the day, however, because the sun can be seen as a car's headlights to the camera. Using traffic data, traffic engineers can work with transportation planners to determine which roads with traffic lights can benefit the most from using timers. Planners also use data gathered from these loops and cameras to analyze current and future congestion issues for signal rescheduling.[20]

2.2. TRANSPORTATION PLANNING

Transportation planners use the information obtained by traffic engineers to evaluate, assess, and design roadways that will improve transportation in the future. There are many different tools for analyzing this information, such as the traffic impact analysis, traffic assessment zones, level of service, and intelligent transportation systems. Each of these procedures assists in the progress and development of roadway conditions.

17 A Summary of Vehicle Detection and Surveillance Technologies used in Intelligent Transportation SystemsThe Vehicle Detector Clearinghouse,[2007]), http://www.nmsu.edu/~traffic/Publications/Trafficmonitor/vdst.pdf.

18 Dahlgren, Turner and Garcia, Collecting, Processing, Archiving and Disseminating Traffic Data to Measure and Improve Traffic Performance

19 "Technology News," Iowa Local Technical Assistance Program, http://www.intrans.iastate.edu/ltap/tech_news/2004/nov-dec/data_collection.htm (accessed 1/29, 2011).

20 "Traffic Signal Timing," Institute of Transportation Engineers, http://www.ite.org/signal/index.asp (accessed 1/29, 2011).

2.2.1. TRAFFIC IMPACT ANALYSIS

One method of transportation planning is the **Traffic Impact Analysis** (TIA). This process involves a detailed, multistep, outline that generates projections in traffic, and is used in determining build or no build conditions.[21] First, a report on the proposed development location is produced, which is then followed by a specified description of the means by which the project will be completed. Afterward, a study is conducted on the current area conditions, including daily traffic volumes at peak hours and potential safety hazards. Next, there must be traffic projections made using trip generation. Trip generation uses a multi-step assessment, including distribution, mode choice, and route assignment to estimate the amount of traffic flow originating at and/or passing through a particular impact analysis area. Finally, an analysis of horizon year conditions is done. The horizon analysis estimates traffic pattern predictions and breakdown for the coming year, which are then followed by a summary of deficiencies, anticipated impacts, and recommendations.[22]

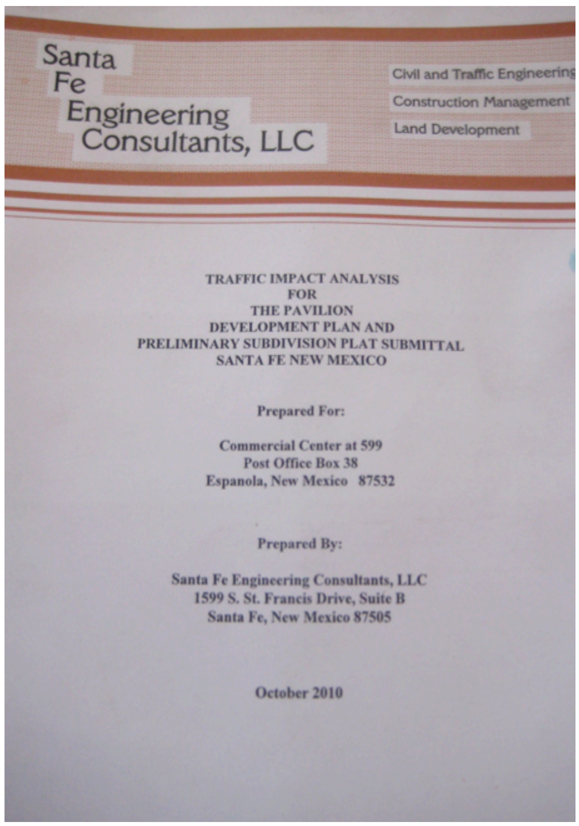

Figure 2.4 Traffic Impact Analysis for the Pavilion

21 Donald Wolfe, Traffic Impact Analysis Report GuidelinesLos Angeles County Public Works,[1997]), http://dpw.lacounty.gov/traffic/traffic%20impact%20analysis%20guidelines.pdf.

22 Guide for the Preparation of Traffic Impact StudiesCalifornia Department of Transportation,[2002]), http://www.dot.ca.gov/hq/traffops/developserv/operationalsystems/reports/tisguide.pdf.

2.2.2. TRAFFIC ANALYSIS ZONES

Another valuable method used in planning and data collection is the **Traffic Analysis Zones** (TAZ) program. This program consists of individual areas, designated by population, roadways, and geographic features, in which the U.S. Census Bureau tracks the amount of traffic flow. The Bureau began using the TAZ program during the 1980 census, and in 1990 it was classified as part of the Census Transportation Planning Package.[23] This package "is a set of special tabulations from decennial census demographic surveys designed for transportation planners."[24] TAZ records an abundance of transportation data, particularly for the working-commuter population.

2.2.3. LEVEL OF SERVICE

Level of service (LOS) is a method most commonly implemented by transportation planners when investigating road conditions. The system has several categories, which rate roadways under such classes as reliability and quality of a road. Additional categories include the effect on community, operational function, technical services, occupancy levels, and current road conditions. After an area and project have been assessed under the above-mentioned categories, a letter grade is determined according to the overall efficiency and value of the particular transportation-engineering project. The process of determining the adequacy of the roadway first involves addressing any problems and/or assets, and then defining what changes need to be made. The changes may include the application of appropriate action to remedy a given situation, or measuring the overall performance target. The main aspect in calculating the level of service grade is the information gathered from the traffic data collection process. Below, Table 2.2 displays what facets are used in the calculation of the letter grade. In the chart percent time-spent-following is the average time span a vehicle spends following another vehicle without the ability to pass.[25]

Table 2.2 Level of Service Grading System[26]

Level of Service	Percent Time-Spent-Following	Average Travel Speed (mi/hr)
A	≤35	>55
B	>35-50	>50-55
C	>50-65	>45-50
D	>65-80	>40-45
E	>80	≤40

23 "Cartographic Boundary Files," U.S. Census Bureau, http://www.census.gov/geo/www/cob/tz_metadata.html (accessed 2/18, 2011).

24 "Census Transportation Planning Projects," http://www.fhwa.dot.gov/ctpp/ (accessed 2/15, 2011).

25 Nicholas Garber and Lester Hoel, Traffic & Highway Engineering, 4th ed. (Canada: Cengage Learning, 2009).

26 Ibid.

2.2.4. INTELLIGENT TRANSPORTATION SYSTEMS

Intelligent Transportation Systems (ITS) is another beneficial tool used in transportation planning.[27] It is implemented through a process of data gathering and viewing in which data is streamlined into giving up-to-date electronic visualizations, whether they are text-based readouts along the side of highways, or data displayed on a web-based mapping system. Different types of ITS include instant traffic updates, real-time traffic management, and accident-monitoring and prevention. This list, which is by no means exhaustive, demonstrates the wide range of ITS. Each works to "improve the links between the infrastructure, the vehicles, and the user to make the transportation system work more efficiently,"[28] and does so by integrating modern computers and communication with a transportation network. These systems "help highway engineers monitor dynamic traffic conditions for analysis, response, and communication" and can give up-to-date traffic information to travelers.[29] With this, transportation planners, traffic engineers, and citizens can all work to reduce congestion.

2.3. SOFTWARE

The transportation platform created for this project is a combination of various computer tools and applications. Given that it is designed for the viewing, editing, and sharing of spreadsheets, maps, and other files, the platform required research into software that could accomplish these tasks. The following sections detail the software and applications most relevant to the formation of the platform.

2.3.1. FILE FORMATS

Before a description of the software is specified, a background on the files that are involved in the platform is necessary to understand the pertinence of each. The files are broken into three main categories: Spreadsheets, Geographical Information Systems (GIS) layers, and other.

27 "Intelligent Transportation Systems - GIS for Highway," Esri, http://www.esri.com/industries/highways/business/intelligent-transport.html (accessed 2/18, 2011).

28 Kenneth John Button and David A. Hensher, Handbook of Transport Systems and Traffic Control, Vol. 3 (Amsterdam ; New York: Pergamon, 2001), 602.

29 Intelligent Transportation Systems - GIS for Highway

2.3.1.1. SPREADHSEETS

There are multiple spreadsheet formats that are used in the platform, and there are two main groups: Comma/Space delimited files and spreadsheet files. Comma/Space delimited files are text files that use commas, spaces, tabs, or some other characters, to separate the columns. The main formats of these files used in the platform are Comma Separated Value files (CSV) and Printer Text Files (PRN). Spreadsheets most commonly come in one of Microsoft Excel's formats XLS or XLSX.

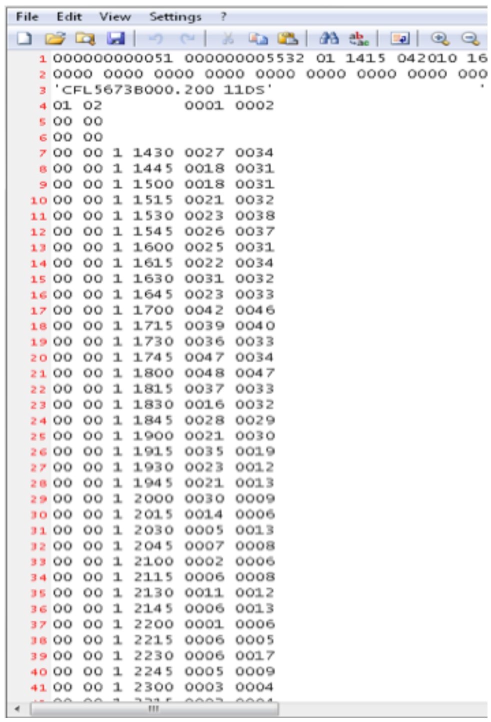

Figure 2.5 Printer Text (PRN) File

2.3.1.2. GIS LAYERS

One way transit data can be displayed is through the use of **Geographical Information Systems** (GIS).[30] GIS are computer platforms on which data can be maintained, analyzed, and displayed with the use of spatial information. There are many examples of GIS; some of the most well-known are Google Maps, Google Earth, and MapQuest.[31] The GIS layers that contain the geographic information usually come in one of two main formats, SHP or KML. SHP stands for shape file and is a collection of seven files, with the main file having extension SHP. The SHP file is recognized by the various computer applications, but all of the collection is required in order for the GIS layer to function correctly. Unlike shape files, KML, which stands for Keyhole Markup Language, is just one file. It is the main file format used by Google Maps and Google Earth, discussed in a later section.

30 Myer Kutz and Ebrary Academic Complete, Handbook of Transportation Engineering (New York: McGraw-Hill, 2004)

31 Rodrigue, Comtois and Slack, The Geography of Transport Systems

2.3.1.3. OTHER FILES

The platform will be populated by various report documents. These are often in one of Microsoft Word's formats, DOC and DOCX, which are text files with the capability of displaying graphics. However, reports are more often created in a Portable Document Format (PDF), which is a document where each page is an image. These files are smaller than the DOC and DOCX files, but are not able to be edited. Images that occur outside of PDF files are of many different formats, Joint Photographic Expert Group (JPEG) format being the most common. Still, many images are in older formats, such as Personal Computer Exchange (PCX), which are used by specialized traffic software.

2.3.2. MICROSOFT EXCEL

Microsoft Excel is a spreadsheet application that allows the user to organize, manipulate, and visualize various types of data. The data is organized by the headers of the columns that the data is stored in, and can then be displayed through various graphs and charts. The creation of these visuals can be automated and expanded upon by further analysis using formulas and macros. A macro is "a single computer instruction that initiates a set of instructions to perform a specific task."[32] Within Excel, a macro can be created n two ways. One is interactive in which the user performs a series of tasks, which the computer automatically creates the macro for. The other is to code it manually through the use of a Visual Basic editor. Perhaps the most useful aspect of Excel is the importing and exporting functionality. Excel can import from various non-spreadsheet files, such as CSV and PRN, organizing the incoming data into the rows and columns.

2.3.3. GOOGLE

Google is a superpower when it comes to Internet-based software. Google Maps is perhaps the most well-known of the Google software, but it is only the tip of the iceberg. Google has capabilities that allow for the importing, exporting, creation, and manipulation of just about any type of data. This section will list the tools that Google has produced that pertain to this project.

2.3.3.1. CHARTS

Google has a tool called Google Charts, which can produce charts independent of other software. Google Charts allows the user to create graphics, solely by entering information into a URL. Data is entered according to Google's scripting language, the graphic is generated by Google's servers, and is then displayed in the browser. These images are easily integrated with websites as the website only needs the URL to display it. There are a number of potential graphs and charts, including pie charts, line charts, and bar graphs. These graphics can be static or interactive, with the interactive graphics displaying further information, such as exact values of data points when scrolled over. A potential usage for Google Charts is through computer scripting by reading data from a database or spreadsheet, and then formatting the data in order to create the URL. One potential problem with Google Charts is the limit on points able to be visualized.

32 "Macro," http://dictionary.reference.com/browse/macro (accessed 4/26, 2011).

2.3.3.2. DOCUMENTS

Google Docs is the base of operations for Google's office suite, and is comprised of Google Spreadsheets, Google Presentations, Google Documents, Google Drawings, and Google Forms. Google Docs can be used to store files, as any file type can be uploaded. When uploading, if the file is a certain type, it has the option of being converted to Google's equivalent format. For example, spreadsheets that have extension XLS, XLSX, or CSV can be converted into Google's Spreadsheet format. Unless a file is converted to Google's format, it cannot be edited and may not be able to be viewed. One particularly useful aspect of Google Docs is the ability to share files. The sharing revolves around the ability to delegate read/write permissions to other Google Docs users and the public. This allows for collaboration and sharing to occur on a level that is not possible for computer files.

2.3.3.2.1. SPREADSHEETS

Google Spreadsheets is Google's equivalent to Microsoft Excel. One major benefit of Google Spreadsheets over Excel is the connection to the Internet. This allows visualizations to be published to the Internet, which allows the graphic to update when changes are made to the data in the spreadsheet. Much like Excel, functions and macros, called scripts in the Google Docs Suite, can be used to manipulate and automate dealings with the data. Google's scripts can be very useful because other Google tools, such as Google Charts and Google Maps, can be connected to Google Spreadsheets. However, the macros and scripts of Excel and Google Spreadsheets are not compatible and do not transfer when converted from Google to Excel and vice versa.

2.3.3.3. MAPS

Google has a number of uses with respect to GIS. Google Maps is an online tool that can display, store, and create GIS layers overtop of Google's various base maps of Earth. These layers can be made public or private, and may only be viewed by a select group. Google Maps reads and creates KML layers, but does not work with shape files. The creation of GIS layers is simplistic, but extremely useful. A simple point and click interface allows for the creation of layers with points, lines, and/or polygons. The display of the shapes is customizable, having the ability to change the size and color of the objects. Lines have the particularly useful ability to be mapped to roadways.

2.3.3.4. EARTH

Google Earth is a standalone computer application with more power than Google Maps. The creation tool is also simplistic, but adds some customization to the points and lines that were not in Google Maps. However, Google Earth is unable to snap lines to roadways. Whereas Google Maps can only work with KML layers, Google Earth can read from various sources, although not SHP. Google Earth can be connected to Google Maps in order to make public the layers it creates.

2.3.3.5. SPREADSHEET MAPPER 2.0

GIS layer creation does not always need to be done manually. Through the use of tools such as Spreadsheet Mapper 2.0, data can be entered in a special Google Spreadsheet, using longitude and latitude, and automatically creates point layers. Since it is a Google Spreadsheet, it has all the abilities that come with it. Data, such as numerical measurements, can be assigned to individual points, which can be displayed once the point is selected in the map. The layers created are viewable in Google Maps and Google Earth, but Google Earth must be used to save the layer in order for other GIS programs to use the data.

2.3.3.6. FUSION TABLES

Similar to Spreadsheet Mapper 2.0, Fusion Tables is a tool specifically designed to streamline the creation of visualizations using spreadsheet information. These vitalizations are either simple statistical graphs or layers on a Google Map. The Maps require a longitude and latitude to be associated with the points of the spreadsheet. It is much easier to create GIS layers with Fusion Tables than it is with Spreadsheet Mapper 2.0, but the power that comes with Google Spreadsheets is lost.

2.3.4. GIS CLOUD

GIS Cloud is another online GIS tool and it has more power than Google Maps and Google Earth, but less than that of ArcGIS. GIS Cloud has a very useful file system that allows files to be stored on the Internet. Various file formats can be uploaded, including KML and SHP. Similarly, the GIS layers used and created in GIS Cloud can be exported in both KML and SHP. Much like ArcGIS, GIS Cloud can display and use various data associated with the points, lines, and polygons in the layers. It is also useful for the creation of radial coverage and hotspot information. One particularly useful capability of GIS Cloud is the ability to embed maps in websites, as well as the ability to use Google Maps to display the GIS data.

2.3.5. ARCGIS

ESRI is a computer company that produces a suite of GIS software called ArcGIS. This software has become the industry standard and is extremely predominant. In contrast to Google's software, ArcGIS is not a simple point and click interface, but allows for much more information to be communicated. Another key aspect is the ability to use the information within the GIS layers for analysis purposes. Simplistic analysis, which is shared with Google's products, includes distance related measurements. More complex analysis includes calculations based on measurements designated to certain points, lines, or polygons.

2.3.6. DROPBOX

Dropbox is a combination of Internet and computer application that allows the user to sync files across multiple computers and keep an Internet backup. Once installed, Dropbox allows the user to designate files and folders on the computer that will be backed-up to the Internet. Dropbox can be installed on another computer and synced to the files on the Internet, thus creating a connection between the computers. This connection is continuous, as any change to a synced file will be changed on all of the systems. One exceptional aspect of Dropbox is the retention of the original folder structure, allowing the organization of those files to remain intact.

2.4. TRAFFIC DATA MODELING

Another way traffic data is used is through the creation of transportation models, which explain the relationships between the different components of the network. These models can contain many aspects such as traffic lights, loop sensors, cars, trucks, bikes, and pedestrians. These components are dependent on the type of data available and the purpose of the model.[33] With the increasing power and prevalence of computers, computer-based models and simulations for transportation purposes have become more common and accurate. Many traffic modeling applications currently exist, including VISSIM created by PTV America. These tools simulate future conditions of the workings of a transportation network during different situations. One problem with standard methods of traffic simulation is the lack of intelligence in the components. For this reason, a new type of simulation, called **agent-based modeling** (ABM) was created.

2.4.1. AGENT-BASED MODELING

An ABM is a model where different agents, such as people, cars, trucks, or any other moving entity, are defined and given certain characteristics. This dictates their movements in space, as well as their interactions with other agents. Unlike customary modeling methods, which use complex equations to determine the individual movements with respect to the group, ABM defines each agent independently. This allows agents to make their own decisions, separate from the others, which is a more natural way of defining a system of free-thinking entities, such as those involved in real-time traffic. Independent thinking also allows for "emergent phenomena", which is the unpredictable or unexpected actions of agents, occurring within the model. This is one of the most interesting aspects of ABM, as it fills in some of the gaps and irregularities that the equations cannot account for. ABM also allows for a great deal of flexibility, as agents can learn, remember, and change throughout a simulation. For these reasons, ABM has been gaining immense popularity in the transportation industry.[34]

There are a number of tools for creating agent-based models, and many are available for public use. NetLogo and MASON from Northwestern and George Mason Universities, respectively, are two such programs that allow for anyone to create small-scale models. Figure 2.6 below shows the use of NetLogo to display the flocking patterns of birds. Using only three simple rules, the intricate patterns of flocking occur. This would have otherwise required the use of complex equations, and therefore gives no insight into the reasons why flocking occurs.

33 Kutz and Ebrary Academic Complete, Handbook of Transportation Engineering

34 Eric Bonabeau, "Agent-Based Modeling: Methods and Techniques for Simulating Human Systems," Proceedings of the National Academy of Sciences of the United States of America 99, no. Suppl 3 (May 14, 2002), 7280-7287.

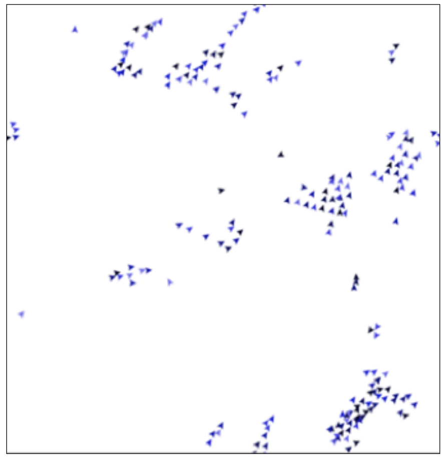

Figure 2.6 ABM Bird Flocking[35]
Inverted image of the flocking example

2.5. TRANSPORTATION IN SANTA FE

Santa Fe, New Mexico is the oldest capital city in North America. It was founded between 1050 and 1150 by the Pueblo Indians. The founders were attracted to the area because of the river, which provided many resources to them; this river was later called the Santa Fe River. The first recorded population for Santa Fe was 4,846 people in 1850.[36] During the late 19th century, the governing body of Santa Fe began to realize the need for transportation alternatives, as a greater number of people desired to travel cross country through Santa Fe. During this time, Santa Fe was becoming a hub for Americans dissatisfied with the industrialized east.

Figure 2.7 Santa Fe, New Mexico 1882

New Mexico has always been an important corridor for trade and migration. The Santa Fe Trail was the US territory's vital commercial and military highway link to the Eastern United States during the early 19th century.[37] It ran for 1,200 miles passing through Kansas, Colorado, and Oklahoma, linking Missouri and Santa Fe.[38] The Camino Real and the Old Spanish Trail were also historic trails that passed through Northern New Mexico and used for trade and travel. The construction of railroads in 1879 replaced these, and other, trails leading to an increase in Santa Fe's population. By 1880, the population had increased from about 4,800 to 6,700 people in just 10 years.[39]

35 U. Wilensky, "Netlogo Flocking Model," Center for Connected Learning and Computer-Based Modeling, http://ccl.northwestern.edu/netlogo/models/Flocking (accessed 2/5, 2011).

36 Fenton Richards, "Santa Fe - the Chief Way," New Mexico Magazine (2005).

37 Ibid.

38 "Santa Fe Trail Association," http://www.santafetrail.org/ (accessed 2/10, 2011).

39 Richards, Santa Fe - the Chief Way

With the rise of rail transportation, additional settlements were founded and existing settlements grew, resulting in the appearance of new cultures. These different cultures created an ideal tourist destination. During the Great Depression of 1929 and the Dust Bowl of the 1930s, these settlers began their move to New Mexico by way of Route 66.[40] As the highway became more popular, businesses in New Mexico became more prosperous. Today, Interstate Highways follow the earlier land routes of the Camino Real, the Santa Fe Trail, and the transcontinental railroads. With the recent creation of the New Mexico Rail Runner Express, the downtown business area of Santa Fe is now able to connect to the larger population base in Albuquerque. As Santa Fe continues its role as a cultural center within New Mexico, the growing population size, currently at 2 million, displays the increasing need for transportation growth.[41]

2.5.1. SANTA FE METROPOLITAN PLANNING ORGANIZATION

Each of the sections mentioned above is a key mechanism in aiding transportation organizations, such as the Santa Fe Metropolitan Planning Organization (SFMPO), New Mexico Department of Transportation (NMDOT), city of Santa Fe, and Santa Fe County, to reduce transportation problems. These organizations are constantly collecting information in order to improve the roads in the state of New Mexico. The main tools of collecting this information, as well as the organizations that use them, are displayed below in Table 2.3.

Table 2.3 Counting Tools Used by Organizations in Santa Fe

	Pneumatic Road Tubes	Inductive Loop Detectors	Video Image Detectors	Manual Count
Organizations	NMDOT	NMDOT		
	Santa Fe MPO			Santa Fe MPO
	Santa Fe County			
	[illegible]	[illegible]	[illegible]	[illegible]

The SFMPO is one of the main organizations in Santa Fe that is responsible for the upkeep of the roadways. They use concepts like traffic engineering and transportation planning in order to design and improve roads. The area that they are concerned with is shown in Appendix B.

40 "Historic Route 66," http://www.historic66.com/ (accessed 2/15, 2011).

41 Richards, Santa Fe - the Chief Way

2.5.1.1. TRAFFIC ENGINEERING IN SANTA FE

One example of action taken to improve roads can be found in the SFMPO's Transportation Improvement Program (TIP). This program lists the short-term transportation projects the SFMPO hopes to accomplish within the following four years. The most current TIP ranges from 2010 to 2014, and involves projects such as road reconstructions, road extensions, and bridge preservations. These projects relate directly with Section 2.1, Traffic Engineering.

Figure 2.8 Cerrillos Road Corridor Study

Traffic engineering is a vital part of carrying out these projections, as the engineers ensure that roadway planning accurately takes into account safety and efficiency standards. For example, the SFMPO is currently working on reconstruction of a 0.58 mile stretch of road at NM14, Cerrillos Road. This reconstruction is estimated to cost $4,000,000, with federal funding covering all except for approximately $600,000. It is vital to use traffic engineers to ensure that the project is completed appropriately and meets the proper regulations. Another fundamental facet of the TIP is traffic data, which encompasses traffic counts, presence, speed, occupancy, classification, and turning movement counts. Each of these features is used when determining whether or not it is necessary for the SFMPO to actually consider whether or not to work on a project. For example, under the TIP, the SFMPO is considering resurfacing NM599 for approximately 13 miles. Before they can come to this conclusion, the SFMPO must gather and record traffic data through various counts to ensure that it is a worthwhile cause.[42]

2.5.1.2. TRANSPORTATION PLANNING IN SANTA FE

Another significant area of work done by the SFMPO is the corridor studies, which makes travel smoother and less time-consuming. The SFMPO has done five major corridor studies; Interstate 25, St. Francis Drive, Richards Avenue Extension, and the NM 599 Interchange. These studies are accomplished through the collection of traffic data, which is valuable as a means of analyzing land use and transportation rates in specific areas. Transportation planning then aides in the assessment of the corridors, and whether or not there need to be adjustments such as additional interchanges or the necessity of acceleration or deceleration lanes.[43]

Transportation planning is also important to the SFMPO, as it is a key element in the Unified Planning Work Program (UPWP). The program includes an explanation of the preparatory efforts and sequential results of a project, as well as the laborer, project framework, project cost, and origin of financial support. The document itself is an excellent example of transportation planning as it outlines a specified fiscal budget, containing sections such as management and support of the planning process, data collection and analysis activities, and transportation planning activities and

42 Transportation Improvement PlanSanta Fe Metropolitan Planning Organization,[2009]), http://santafempo.org/wp-content/uploads/2009/07/TIP2010-2013_DRAFT_Amendment_05-12-11.pdf.

43 Ibid.

initiatives. It is only while keeping each of these categories in mind that the SFMPO can accurately plan which projects should be selected.[44]

44 Unified Planning Work Program

3. METHODOLOGY

This project is intended to help the Santa Fe Metropolitan Planning Organization (SFMPO), as well as other traffic management organizations, in the development of a transportation platform, which would allow for the maintenance, organization, and modeling of traffic data in the Santa Fe metropolitan area. In order for this project to be completed, it has been separated into four main objectives, which have been completed between March 21 and May 6, 2011:

1. Gathering, organizing, and maintaining traffic data.
2. Determining appropriate approaches to visualizing traffic data.
3. Designing and creating a transportation platform for traffic planning.

3.1. GATHERING, ORGANIZING, AND MAINTAINING TRAFFIC DATA

Before the main goal of this project was completed, traffic data was gathered and organized into a database. To begin collecting data, the team consulted several transportation organizations in New Mexico. Collecting data from the Santa Fe metropolitan planning area, displayed in Appendix B, was the team's main focus. Once all of the data was organized into the database, different methods were implemented to ensure its consistent maintenance. This objective forms the basis for this project and all of the other objectives needed to complete it.

3.1.1. GATHERING DATA

Before the team started gathering traffic data, a spreadsheet of all contacts within the transportation-related organizations in New Mexico was created. This spreadsheet can be found in Appendix C. Keith Wilson, one of the liaisons for this project, gave the team the necessary contacts. This spreadsheet contains contacts within the SFMPO, NMDOT, City of Santa Fe, Santa Fe County, and other important people pertinent to the completion of this project.

The team then emailed each contact to set up initial meeting dates. Each of these meetings is shown in the calendar located in Appendix D. During each meeting, the team requested any available traffic data to either be sent by email or put on a thumb drive. This information includes traffic counts, volumes, turning movement counts, and GIS maps. Other information related to traffic data, such as counting and software data, was also obtained. Once all of this information was acquired from the initial meetings, the team listed what data was still needed. Each contact was then emailed or met with again to retrieve this data. This process was continued until all relevant data was obtained.

3.1.2. ORGANIZING DATA

As the team received traffic data from the various contacts, it was organized into a database created by the team. For this purpose, the team began by researching and designing different types of databases, the goal being to create an easy way for the data to be uploaded by each contact. Since the goal was to have multiple organizations access it, an online database was ideal.

During the research process, the team found Dropbox and GIS Cloud to be the most useful databases for the purpose of this project. More information on these databases can be found in the Results section. Dropbox provides a place for each contact to deposit their data into one centralized location. By creating usernames, the data can then be sorted by contacts. It also allows for the sorting of data by different groupings, such as organization, location, and date of each count. GIS Cloud was used to store all of the city's GIS layers obtained in Objective 1.

Most of the data being placed into Dropbox is in the form of PRN files. The team created an automatic way to convert these files to spreadsheet form by using Excel. These spreadsheets were then uploaded to Dropbox, which allows the data to be connected to Google Maps. This is helpful for the completion of Objective 2, visualizing the data. The creation of this conversion is discussed in the next section.

3.1.2.1. FORMATTING PRN FILES

The traffic volume counts are not as useful in the PRN format, so the team worked to convert them into XLS format; this was done by creating a template XLS file that has two macros to import and format the data. To create a macro, the Developer Tab in the Excel toolbar, which is defaulted to being hidden, must be viewable. This tab allows for the creation and editing of the macros. Using the Record Macro button, followed by defining a name, description, and shortcut key, creates a blank macro.

Coding the macros is necessary because the importing and reformatting of PRN files is not simple spreadsheet data manipulation, and the coding is done in Microsoft Visual Basic. In order for the PRN files to be imported, the macro must first find the appropriate file. This is done by having the user type information about the file, such as the location of the containing folder and the filename, into a cell of the spreadsheet. The macro then reads this information and imports the file. The formatting of the data is difficult as there is a great deal of information that needs to be specified. The most important component is limited data space, and because of this the variable TextFileSpaceDelimiter must be set to true. Also, other variables such as TextFileCommaDelimiter must be set to false. This breaks the file into columns that are visible as space breaks in the PRN file. Another important component is the data type associated to each of the columns, and because of this the array TextFileColumnDataTypes must be defined. There are various data types, but the main ones used are text and number. Leaving columns blank defines the column as the default type, number. Once the macro is finished, it can be run either by using the Developer tab or the shortcut defined during the creation of the macro.

It was necessary to create another macro that further formats the data imported from the PRN. This was done by using already existing templates that are used by the SFMPO. There are several sheets involved, but they all read data from the first sheet. Thus, this macro is mainly concerned with copying the data from the PRN sheet to the first of the template sheets. The macro must first determine information, such as start and end dates and times, and then determine where the data is to be copied in the other sheet. The macro must continually switch between these sheets, copying the information.

An important component of the spreadsheet is the line graph. This is in a sheet of its own that reads from the same sheet as the template sheets. The chart tool is built into Excel and automatically formats the data.

After the macros have run, it is important to save the file under a different name so that the template can be used again. The creation of these macros can be found in the Results section. The code can be found in Appendix E.

3.1.2.2. UNIVERSAL LABELING SYSTEM

While organizing the data received, it became apparent that the SFMPO and City's Engineering Department used different labeling systems for their data collection sites in Santa Fe. The SFMPO uses Consolidated Highway Database numbers, or CHDB, that label road segments in order to easily relay them to the NMDOT. The City's Engineering Department has a separate labeling system for the intersections where they collect, with no universal identification. The Department labels them by the specified roads that collect data via inductive loop detectors and traffic video cameras. The main concern with the two labeling systems is the lack of a simple way to cross-reference between them. Another problem is that every road labeled by the city is not necessarily used by the SFMPO. It became necessary to create one universal labeling system for the roads of Santa Fe to avoid confusion.

STREET	ROAD ID	BETWEEN
CORDOVA	4738--------000.900	ST FRANCIS-CERRILLOS
RUFINA	5763--------001.500	RICHARDS-POLVOSO
OSAGE AVE	5672--------000.300	CERRILLOS-ROSINA
ATAJO	CF49006	AIRPORT-LOPEZ
DON DIEGO	5756--------000.500	MARQUEZ-CUBERO
GOVERNOR MILES	5802--------002.500	RICHARDS-CLIFF PALACE
CORDOVA	4738--------000.300	ST FRANCIS-EARLY
HYDE PARK RD	CNM0475000.500	BISHOPS LODGE-SUNSET
AGUA FRIA	4735-------000.300	GUADALUPE-DUNLAP
Hopewell	5783-------000.100	6th/Llano
Alameda	5758-------000.300	Jct CM Carlos Rael west of
BACA	5674--------000.300	SIERRA VISTA-POTENCIA
OLD PECOS TRAIL	CNM0046600.300	ZIA-ESPEJO
CANYON RD	4732--------001.000	GARCIA
ST MIKES	CNM0046601.000	HOSPITAL RD
SIRINGO	5738-------000.900	CAMINO CARLOS REY
AGUA FRIA	5758-------000.200	ALAMEDA-CM CARLOS RAEL
AGUA FRIA	5735-------002.100	OSAGE-CM CARLOS RAEL
YUCCA	5733-------000.550	ZIA-SIRINGO
PALACE AVE	4750-------000.580	ALAMEDA-DELGADO
AGUA FRIA	4735-------003.000	HENRY LYNCH-SILER

Figure 3.1 SFMPO Road Segment IDs

100 - CERRILLOS ROAD	
100 - 10	Cerrillos Road & Paseo de Peralta
100 - 20	Cerrillos Road & Guadalupe Street / Don Diego Avenue
100 - 30	Cerrillos Road & St. Francis Drive
100 - 40	Cerrillos Road & Cordova Road
100 - 50	Cerrillos Road & Baca Street / Monterey Drive
100 - 60	Cerrillos Road & Second Street
100 - 70	Cerrillos Road & Fire Station #3 - Ashbaugh Park
100 - 80	Cerrillos Road & St. Michael's Drive / Osage Avenue
100 - 90	Cerrillos Road & Lujan Street
100 - 100	Cerrillos Road & Camino Carlos Rey
100 - 110	Cerrillos Road & Siler Road
100 - 120	Cerrillos Road & Calle de Cielo
100 - 125	Cerrillos Road & Wal-Mart / Camino Consuelo
100 - 130	Cerrillos Road & Richards Avenue
100 - 133	Cerrillos Road & Avenida de las Americas
100 - 135	Cerrillos Road & Vegas Verdes Drive
100 - 137	Cerrillos Road & Zafarano Drive
100 - 140	Cerrillos Road & Airport Road / Rodeo Road
100 - 160	Cerrillos Road & Wagon Road / Camino Entrada
100 - 165	Cerrillos Road & Christo's
100 - 170	Cerrillos Road & Jaguar Drive
100 - 180	Cerrillos Road & Beckner Road

Figure 3.2 City Engineering Department's Intersection IDs

In order to create this labeling system, the lists of roads and intersections used by both entities were combined and sorted alphabetically. The team decided to label all of the roads using four-digit numbers. Road segments were then labeled using three four-digit numbers, while intersections were labeled using two four-digit numbers corresponding with the intersecting road IDs. The first four-digit number of each identifies the main road of the collection site. For example, if the SFMPO collects traffic data at an intersection, they would simply look on the list of roads and record its corresponding numbers and the ID for that intersection would be two four-digit numbers. If, however, they collected data at a road segment, the identification for that segment would be three 4-digit numbers; this would identify the road at which the count was collected on as well as the intersecting road. In short, a road segment has a labeling format of xxxx-xxxx-xxxx, and an intersection has the format xxxx-xxxx. The Results section further details the creation of this universal labeling system. This labeling system can be found in Appendix F.

3.1.3. MAINTAINING DATA

Once the database was created and all traffic data had been obtained by the team and input into it, the team must make sure all contacts will continue uploading data on a regular basis. This was done by emailing each contact once before the end of the project and asking them to do so. Each contact was also briefed on how to upload data to the database. For this purpose, the team created several tutorials on how to convert PRN files to XLS and use the platform, Google, Dropbox, and GIS Cloud. These tutorials were created using Adobe Dreamweaver and placed on the platform for ease of access by the contacts. The specific contents of these tutorials can be found in the Results section of this paper.

3.2. DETERMINING APPROPRIATE APPROACHES TO VISUALIZING TRAFFIC DATA

The visualizing of the traffic data gathered in the previous objective is important for the planning done by the SFMPO. One common practice of the SFMPO is the construction of line graphs, with the horizontal axis indicating time and the vertical axis indicating the number of cars during a certain time interval. The team desired to automate this task within Microsoft Excel and the Google Docs Suite. The process to convert and visualize these files in Excel is discussed in Objective 1. This data is site specific, and so it is important to see how the traffic data collected is related to its location. For this task, the team set out to create a GIS map that would display the universal labeling system, outlined in Objective 1, that allows for the uploading and viewing of data related to the locations. Another important task the team researched was the creation and sharing of GIS layers that display information, such as traffic counts.

3.2.1. VISUALIZING GOOGLE SPREADSHEETS

Once the PRN files were converted and uploaded to Google Docs, the team worked to create visualizations that would appear inside and outside the spreadsheets. In order to create these visualizations, it was necessary to learn the Google Apps Script and how to incorporate it with Google Spreadsheets, Google Docs, Google Maps, and Google Sites.

In order to understand how to use the scripting, the team studied the documentation of Google Code. The services studied were: DocsList Services, Maps Services, Properties Services, Spreadsheet Services, Ui Services, Utilities Services, and XML Services.[45] The first task was to make a list of the relevant methods, i.e. functions that can be performed, in each service pack.

Since the volume counts were stored in spreadsheets in Google Docs, the scripting was done within the Google Spreadsheets application. One difficulty with creating and using the scripts was dealing with the two ways to use scripts in multiple spreadsheets. One publishes the script, and then sends the script to Google for them to check, which takes time. The second way is to copy and paste the code from the original script to a new script in the desired spreadsheet. The way the team navigated this lack of scripting function was to designate a master spreadsheet that would allow the user to find the desired Google Spreadsheet and then operate in it. Another way was to publish the

45 "Google Apps Script Overview," Google, http://code.google.com/googleapps/appsscript/guide.html (accessed 4/25, 2011).

script as a service, giving the script a web address, and then use Google Sites to embed the service in a web page.

The actual scripting in Google Spreadsheets was often long and tedious, but not without results. A main problem was the inability to create complex charts using only scripting. In order to script charts into the spreadsheet, Google Charts API and the creation of a long URL was used, along with other HTML code, to insert the image in the spreadsheet. There were problems with the large amounts of data that was sent and the image did not update when changes were made to the data. For the image to change, the script needed to be run, which results in duplicate charts; the old chart must then be deleted. To bypass this, a chart was created using the Google Spreadsheets chart tool, which acts like the charts of Excel, as it reads from the spreadsheet. The script copied the sheet the chart was on and overwrote the data it was using with the new data. The full script will be discussed in further detail in the Results section of this paper and is shown in Appendix G.

3.2.2. MAPPING WITH FUSION TABLES

Fusion Tables is a fairly straightforward tool, which required little study because of the simplistic aspects, like the creation of point layers. The organization of the points was of the utmost importance, as the intersections and road segments will be found and referenced by the unique IDs that they were given. Thus, the Fusion Table containing all of this data was created by uploading the spreadsheet used to organize the intersections and road segments.

Next was the assignment of coordinate locations to the intersections and road segments. This required the allocation of one of the columns to the type "Location", and the entering of the latitude and longitude into that column. The coordinates of the intersections and road segments were found using Google Earth, making a point to get them in decimal form, as it is the only form recognized by Fusion Tables. This information links directly to the Google Maps API to generate the map with information at those points.

Another important feature is the creation of the road segments where the city collects the traffic volumes. In order to create these lines, KML code was imbedded in the Location column, giving the endpoints and a few intermediate points when the road was curved. Figure 3.3 below displays some code used in Fusion Table.

- Line:

```
<LineString>
<coordinates> lng,lat[,alt] lng,lat[,alt] ... </coordinates>
</LineString>
```

Figure 3.3 Format of KML Code Used in Fusion Tables

Other columns were added to give more information about the points. This included the web addresses of the upload and store locations of the data. The map created using Fusion Tables will be discussed further in the Results section of this paper.

3.2.3. MAPPING WITH GIS CLOUD

GIS Cloud was primarily used for the storage of the GIS files that already exist. The files are viewable, both within the GIS Cloud application and within the various website locations. To view files within GIS Cloud, the layers need to be connected to a map with a base layer that has a geospatial location system; the base layer from Google Maps was used for this. Any number of layers can be added to this map because the visibility of the layer can be turned on or off as desired.

The main focus was the displaying of these maps in websites viewable by the public. GIS Cloud gives users the ability to embed the maps in websites using Google Maps or a GIS Cloud applet. Although this is simple, it must be done manually for each map. Also, it requires access to and some familiarity with the HTML code of the website the map is to be embedded in. Since the SFMPO website is not under the control of the SFMPO, the maps needed to be embedded within another location, namely Google Sites. Since Google Sites has restrictions on the owner's editing of the HTML code of the webpages, it was not possible to embed the Google Maps of the GIS Cloud layers. Thus, GIS Cloud was the only way and also offers functionality that Google Maps does not. For one, it allows the viewer to choose between the many layers of the map, determining the visibility. It also allows the user to view the detailed information at those points. Furthermore, if the owner wishes to display only the map and the points, rather than the information at those points, the other functionalities can be turned off. The team determined that it would be most beneficial to have both the layer list and toolbar. The code is automatically generated by GIS Cloud, which is then copied and pasted into the limited HTML editing part of a Google Sites page. Since the map layers are not hard coded to the webpage, but rather pulled from the GIS Cloud servers, the embedded map updates when the map is edited in GIS Cloud.

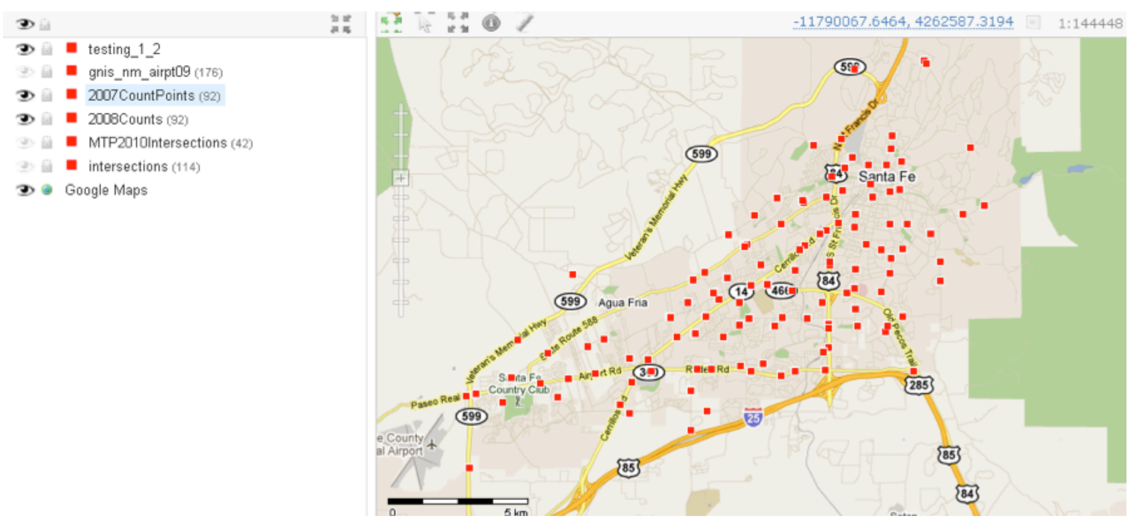

Figure 3.4 GIS Map Embedded in Google Sites

3.3. DESIGNING AND CREATING A TRANSPORTATION PLATFORM FOR TRAFFIC PLANNING

The main outcome of this project was to design and create a transportation platform for the purpose of aiding the traffic planning process. This platform is a combination of both the first and second objectives, containing a database in which all of the traffic data collected by the team is stored, as well as visualizations of this data.

The first step in creating the platform was to research different types of platforms that would be useful for the purpose of this project. Initially, the team outlined what was needed in the platform and what abilities it needed to have. This outline, located in Appendix H, provided a guideline for future research. It includes what types of data should be stored, as well as various settings it must have. After speaking with the liaisons of the project, the team recognized that an online platform was preferred. For this reason, the team created a website that incorporated the different applications needed: Google Docs, Google Maps, GIS Cloud, and Dropbox. GIS Cloud and Dropbox act as databases for the platform. They will contain all of the traffic data collected, and users will be able to upload and download data directly from the website. Google Maps and Google Spreadsheets will serve as visualization tools, containing locations of data points and visualizations of traffic data, respectively. Another mapping tool, GIS Cloud, will be used to store, create, and share GIS layers.

After much thought and consideration, the team chose to use Adobe Dreamweaver, an application used to generate web pages in HTML, to create the website. After downloading Dreamweaver, the team researched how to make a website by using tutorials from the Adobe website.[46] Figure 3.5 displays the building process of the website's home page through Dreamweaver.

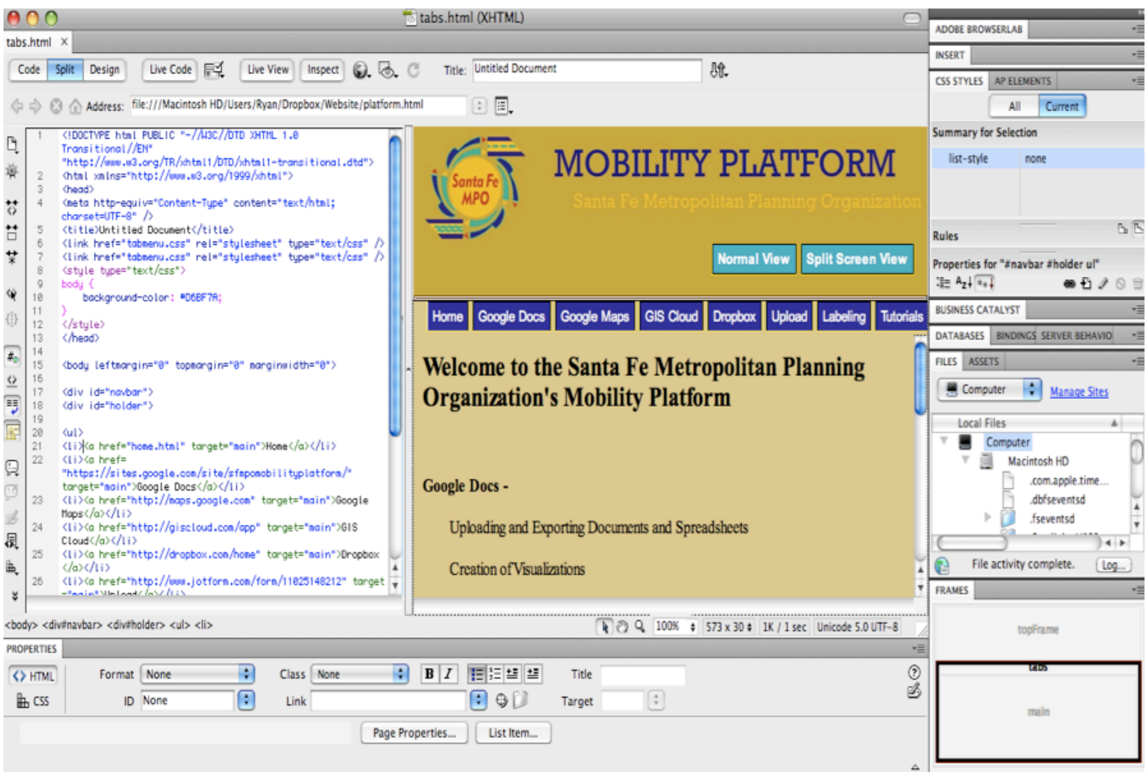

Figure 3.5 Building the Website in Dreamweaver

Using Dreamweaver, the team was able to integrate all of the applications used and create a fully functioning website. The team included features, such as a tab system and a split screen view, to make navigation easier. Creation of the website began by watching several tutorials on how to create the tab system.[47] Once created, each tab was set to direct the user to the login page of the application. Once logged in, the user is able to use the application directly from the hosting website. A difficulty

46 "Using Adobe Dreamweaver CS4," http://help.adobe.com/en_US/Dreamweaver/10.0_Using/index.html (accessed 4/20, 2011).

47 James Brand, "Dreamweaver Tutorial," http://www.dreamweavertutorial.co.uk/ (accessed 4/20, 2011).

encountered by the team was connecting Google Docs to the website. In order to connect the two, the team used a Google gadget embedded in a Google Site to access Google Docs. Unfortunately, when opening a document the page still opens in a separate window. The split screen ability was added to give users the option of viewing two applications at once instead of having to view them in two separate windows. Screenshots of these, and other, features of the platform are located in Appendix I.

Next, the tutorials in Objective 1 were made available on the website under the "Tutorials" tab. They are available to any user, and teach the user to navigate the website with ease. The tutorials give a step-by-step overview on using each application, with a focus on uploading and downloading data.

The last step of this objective was to create login information for each person using the platform. In order to use the platform, users must have usernames and passwords to log into each application. Usernames were created for Keith Wilson, Mark Tibbetts, Joyce Gonzales, John Romero, Rick Devine, and Johnny Baca. These contacts were chosen because they are the main people who will be using the platform. A username was also made for public use, allowing anyone to use the platform, but would have separate permissions as well as viewing capabilities. This username would authorize the user to view only public folders. The team then created Gmail and Dropbox accounts for each of the aforementioned contacts. The Gmail accounts are used for signing into GIS Cloud, as well as Google, and the Dropbox accounts are used for viewing and uploading data into Dropbox.

4. RESULTS AND ANALYSIS

This section of the paper includes all of the results to be delivered at the end of the project. These results are:

- The transportation platform
- Tutorials
- The universal labeling system
- A map created using Fusion Tables
- Conversion of PRN files
- Creating Google spreadsheets for visualizations
- File storage in Dropbox

Each of these topics were touched upon in the Methodology section, but will be explained in further detail in this section. Also, not everything researched an attempted was found useful at the completion of this project. Prior to the creation of the platform, traffic data within the city of Santa Fe was dispersed. With what the team has created, the platform currently combines two main traffic organizations in Santa Fe, the County and the SFMPO. See Appendix J for a flow chart detailing this past and current flow of traffic data and how the platform assists in the compilation of the data.

4.1. TRANSPORTATION PLATFORM

The main result of this project was the creation of the transportation platform. There are several different components of the platform: Google Docs and Spreadsheets, Google Maps, GIS Cloud, Dropbox, a data upload form, a labeling system, and tutorials. By using Dreamweaver, the team was able to create a website that incorporated each component of the platform. The website also has three main functionalities: a tab system, a normal screen viewing option, and a split screen viewing option. The tabs at the top of the page are linked directly to certain applications and the other features of the website. The normal screen view is shown as one tab screen, whereas split screen view allows the user to view two, independent, tab screens at once. Screenshots of the platform are located in Appendix I. To view the website online, go to http://bit.ly/SFMPO_mobilityplatform.

4.1.1. HOME PAGE

When first arriving at the website, the user is automatically directed to the home page. This is also the first tab on the site. The home page provides a brief description of Google, GIS Cloud, and Dropbox, including the main functions of each and how they are used in the platform.

4.1.2. DROPBOX

Dropbox is the main database located on the platform. The "Upload" tab directs the user to a form where they can fill out their name and information on the data they are uploading. This data is then uploaded directly into Dropbox and becomes available to other users with access to it. The Dropbox tab on the website will then direct the user to their Dropbox account. This will contain the data they uploaded, as well as data from other sources. How the data is organized and stored will be discussed further in a later section.

4.1.3. LABELING SYSTEM

The labeling tab will direct the user to the unique labeling system created by the team, which will be discussed in more detail in a later section. There are two spreadsheets available on the website. The first one, which appears when the user clicks on the labeling tab, displays the universal labels as well as the labels from the SFMPO and City's Engineering Department. On the bottom left corner of the webpage, a tab for both sheets is available. The first one is called the Conversion Sheet. The second sheet, Road Segment IDs, provides a list of each road segment and the ID number they were assigned. It provides the user with information on labels of road segments and intersections given by the team.

4.1.4. GOOGLE

Google is the next tab on the website, and leads to the login page for Google Docs. By logging in, the user gains full access to all of Google's capabilities, such as Google Docs, Google Spreadsheets, and Google Maps. Google Maps is the main application used on the platform. It is used to visualize the data by means of Fusion Tables. When the "Google Maps" tab is clicked, the user is directed straight to the map with all of the intersections and road segments that are used in the traffic data collection process throughout the city.

4.1.5. GIS CLOUD

The fourth tab on the website links to GIS Cloud, an online mapping database. This application is used for GIS layer storage, creation, and sharing. All of the GIS layers the team received from the city of Santa Fe and were put into an account on GIS Cloud. The SFMPO has access to these layers as well as the ability to create more layers using GIS Cloud. The organization and sharing of the layers will be discussed further in a later section. Lastly, there is a "Public Maps" tab, which directs the user to a Google Site containing GIS layers for the city, county, and state. This tab will mainly beused for public use, but it also used by the SFMPO to add layers and edit the "Public Maps" section.

4.1.6. TUTORIALS

The tutorials section of the website provides tutorials on each tool used in the website: Google, GIS Cloud, Dropbox, converting PRN files to spreadsheets, and using the website in general. Clicking on a link will direct the user to that specific tutorial. Each tutorial will be discussed later.

4.2. FILE STORAGE

One of the main components of the platform is a centralized database. The team chose to user two types of databases: Dropbox and GIS Cloud. Each uses a different method of storing and organizing files. In this section, the filing system the team created for each application will be discussed.

4.2.1. WITHIN DROPBOX

The team used Dropbox as one of the applications to upload and store traffic data files. Inside Dropbox, a filing system is used to order the data by location. When importing data, the "Upload" tab is used as a form to gather information respective to the data. This includes the name of the person uploading the data, as well as other information the user wants to provide. The data is then automatically directed to the JotForm folder in Dropbox.

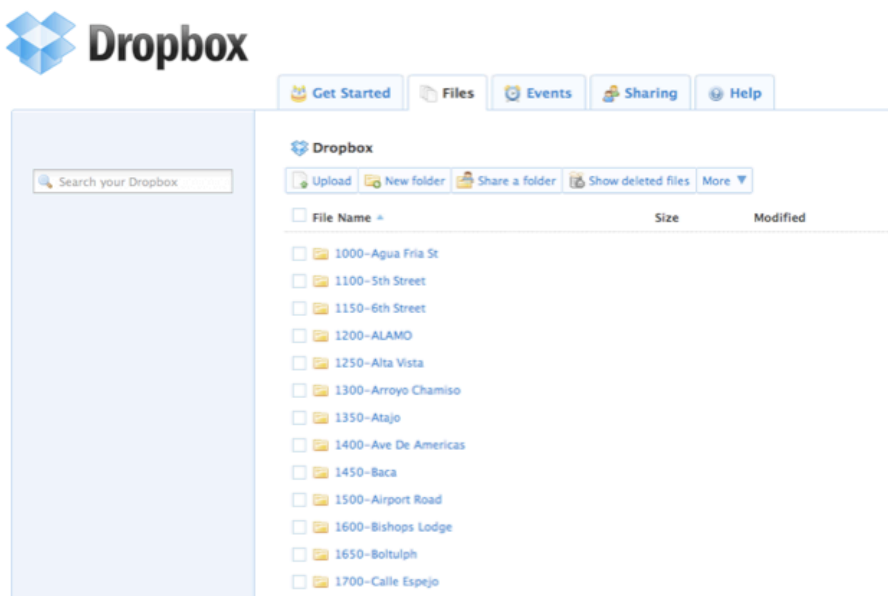

Figure 4.1 File System in Dropbox

4.3. UNIVERSAL LABELING SYSTEM

A major component that assisted in organizing the traffic data was the labeling system that the team created. The labeling system was created as a means to sort the roads within Santa Fe. Currently there are two known methods for identifying the roads; one done by the City's Engineering Department, and another done by the SFMPO. The method used by the city only identifies major roads used for collecting data from video cameras and inductive loop detectors. The method used by the SFMPO can be very random as data is collected by the use of pneumatic road tubes. Until 2008, the locations were not very specific; street names were given but the actual point location was not known. With these two varied forms of identifying roads, there was no universal system with which to label the roads. The team decided to create a universal labeling system, which would benefit all of the transportation organizations. Each road was categorized alphabetically and then given a four-digit number starting from 1100. Prior to all of the roads being alphabetized, the roads used by both the SFMPO and the City's Engineering Department were separated and labeled. These numbers differ from the rest as they are ordered from 1000 and increase by increments of 500. Not only are roads identified by names but also have a unique number with which to identify them. Intersections have a four by four digit identifier while road segments have a four by four by four digit identifier.

When an organization wants to locate data on the platform, they can simply upload the data based on the street ID. When uploading data onto platform, all of the data pertaining to one specific location can easily be grouped through the unique identifications for a location. This provides ease of access to a user to find and upload data. Below, in Figures 4.2 and 4.3, is an example of the labeling system along with the short list of some of the labeled roads.

	A	B	C	D	E	F	G
1	Name of Road	WPI Street Label	Rick Devine Label	STREET	ROAD ID	BETWEEN	WPI Intersection Label
2							
3	Agua Fria Street	1000	500	AGUA FRIA	4735--------000.300	GUADALUPE-DUNLAP	1000-3750-2950
4				AGUA FRIA	5758--------000.200	ALAMEDA-CM CARLOS RAEL	1000-2000-1850
5				AGUA FRIA	5735--------002.100	OSAGE-CM CARLOS RAEL	1000-4800-1850
6				AGUA FRIA	4735--------003.000	HENRY LYNCH-SILER	1000-3800-5700
7				AGUA FRIA	CL49006--003.000	LOPEZ	1000-4400
8				AGUA FRIA	4725---------000.500	IRVINE	1000-4200
9				AGUA FRIA	4735---------001.400	BACA-HICKOX	1000-1450-3850
10	Airport Road	1500	1600	AIRPORT	4726---------000.250	LOPEZ-ATAJO	1500-4400-1350
11				AIRPORT	4726---------000.420	ZEPOL-PASEO DEL SOL	1500-6150-5100
12				Airport Rd	4726---------000.166	Jct Zepol	1500-6150
13				AIRPORT RD	4726---------000.100	CERRILLOS-LOPEZ	1500-2500-4400
14	Alameda Street	2000	900	Alameda	5758--------000.300	Jct CM Carlos Rael west of	2000-1850
15				ALAMEDA	4805---------000.100	ST FRANCIS-SOLANA	2000-7500-5750
16				ALAMEDA	4805---------000.500	SOLANA-ST FRANCIS	2000-5750-7500
17				ALAMEDA	4805---------000.800	CATHEDRAL PLACE	2000-2350
18	Cerrillos Road	2500	100	CERRILLOS RD	CNM0014048.350	JAGUAR-CN ENTRADA	2500-4250-2600
19				CERRILLOS RD	CNM0014052.000	LUJAN-OSAGE	2500-4450-4800
20				CERRILLOS RD	CNM0014-053.350	ALTA VISTA-BACA	2500-1250-1450
21				CERRILLOS RD	CNM0014053.950	ST. FRANCIS-GUADALUPE	2500-7500-3750

Figure 4.2 Universal Labeling System

	A	B	C	D	E
1	Street Name	Label #			
2	**Unique Road Identifiers**				
3					Roads that Rick Devine and the MPO use
4	Agua Fria St	1000			
5	Airport Road	1500			
6	Alameda St	2000			
7	5th Street	1100			
8	6th Street	1150			
9	ALAMO	1200			
10	Alta Vista	1250			
11	ARROYO CHAMISO	1300			
12	Arroyo Chamiso	1300			
13	ATAJO	1350			
14	Atajo	1350			
15	AVE DE AMERICAS	1400			
16	BACA	1450			
17	Bishops Lodge	1600			
18	BISHOPS LODGE RD	1600			
19	BOLTULPH	1650			
20	CALLE ESPEJO	1700			
21	CALLE LORCA	1750			

Figure 4.3 Road Identification Numbers

4.4. MAPS CREATED USING FUSION TABLES

Along with the creation of the labeling system, the team decided to use Google Fusion Tables to map out the location of intersections and road segments. Google Fusion Tables makes importing spreadsheets from Microsoft Excel simple. After importing the Excel spreadsheet of the labels, the next step was to find their corresponding longitude and latitude. For intersections, it was a coordinates that created a point on the map. The coordinates were entered in the format of Latitude, Longitude. For road segments however, it was necessary to gather multiple locations for that segment to create a line representation. Below is a screenshot of the labeling system on Google Fusion Tables, showing the roads as well as the universal identification number for the road segment or intersection.

Google fusion tables Labeling.xlsx-Sheet1 Mobility Platform Discussions (0) Get link

File View Edit Visualize Merge

Current view: All - Show options 1

Name of Road	STREET	ROAD ID	BETWEEN	Universal Labeling	Location	Data
Agua Fria Street	AGUA FRIA	4735-------000.300	GUADALUPE-DUNLAP	1000-3750-2950	kml...	https://dav.dropdav.com/10 Agua%20Fria%20St/3750-2950%20-%20Guadalupe-Dunlap/
Agua Fria Street	AGUA FRIA	5758-------000.200	ALAMEDA-CM CARLOS RAEL	1000-2000-1850		https://dav.dropdav.com/10 Agua%20Fria%20St/2000-1850%20-%20Alameda-Cm%20Carlos%20Rael/
Agua Fria Street	AGUA FRIA	5735-------002.100	OSAGE Ave-CM CARLOS RAEL	1000-4800-1850	kml...	https://dav.dropdav.com/10 Agua%20Fria%20St/4800-1850%20-%20Osage-Cm%20Carlos%20Rael/
Agua Fria Street	AGUA FRIA	4735-------003.000	HENRY LYNCH-SILER	1000-3800-5700	kml...	https://dav.dropdav.com/10 Agua%20Fria%20St/3800-5700%20-%20Henry%20Lynch-Siler/
Agua Fria Street	AGUA FRIA	CL49006--003.000	LOPEZ Lane	1000-4400	35.654722,-106.022766	https://dav.dropdav.com/10 Agua%20Fria%20St/4400%20Lopez/

Figure 4.4 Labeling System in Fusion Tables

Once each location was correctly mapped the team was then able to connect the relevant data PRN files associated with each location. This map was then uploaded and shared on the transportation platform. Data files were also uploaded onto Dropbox and can therefore be located through multiple means. Figure 4.5 below also shows a link to the data for each location. Having both the labeling system and map on the platform allows for easy cross-referencing between them.

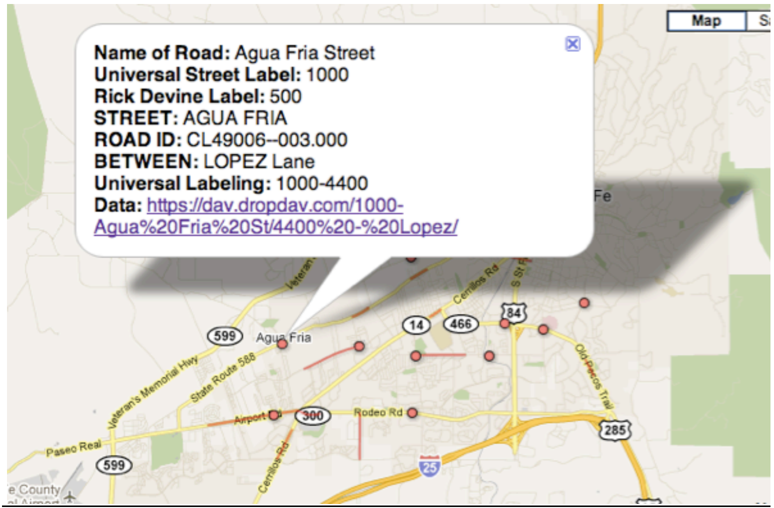

Figure 4.5 Data Displayed on Map

4.5. CONVERSION OF PRN FILES

The team produced an Excel spreadsheet, "Prn Converter.xls", which reads from a PRN file from Joyce Gonzales and formats the data into the columns of the Excel file. In order to convert the PRN file, it must be in the same folder as the converter file. The title of the PRN file, excluding the extension (.xls), is typed into the top left box. Finally, the keyboard sequence Ctrl + Shift + i, is pressed and the information from the PRN files is now in the Excel file. The data shows as many columns, the first two are text columns. They contain the identification numbers of the road segment that the data was collected from. Column C indicates the directions of the traffic in cardinal directions. Column D indicates the time interval of the measurements. Columns E and F indicate the number of cars that traveled across the pneumatic tube during the fifteen minutes prior to the time in column D. Column E is the North/East direction and column F is the South/West direction. Through the use of another shortcut sequence Ctrl + Shift + o, this data is then automatically copied into a sheet that recognizes the time the data was taken. Furthermore, the data is automatically formatted into a new sheet with a table that shows comparison of the data across the different days the data was taken, as well as the average volume of that hour; Figure 4.6 displays this sheet. A line chart has been created that reads the data from the "Volume Report Data" sheet. An example line graph is displayed in Figure 4.7. This graph has a line for each day of data collection. The horizontal axis is indexed by hour, displaying the 24 hours of the day. The vertical axis displays the traffic volumes, automatically adjusting the maximum value according to the largest volume.

Santa Fe Metropolitan Planning Organization — Page 1
P.O. Box 909, 120 S. Federal Place, Room 321
Santa Fe , NM 87504
Phone: 505-955-6706

County: Santa Fe
Counted E City of Santa Fe

Functional Class
Primary Arterial Urban

Location: 'CNM0014B053.350 11DS' 'CERRILLOS ROAD JCT ALTA VISTA

Start	Tue 22-Jun-10		23-Jun-10		24-Jun-10		25-Jun-10		26-Jun-10		27-Jun-10		28-Jun-10		Weekday Average	
Time	EB	WB	EB	WB	EB	WB	EB	WB	EB	WB	EB	WB	EB	WB	EB	WE
12:00 AM			47	66	63	56									55	61
1:00			26	29	36	32									31	31
2:00			14	24	14	19									14	22
3:00			19	13	13	10									16	12
4:00			12	12	14	22									13	17
5:00			60	62	66	48									63	55
6:00			205	229	186	204									196	217
7:00			802	696	759	750									781	723
8:00			1314	1130	1364	1139									1339	1135
9:00			1131	1065	1010	1051									1071	1058
10:00			1011	1143	1028	1157									1020	1150
11:00	733	963	1083	1267	1007	1181									941	1137
12:00 PM	1139	1512	1054	1432	1040	1152									1078	1365
1:00	1410	1188	1471	1196											1441	1192
2:00	1313	1178	1258	1136											1286	1157
3:00	1224	1278	1242	1365											1233	1322
4:00	1196	1444	1049	1428											1123	1436
5:00	1144	1332	1160	1389											1152	1361
6:00	827	770	909	810											868	790
7:00	577	595	571	517											574	556
8:00	432	383	437	435											435	409
9:00	284	267	261	302											273	285
10:00	211	169	233	164											222	167
11:00	123	128	166	136											145	132
Total	10613	11207	15535	16046	6600	6821									15365	15786
Day	21820		31581		13421										31151	
AM Peak																
Vol.	733	963	1314	1267	1364	1181									1339	1150

PRN / Volume Report Data / FRCOG Act Volume Report / Excel Chart

Figure 4.6 Volume Report Produced from PRN Conversion

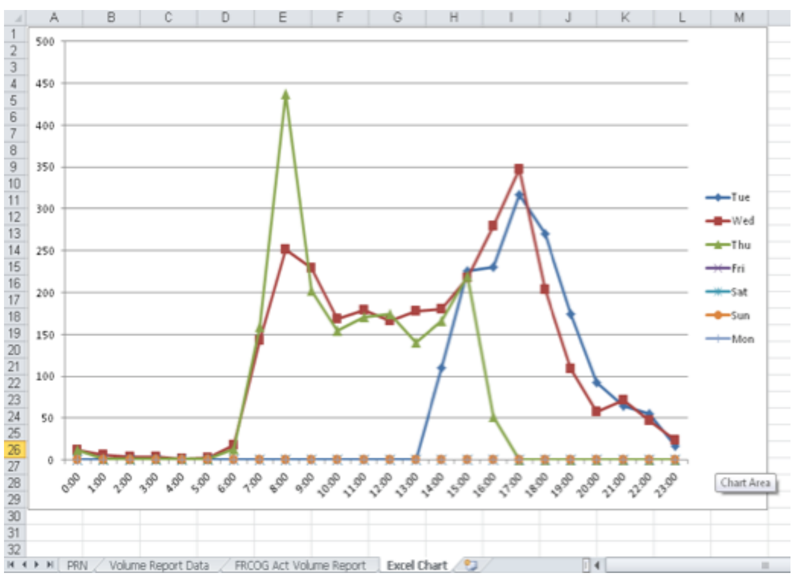

Figure 4.7 PRN Data Displayed in Line Graph

The PRN files also contain information about the location of the data. The format this information is in depends upon the PRN file, as the location can contain a combination of CHDB numbers and text. Figure 4.6 shows that this data is automatically formatted into the sheet with the daily table. This is done by the use of a formula that reads the text from the imported PRN data and inserts a space after any cell with text. However, it can only read the first 29 columns of data and so any location data in columns 30 or higher do not get read in. The location information is displayed on the table in the "FRCOG Act Volume Report" sheet. It is displayed at the top of the table for easy reference to the location of the traffic counts. See Appendix E for the macro code containing comments to illustrate the purpose of each line of code. The formulas associated with the sheets can be seen in the spreadsheet within the attached CD.

4.6. GRAPH CREATION WITH GOOGLE SPREADSHEETS

The team is also delivering a tool to create a line graph in Google Spreadsheets using the PRN files, which were converted to XLS, uploaded to Google Docs, and converted to a Google Spreadsheet. The tool is a Google Spreadsheet, titled "Chart Template", with a Google Apps Script and a button that runs the script. Once the button is pressed, a popup textbox appears asking for the name of the target Google spreadsheet. Once the name is entered, the script finds the Google spreadsheet, copies the sheet title "Chart" from the "Chart Template" spreadsheet to the target spreadsheet. It then copies over the columns with the data from the target spreadsheet. The result is a sheet in the target spreadsheet that has four columns: the time, volumes from each direction, and the total volume. The sheet uses these columns to create the interactive line chart displayed within the sheet. Appendix H displays the Google Apps Script and a screen shot of the "Chart" sheet of the "Chart Template" spreadsheet.

This tool is mainly useful for creating sharable line graphs. Also, the use of Google Spreadsheets allows users of the platform to view the volume counts and the line graphs online, without the need to download the files. It also does not require Microsoft Excel to be installed on the viewer's computer. However, the Excel file created from the PRN conversion file is more powerful and must still be used in order to upload to Google Docs. Most of the viewers of these files will have Microsoft Excel, and so this tool is not seen as a major deliverable.

4.7. TUTORIALS

The tutorials division of the website was necessary to ensure a thorough understanding of the website's multiple functions, and serves as a guide for new contacts. Each tutorial gives both specific and general overviews of each program. These tutorials teach the user how to use Google, Dropbox, GIS Cloud, PRN conversion, and using the website in general. The Google tutorial instructs the user on how to use Google Spreadsheets and Google Maps for this platform. The Dropbox tutorial mainly focuses on the basics of using Dropbox, as well as installing it. The GIS Cloud tutorial shows how to upload and share GIS layers. PRN conversion and visualization has a tutorial that explains the process. Lastly, navigating the website is made easy using the tutorial which describes the tab system and split screen viewing option.

5. CONCLUSIONS AND RECOMMENDATIONS

At the end of this project, data from several organizations had been collected and organized into a database. The team was also able to create a fully functional website, which acts as the platform, as well as other results which are helpful to the SFMPO. These results are explained in the previous section. To continue further work on this project, the team has made several recommendations to the SFMPO, including creating traffic models and continuing work on the platform.

5.1. CREATE TRAFFIC MODELS

One recommendation the team is making is to investigate the use of agent-based modeling in the platform. Models such as these are able to provide information on traffic flow, as well as depict road closures and construction. This information has the potential to help in planning decisions, such as adding lanes or signs to a roadway. Analysis on road conditions and other traffic related data is easier with the use of models. NetLogo is one application that would be useful for this. The team has studied and experimented with NetLogo during this project, and it has the potential to create models for transportation planning. It also allows for GIS layers to be uploaded and used inside the model, which can be useful for studying traffic flow at certain times and locations.

5.2. PRN CONVERSION

The PRN conversion tool is a great asset to the MPO, but there are many ways to improve the process as well as make it helpful to other organizations. One improvement is through the creation of a macro to further format the data in the weekly volume table, ideally having the week always start on Monday instead of first day of data collection. Another possible improvement is through the addition of the labeling system to the conversion process. By adding a macro, the CHDB numbers in the PRN file can be cross-referenced to determine the unique identification number of the universal labeling system. A final recommendation for the PRN conversion tool is the modification to convert the PRN files from the City's Engineering Department. Currently, these files would not format properly as they contain different information and are formatted differently due to different software.

5.3. WORK ON THE PLATFORM

The team also recommends future work be completed on the platform. Currently, the platform is running smoothly and data can be accessed fairly easily. The platform also makes use of several applications for storing and using traffic data. These applications, however, are not connected very well. For example, data from Dropbox cannot be easily upload to Google Docs. Research into the relationships between these applications, such as Dropbox and Google, would be very helpful. Throughout research for the platform, several Beta forms of connecting GIS Cloud and Google Maps was found as well as programs to connect other applications. These would be valuable tools and it would be helpful to look into them. With the use of these programs, data would move easily throughout the platform and each application if they were connected better. Also, the team hopes that the platform will compile data from all transportation organizations in Santa Fe and provide for better communication between them. A flow chart displaying this is located in Appendix J.

5.4. FUTURE WORK

The results from this project have the potential to help the SFMPO, and other transportation organizations in Santa Fe, in many ways. One main way, of course, is by providing a database for traffic data collected in the Santa Fe metropolitan area. These recommendations have been made to improve the usefulness of this platform and increase the collaboration between the different transportation organizations in Santa Fe. The team anticipates these recommendations will be carried out with future work completed on this project.

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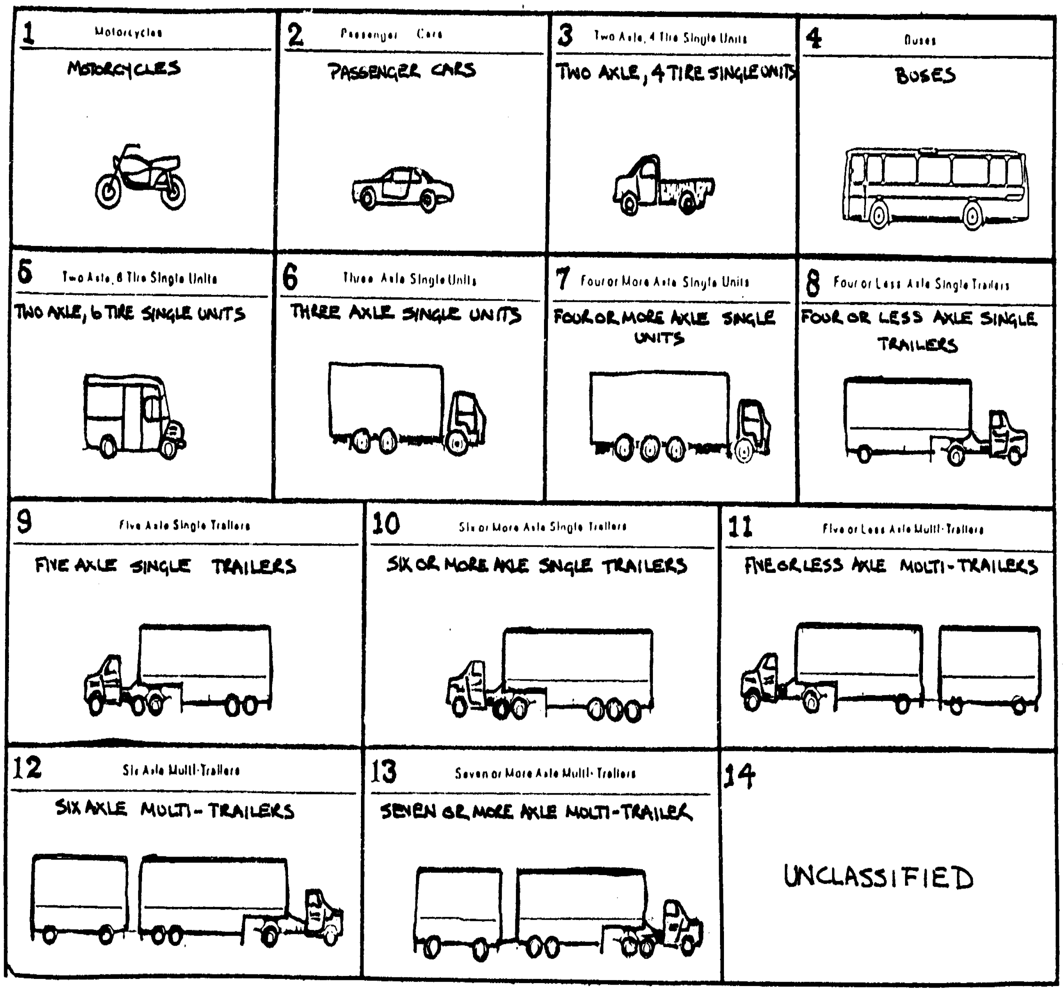
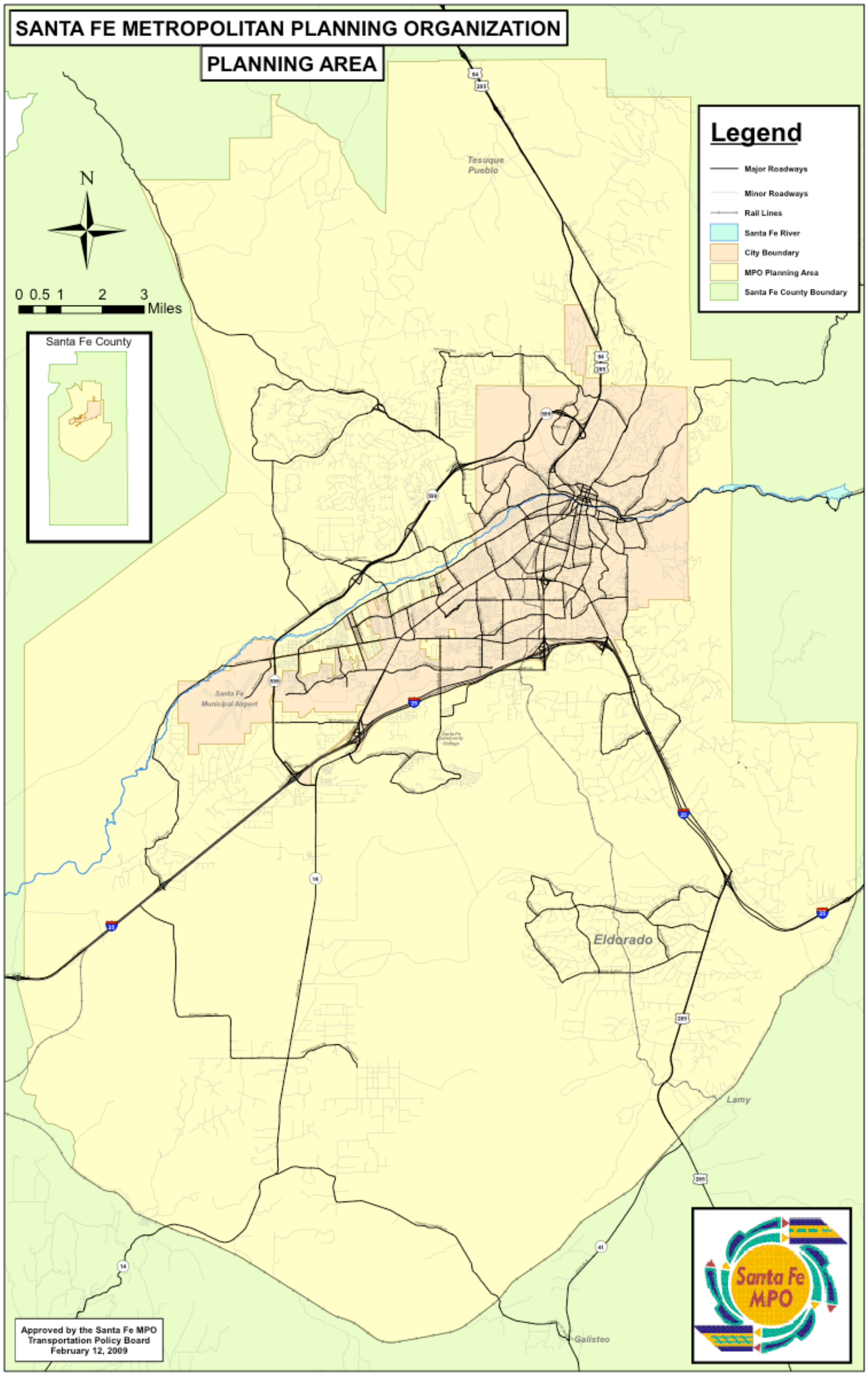
APPENDIX A: VEHICLE CLASSIFICATION CHART



FHWA VEHICLE CLASSIFICATION

TYPICAL VEHICLE SILHOUETTES

APPENDIX B: SANTA FE METROPOLITAN PLANNING AREA



APPENDIX C: CONTACT SPREASHEET

	Contact	Email Address	Phone Number	Department	Title
Metropolitan Planning Organization	Keith Wilson	kpwilson@ci.santa-fe.nm.us	(505) 955-6706	Metropolitan Planning Organization	Metropolitan Planning Organization Senior Planner
	Mark Tibbetts	mstibbetts@ci.santa-fe.nm.us	(505) 955-6614	Metropolitan Planning Organization	Metropolitan Planning Organization Officer
City of Santa Fe	Rick Devine	rjdevine@ci.santa-fe.nm.us	(505) 955-2320	Engineering	Traffic Operations Supervisor
	John Romero	jjromero1@ci.santa-fe.nm.us	(505) 955-6638	Engineering	Traffic Impacts/ Development Review Supervisor
	Robert Montoya	rbmontoya@ci.santa-fe.nm.us			
	Joyce Gonzales	jegonzales@ci.santa-fe.nm.us	(505) 660-5491		
	Albert Martinez		(505) 955-6994	Parking Division	Parking Operations Manager
	Sevastian Gurule	segurule@santafenm.gov	(505) 955-6611	Constituent Services	Constituent Services Manager
	Denise Salazar Vigil	dsvigil@santafenm.gov	(505) 955-6841	Geographic Information System	Manager
New Mexico Department of Transportation	John DiRuggiero	John.DiRuggiero@state.nm.us	(505) 827-5129	Intelligent Transportation Systems Bureau	Supervisor, Webmaster
	Elizer Pena	Elizer.Pena@state.nm.us	(505) 827-5529	Transportations Systems Bureau	Management Analyst
Santa Fe County	Johnny Baca	jpbaca@co.santa-fe.nm.us	(505) 992-3010	Public Works	Traffic Engineering Technician
	Steve Guerin	stephen.guerin@redfish.com		Santa Fe Complex	
	Michael Gomez	MGomez@SantaFeEngineering.com		Santa Fe Engineering	

APPENDIX D: CALENDAR OF INITIAL MEETINGS WITH CONTACTS

March 2011						
Sun	**Mon**	**Tue**	**Wed**	**Thu**	**Fri**	**Sat**
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21 Meeting with Keith Wilson and Mark Tibbetts	22	23 Meeting with Albert Martinez and Sevastian Gurule	24 Meeting with Steve Guerin	25 Meeting with Rick Devine	26
27	28 Meeting with Denise Vigil Salazar	29 Meeting with John DiRuggiero	30 Meeting with John Romero and Robert Montoya	31 Meeting with Elizer Pena		

April 2011						
Sun	Mon	Tue	Wed	Thu	Fri	Sat
					1	2
3	4	5 Meeting with Johnny Baca Meeting with Michael Gomez	6	7	8	9
10	11	12	13 Meeting with Joyce Gonzales	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30

APPENDIX E: EXCEL MACRO CODE

The text in red are comments, which do not influence the execution of the code. Comments are made above the respective code and only in the case of the introduction of a new task or function call.

```
Sub Import_Prn()
    Dim fileName As String, folder As String

    'finds the location of the Prn Converter
    folder = ActiveWorkbook.Path
    'gets the name of the PRN file in the top left box
    fileName = Range("A1").Value

    'selects the second box in the first column as the start point of the data to be copied
      'this allows the original filename to be stored in the spreadsheet
    Range("A2").Select

    'formatting of the data imported from the PRN file into the columns
      'this includes finding the file
      'telling the sheet the data is separated by spaces
      'setting the format of the first few columns of data
    With ActiveSheet.QueryTables _
        .Add(Connection:="TEXT;" & folder & "/" & fileName & ".prn", Destination:=ActiveCell)
        .FieldNames = True
        .RowNumbers = False
        .FillAdjacentFormulas = False
        .PreserveFormatting = True
        .RefreshOnFileOpen = False
        .RefreshStyle = xlInsertDeleteCells
        .SavePassword = False
        .SaveData = True
        .AdjustColumnWidth = True
        .RefreshPeriod = 0
        .TextFilePromptOnRefresh = False
        .TextFilePlatform = 850
        .TextFileStartRow = 1
        .TextFileParseType = xlDelimited
        .TextFileTextQualifier = xlTextQualifierDoubleQuote
        .TextFileConsecutiveDelimiter = False
        .TextFileTabDelimiter = False
        .TextFileSemicolonDelimiter = False
        .TextFileCommaDelimiter = False
        .TextFileSpaceDelimiter = True
        .TextFileColumnDataTypes = Array(xlTextFormat, xlTextFormat, xlGeneralFormat, xlTextFormat, xlTextFormat,
xlTextFormat, xlTextFormat)
        .TextFileTrailingMinusNumbers = True
        .Refresh BackgroundQuery:=False
    End With

    'this is to save the top left box as the title of original PRN
    Range("A1").Value = fileName
```

End Sub[48]

Sub formatting()

```
'determines the number of rows of the data
lastrow = ActiveSheet.UsedRange.Rows.Count + ActiveSheet.UsedRange.Row - 1

'this block changes start time from text to time format
'reads the hour from the string
timeHour = Left(Cells(2, 4).Value, 2)
'reads the minute from the string
timeMin = Right(Cells(2, 4).Value, 2)
'combines the hour and minute and saves it to the cell
Cells(2, 4).Value = timeHour + ":" + timeMin
'formats the cell as time
Cells(2, 4).NumberFormat = "[$-F400]h:mm:ss AM/PM"

'this block changes end time from text to time format
timeHour = Left(Cells(6, 4).Value, 2)
timeMin = Right(Cells(6, 4).Value, 2)
Cells(6, 4).Value = timeHour + ":" + timeMin
Cells(6, 4).NumberFormat = "[$-F400]h:mm:ss AM/PM"

'this block changes the start and end dates from text to date format
startmonth = Left(Cells(2, 5).Value, 2)
'this takes the text, 2 character string starting at the 3rd character
startday = Mid(Cells(2, 5).Value, 3, 2)
startyear = Right(Cells(2, 5).Value, 2)
endmonth = Left(Cells(2, 7).Value, 2)
endday = Mid(Cells(2, 7).Value, 3, 2)
endyear = Right(Cells(2, 7).Value, 2)
'formats the cells as a date with 2 digit year
Cells(2, 5).NumberFormat = "m/d/yy;@"
Cells(2, 7).NumberFormat = "m/d/yy;@"
Cells(2, 5).Value = startmonth + "/" + startday + "/" + startyear
Cells(2, 7).Value = endmonth + "/" + endday + "/" + endyear

'this block changes the end time from text to time format
starthour = Left(Cells(2, 6).Value, 2)
startmin = Right(Cells(2, 6).Value, 2)
Cells(2, 6).NumberFormat = "h:mm;@"
Cells(2, 6).Value = starthour + ":" + startmin


'this determines the row for the Volume Report Data sheet in which to start the
  'copy of the data
Cells(1, 4).NumberFormat = "h:mm;@"
Cells(1, 4).Value = Cells(2, 4).Value
Cells(1, 4).NumberFormat = "#"
Cells(1, 4).Value = Cells(1, 4).Value * 96
startrow = Cells(1, 4)
```

48 "Importing CSV Files into Excel using a Macro," Superuser, http://superuser.com/questions/230541/importing-csv-files-into-excel-using-a-macro (accessed 4/25, 2011).

```
    startrow = startrow + 3

    'this For loop changes the times from text to time format
      'it also copies it over to the Volume Report Data sheet
      'it starts at row 8 and goes to the last row with data
    For x = 8 To lastrow
     'this block changes the time from text to time format
     timeHour = Left(Cells(x, 4).Value, 2)
     timeMin = Right(Cells(x, 4).Value, 2)
     Cells(x, 4).NumberFormat = "h:mm;@"
     Cells(x, 4).Value = timeHour + ":" + timeMin

     'this block changes the volumes of the North/East direction
       ' from text to integer format and saves the value to vol1
     volumes = Cells(x, 5).Value
     Cells(x, 5).NumberFormat = "#"
     Cells(x, 5).Value = volumes
     vol1 = Cells(x, 5).Value

     'this block changes the volumes of the South/West direction
       ' from text to integer format and saves the value to vol2
     volumes = Cells(x, 6).Value
     Cells(x, 6).NumberFormat = "#"
     Cells(x, 6).Value = volumes
     vol2 = Cells(x, 6).Value


     'this block copies the data over to Volume Report Data sheet
     'this finds selects the Volume Report Data sheet
     Sheets("Volume Report Data").Select
     'sets the value of the row as the volume from North/East direction
     Cells(startrow + x - 7, 4).Value = vol1
     'sets the value of the row as the volume from South/West direction
     Cells(startrow + x - 7, 5).Value = vol2
     'sets the sheet back to the PRN sheet
     Sheets("PRN").Select

     'iterates back to the beginning of the For loop, incrementing the row by 1
    Next x

End Sub
```
[49]

49 "Reference," Microsoft, http://msdn.microsoft.com/en-us/library/ff846392.aspx (accessed 4/25, 2011).

APPENDIX F: UNIVERSAL LABELING SYSTEM

Name of Road	Universal Street Label	City Label	STREET	SFMPO ROAD ID	BETWEEN	Universal Intersection Label
Agua Fria Street	**1000**	**500**	**AGUA FRIA**	**4735-------000.300**	GUADALUPE-DUNLAP	1000-3750-2950
			AGUA FRIA	**5758-------000.200**	ALAMEDA-CM CARLOS RAEL	1000-2000-1850
			AGUA FRIA	**5735-------002.100**	OSAGE-CM CARLOS RAEL	1000-4800-1850
			AGUA FRIA	**4735-------003.000**	HENRY LYNCH-SILER	1000-3800-5700
			AGUA FRIA	**CL49006--003.000**	LOPEZ	1000-4400
			AGUA FRIA	**4725--------000.500**	IRVINE	1000-4200
			AGUA FRIA	**4735--------001.400**	BACA-HICKOX	1000-1450-3850
Airport Road	**1500**	**1600**	**AIRPORT**	**4726--------000.250**	LOPEZ-ATAJO	1500-4400-1350
			AIRPORT	**4726--------000.420**	ZEPOL-PASEO DEL SOL	1500-6150-5100
			Airport Rd	**4726--------000.166**	Jct Zepol	1500-6150
			AIRPORT RD	**4726--------000.100**	CERRILLOS-LOPEZ	1500-2500-4400
Alameda Street	**2000**	**900**	**Alameda**	**5758-------000.300**	Jct CM Carlos Rael west of	2000-1850
			ALAMEDA	**4805--------000.100**	ST FRANCIS-SOLANA	2000-7500-5750
			ALAMEDA	**4805--------000.500**	SOLANA-ST FRANCIS	2000-5750-7500
			ALAMEDA	**4805--------000.800**	CATHEDRAL PLACE	2000-2350
Cerrillos Road	**2500**	**100**	**CERRILLOS RD**	**CNM0014048.350**	JAGUAR-CN ENTRADA	2500-4250-2600
			CERRILLOS RD	**CNM0014052.000**	LUJAN-OSAGE	2500-4450-4800
			CERRILLOS RD	**CNM0014-053.350**	ALTA VISTA-BACA	2500-1250-1450
			CERRILLOS RD	**CNM0014053.950**	ST. FRANCIS-GUADALUPE	2500-7500-3750
Cordova Road	**3000**	**1200**	**CORDOVA**	**4738--------000.900**	ST FRANCIS-CERRILLOS	3000-7500-2500
			CORDOVA	**4738--------000.300**	ST FRANCIS-EARLY	3000-7500-3100
Old Pecos Trail	**3500**	**600**	**OLD PECOS TRAIL**	**CNM0046600.300**	ZIA-ESPEJO	3500-8500-3250
Paseo de	**4000**	**400**	**PASEO DE**	**CNM0475000.215**	GUADALUPE-ST	4000-3750-

Peralta			**PERALTA PASEO DE PERALTA**	**CNM0475000.750**	FRANCIS ST. FRANCIS-1/2 WAY TO GUAD	7500 4000-7500-3750
Richards Avenue	**4500**	**1900**	**RICHARDS AVE**	**5680--------000.100**	RODE0-GOVENOR MILES	4500-5000-3650
Rodeo Road	**5000**	**800**	**RODEO RD**	**4727-------001.000**	CERRILLOS-ZAFARANO	5000-2500-6100
Rufina Street	**5500**	**1800**	**RUFINA**	**5763--------001.500**	RICHARDS-POLVOSO	5500-4500-5150
			RUFINA	**5763--------000.400**	H LYNCH	5500-3800
San Francisco	**6000**	**1000**	**SAN FRANCISCO**	**5787--------000.700**	GUADALUPE-SANDOVAL	6000-3750-5400
San Mateo Road	**6500**	**1700**	**SAN MATEO**	**5737--------000.300**	OLD PECOS TRAIL	6500-3500
Siringo Road	**7000**	**1400**	**SIRINGO**	**5738-------000.900**	CAMINO CARLOS REY	7000-1850
			SIRINGO	**5738--------001.000**	LLANO-YUCCA	7000-4350-5950
			SIRINGO	**5738--------000.100**	CM CARLOS REY-YUCCA	7000-1850-5950
			SIRINGO	**5738--------002.150**	CALLE LORCA	7000-1750
St. Francis Drive	**7500**	**200**	**ST FRANCIS**	**CUS285---166.100**	ALAMO-PASEO DE PERALTA	7500-1200-4000
			ST FRANCIS	**CUS285---165.270**	CERRILLOS-CORDOVA	7500-2500-3000
St. Micheals Drive	**8000**	**300**	**ST MIKES**	**CNM0466.000.500**	FIFTH -ESPINITAS	8000-1100-3300
			ST MIKES	**CNM0466.000.700**	WEST OF PACHECO	8000-4900
			ST MIKES	**CNM0466.000.000**	FIFTH-LLANO	8000-1100-4350
			ST MIKES	**CNM0466 000.000**	WEST OF LLANO-CERRILLOS ROAD	8000-4350-2500
			ST MIKES	**CNM0046601.000**	HOSPITAL RD	8000-4100
			ST MIKES	**CNM0466---2.150**	ARROYO CHAMISO-HOSPITAL	8000-1300-4100
Zia Road	**8500**	**700**	**Zia Road**	**5733--------000.300**	Jct Rodeo	8500-5000

Rick Devine		
Sandoval Street	**5400**	**1100**
Washington Avenue	**5900**	**1300**
Guadalupe Street	**3750**	**1500**
Jaguar Drive	**4250**	**2000**
Second Street	**5600**	**2100**

MPO		`	
ALAMO	5750--------000.050	CM DE LAS CRUCITAS-ST FRANCIS	1200-1950-7500
ARROYO CHAMISO	5776--------000.500	ST MIKES	1300-8000
ATAJO	CF49006	AIRPORT-LOPEZ	1350-1500-4400
AVE DE AMERICAS	5772--------000.050	CERRILLOS	1400-2500
BACA	5674--------000.300	SIERRA VISTA-POTENCIA	1450-2250-5200
Bishops Lodge	4801--------001.300	Jct CM Encandado	1600-2100
BISHOPS LODGE RD	4801--------001.000	VALLEY DRIVE	1600-5850
BOLTULPH	5734--------000.500	CM FELIZ-ST MIKES	1650-2150-8000
CALLE ESPEJO	5678--------000.100	ZIA	1700-8500
CALLE LORCA	5745--------000.500	CLOSE TO ST MIKES	1750-8000
CALLE RESOLANA	5775--------000.100	CERRILLOS RD	1800-2500
CANYON RD	4732--------001.000	GARCIA	2300-3450
CM ENCANTADO	5686--------000.500	BISHOPS LODGE	2100-1600
CRISTO REY	5673--------000.200	CANYON RD	2750-2300
DON DIEGO	5756--------000.500	MARQUEZ-CUBERO	2900-4650-2800
EAST ZIA	5734--------000.260	BOLTULPH-ARROYO CHAMISO	3150-1650-1300
EAST ZIA	5770--------000.050	CONEJO	3150-2700
EL RANCHO RD	5780--------000.250	ALAMEDA	3200-2000
ESPINITAS		FIFTH -CALLE LORCA	3300-1100-1750
FIFTH STREET	5744--------000.521	NORTH OF ST MIKES	1100-8000
GALISTEO	5766--------000.065	ALTA VISTA-COLUMBIA	3400-1250-2650
GARCIA	5730--------000.050	CM CORRALES	3450-1900
GONZALES RD	5749--------000.500	HYDE PARK ROAD-CERRO GORDO	3600-4150-2400
GOVERNOR MILES	5802--------002.500	RICHARDS-CLIFF PALACE	3650-4500-2450
Hopewell	5783-------000.100	6th/Llano	3900-1150-

			4350
HYDE PARK RD	**CNM0475000.500**	**BISHOPS LODGE-SUNSET**	4150-1600-5800
HYDE PARK RD	**CNM0475-001.462**	**GONZALES-SUNSET**	4150-3600-5800
JOHNSON ST	**5781--------000.200**	**GUADALUPE-GRANT**	4300-3750-3700
LOPEZ	**5778--------000.300**	**AIRPORT-RUFINA**	4400-1500-5500
LUJAN	**5673--------000.200**	**CLOSE TO CERRILLOS ROAD**	4450-2500
MARCY ST	**5679--------000.345**	**OTERO**	4600-4850
OLD SANTA FE TRAIL	**4734--------000.950**	**CM MONTE SOL**	4750-2200
OSAGE AVE	**5672--------000.300**	**CERRILLOS-ROSINA**	4800-2500-5300
OSAGE AVE	**5776--------000.200**	**HOPI-AGUA FRIA**	4800-3950-1000
PALACE AVE	**4750-------000.580**	**ALAMEDA-DELGADO**	4950-2000-2850
PASEO DEL SOL	**CL49003--000.400**	**AIRPORT-JAGUAR**	5100-1500-4250
RICARDO	**5778--------000.500**		5250
SAN ACACIO	**5684--------000.050**	**SANDANTER**	5350-5450
SETON VILLAGE	**CNM0030-000.100**	**FRONTAGE ROAD AT OLD LAS VEGAS**	5650-3350-4700
SILER	**5740-------000.500**	**SILER EXTENSION-AGUA FRIA-ALAM**	5700-1000-1200
SILER	**4740--------000.100**	**CERRILLOS RD-RUFINA**	5700-2500-5500
YUCCA	**5733-------000.550**	**ZIA-SIRINGO**	5950-8500-7000

Unique Road Identifiers

Roads that Rick Devine and the MPO use

Street Name	Label ID
Agua Fria St	1000
Airport Road	1500
Alameda St	2000
5th Street	1100
6th Street	1150
ALAMO	1200
Alta Vista	1250
ARROYO CHAMISO	1300
Arroyo Chamiso	1300
ATAJO	1350
Atajo	1350
AVE DE AMERICAS	1400
BACA	1450
Bishops Lodge	1600
BISHOPS LODGE RD	1600
BOLTULPH	1650
CALLE ESPEJO	1700
CALLE LORCA	1750
CALLE RESOLANA	1800
Camino Carlos Rael	1850
Camino Corrales	1900
Camino de Las Crucitas	1950
Camino Encatado	2100
Camino Feliz	2150
Camino Monte Sol	2200
Camino Sierra Vista	2250

Henry Lynch	3800
Hickox	3850
Hopewell	3900
Hopi Road	3950
Hospital	4100
HYDE PARK RD	4150
HYDE PARK RD	4150
Irvine	4200
Jaguar Drive	4250
JOHNSON ST	4300
Llano	4350
LOPEZ	4400
LUJAN	4450
MARCY ST	4600
Marquez Place	4650
Old Las Vegas Highway	4700
Old Pecos Trail	3500
OLD SANTA FE TRAIL	4750
OSAGE AVE	4800
OSAGE AVE	4800
Otero Street	4850
Pacheco	4900
PALACE AVE	4950

CANYON RD	2300
Cathedral Place	2350
Cerrillos	2500
Cerro Gordo	2400
Cliff Place	2450
Cn Entrada	2600
Columbia Street	2650
Conejo Trail	2700
Cordova	3000
CRISTO REY	2750
Cubero Court	2800
Delgado Street	2850
DON DIEGO	2900
Dunlap	2950
Early	3100
EAST ZIA	3150
EAST ZIA	3150
EL RANCHO RD	3200
Espejo	3250
ESPINITAS	3300
Frontage Road	3350
GALISTEO	3400
GARCIA	3450
GONZALES RD	3600
GOVERNOR MILES	3650
Grant	3700
Guadalupe Street	3750

Paseo de Peralta	4000
PASEO DEL SOL	5100
Polvoso	5150
Potencia Street	5200
RICARDO	5250
Richards Ave	4500
Rodeo Road	5000
Rosina Street	5300
Rufina Street	5500
SAN ACACIO	5350
San Francisco	6000
San Mateo Road	6500
Sandoval Street	5400
Santanter Lane	5450
Second Street	5600
SETON VILLAGE	5650
SILER	5700
SILER	5700
Siringo Road	7000
Solana	5750
St. Francis Drive	7500
St. Micheals Drive	8000
Sunset	5800
Valley Drive	5850
Washington Avenue	5900
YUCCA	5950
Zafarano	6100
Zepol	6150
Zia Road	8500

APPENDIX G: GOOGLE APPS SCRIPT

The text in red are comments, which do not influence the execution of the code. Comments are made above the respective code and only in the case of the introduction of a new task or function call.

```
function Add_Traffic_Graph() {

 var traffic = SpreadsheetApp.getActiveSpreadsheet();

 //generates popup box that asks for the name of the target spreadsheet
 var spreadsheet_name = Browser.inputBox("Input the name of the Google Spreadsheet with the data:");
 //searches all the files in Google Docs for the one with the name typed above
 var ss_list = DocsList.find(spreadsheet_name);

 //retrieves the unique doc id of the first result from the search
 var ss_id = ss_list[0].getId();
 //defines ss as the spreadsheet with the above id
 var ss = SpreadsheetApp.openById(ss_id);
 // sets ss as the active spreadsheet
 SpreadsheetApp.setActiveSpreadsheet(ss);

 //gets the sheet with the data, this is known as PRN because it is a converted prn
 var data_temp = ss.getSheetByName("PRN");

 //sets the active sheet back to the original sheet, the one with the chart
 SpreadsheetApp.setActiveSpreadsheet(traffic);
 //gets the sheet with the chart
 var chart_temp = traffic.getSheetByName("Chart");
 //sets the active sheet to the one with the chart
 SpreadsheetApp.setActiveSheet(chart_temp);
 //copies the sheet with the chart to the target spreadsheet
 SpreadsheetApp.getActiveSheet().copyTo(ss);
 //sets the target spreadsheet as the active spreadsheet
 SpreadsheetApp.setActiveSpreadsheet(ss);
 //finds the copied chart sheet in the target spreadsheet
 var chart = ss.getSheetByName("Copy of Chart");
 //sets the copied chart sheet as the active sheet
 SpreadsheetApp.setActiveSheet(chart);
 //renames the copied chart sheet to "Chart"
 SpreadsheetApp.getActiveSpreadsheet().renameActiveSheet("Chart");


 //in the sheet with data in ss, finds the last row with data
 var lastrow_data = data_temp.getLastRow();
 //defines the range of data, including the time axis, from the sheet with data
 var range = data_temp.getRange("D8:F"+lastrow_data);
 //gets the data
 var data = range.getValues();

 //sets the sheet with the chart as the active sheet
 SpreadsheetApp.setActiveSheet(chart);

 //is now the last row of the active sheet
```

```
  var lastrow_data = lastrow_data -6;

 //deletes all but the necessary rows from the sheet
  SpreadsheetApp.getActiveSheet().deleteRows(lastrow_data + 1, 400 - lastrow_data);
 //selects all the cells that will be replaced
  SpreadsheetApp.getActiveSheet().setActiveSelection("A2:C"+lastrow_data);
//replaces the selected cells with the data
  SpreadsheetApp.getActiveSheet().getActiveRange().setValues(data);
}
```
[50]

50 "Google Code: All Services," Google, http://code.google.com/googleapps/appsscript/allservices.html (accessed 4/25, 2011).

APPENDIX H: PLATFORM OUTLINE

Store Files

- File types
  - Spreadsheets
    - CSV
    - XLS
  - Images
    - JPEG
    - PNG
    - PDF
  - GIS
    - SHP
    - KML
  - Reports
    - DOC
    - PDF
    - PRN
    - Text
    - Other
- Easy access from anywhere
  - Share with other organizations
    - Give different permissions
  - Ability to edit and download data
    - Output to different file formats
- Automatic update of files

View Files

- GIS
  - View and edit layers
  - Link points on layer to reports and documents
- Spreadsheets
  - Charts and graphs
    - Updates automatically with editing spreadsheet
  - Display on websites
  - Produce reports
- Written Reports
  - PDF
  - DOC
  - Etc

Settings (customization) (user abilities)

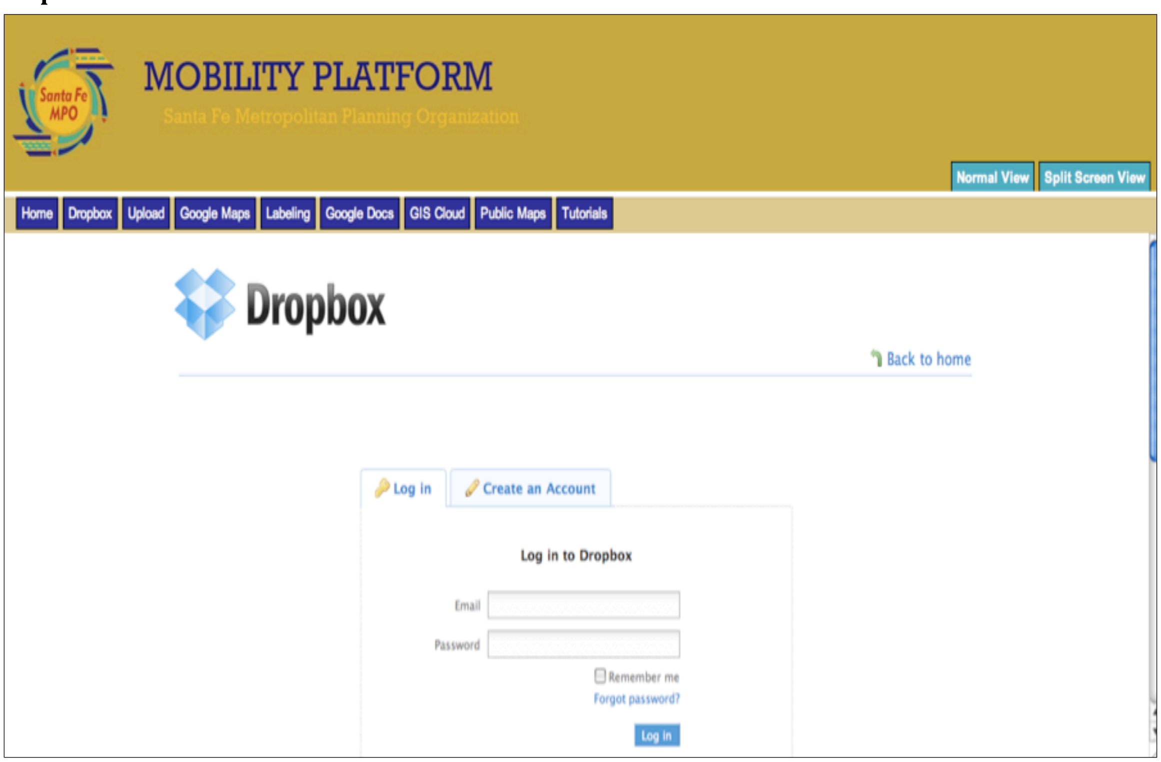
- Simple
  - Minimal editing of GIS layers
    - Simplistic adding of points and lines
  - Focus on viewing and organizing files
  - Simple system settings

    - No loss of capability to produce or output files
    - All options are presented in
- Advanced
    - Complex GIS layer editing
        - Near full capabilities
    - Change system settings
        - Automatic data gathering from organizations
        - Automatic file sending to websites and organizations

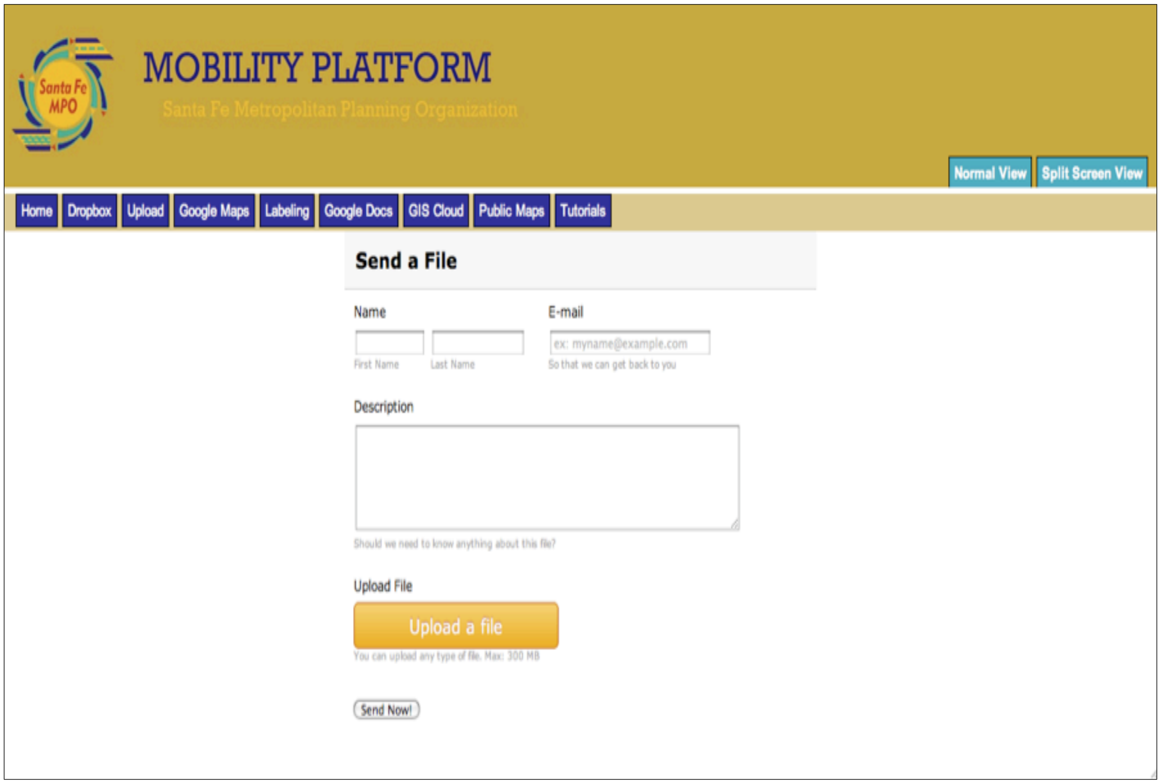
APPENDIX I: PLATFORM SCREENSHOTS

Home Page:

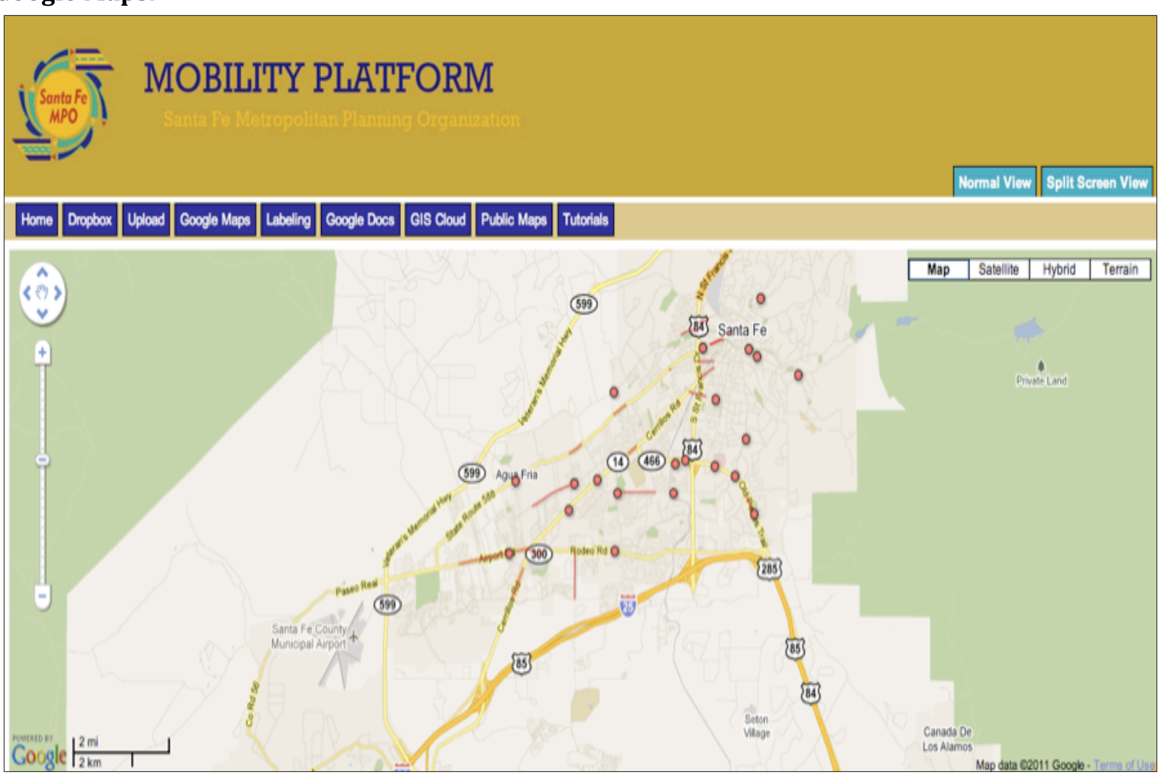
Dropbox:



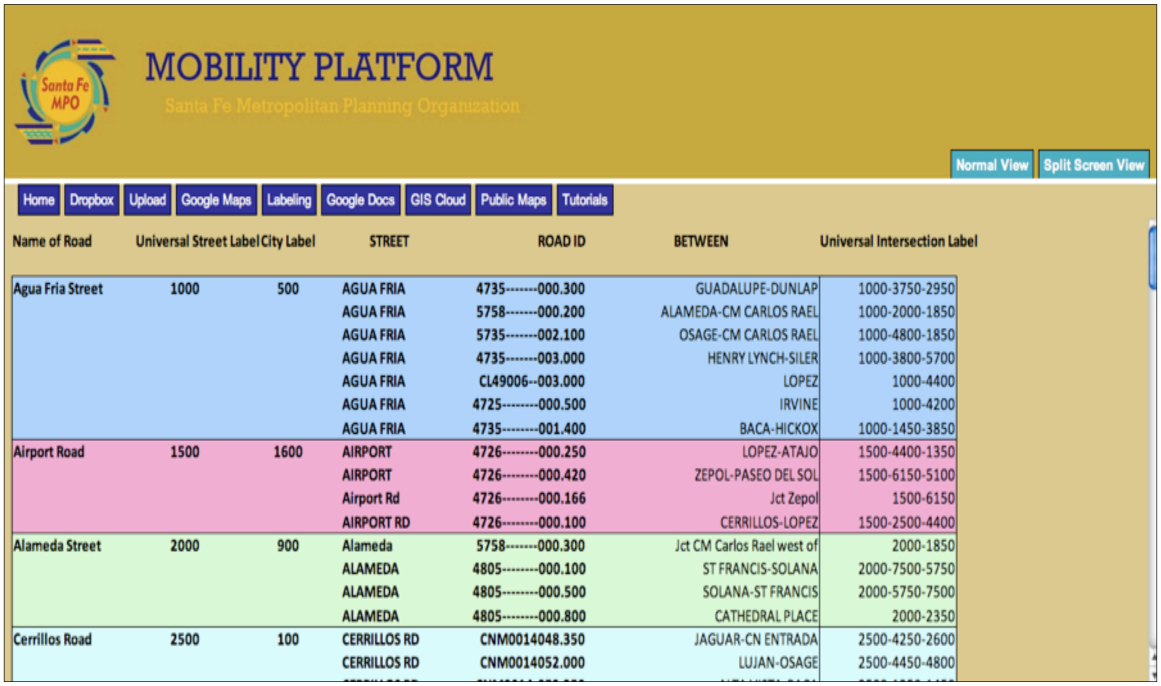
Upload Form:



Google Maps:

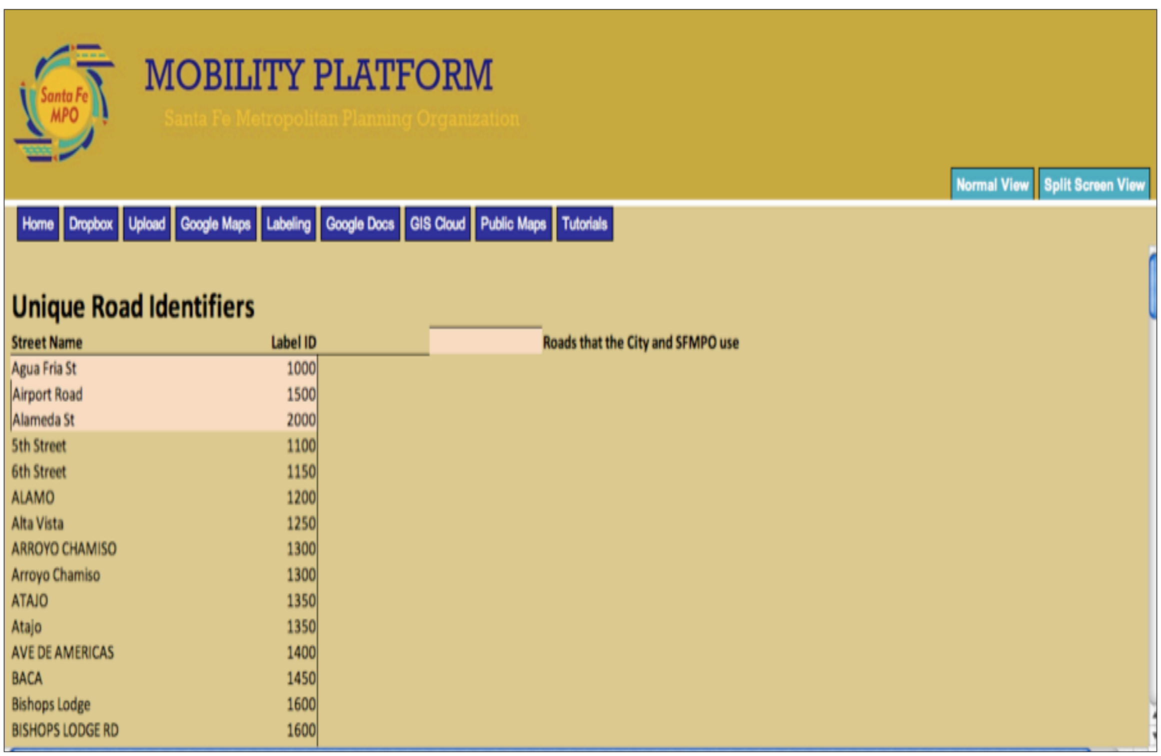


Labeling (Sheet 1):



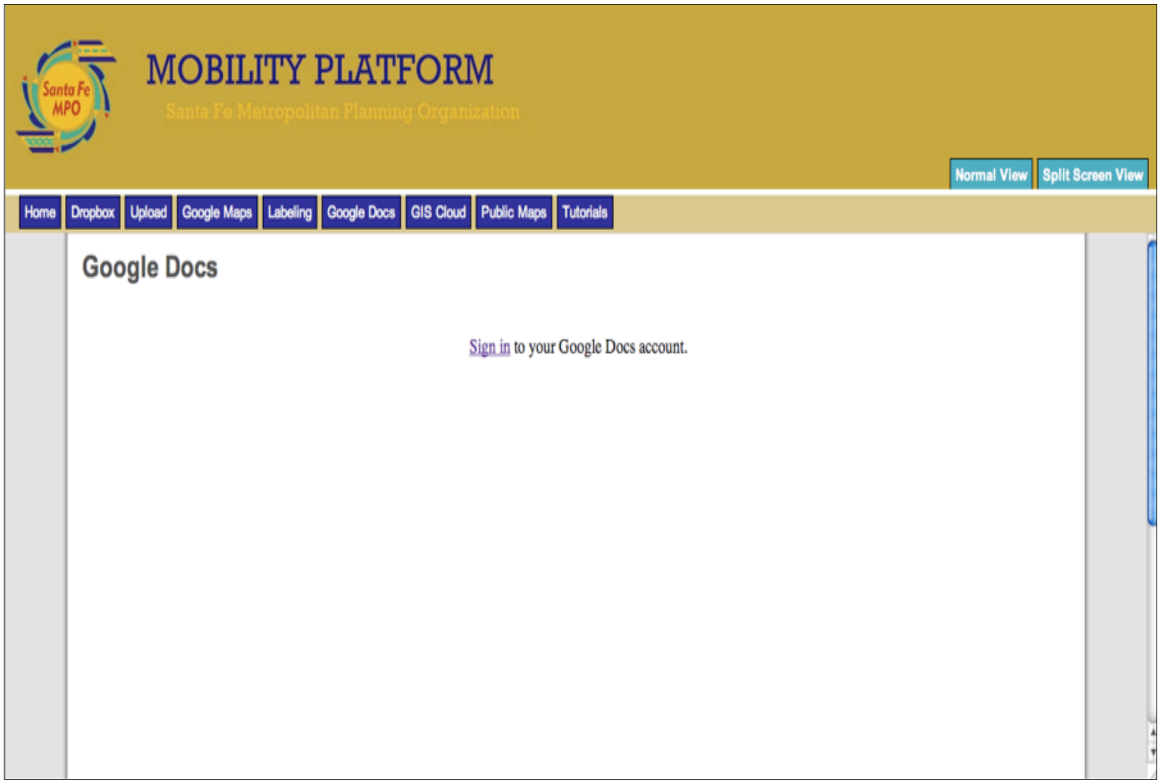
Name of Road	Universal Street Label	City Label	STREET	ROAD ID	BETWEEN	Universal Intersection Label
Agua Fria Street	1000	500	AGUA FRIA	4735-------000.300	GUADALUPE-DUNLAP	1000-3750-2950
			AGUA FRIA	5758-------000.200	ALAMEDA-CM CARLOS RAEL	1000-2000-1850
			AGUA FRIA	5735-------002.100	OSAGE-CM CARLOS RAEL	1000-4800-1850
			AGUA FRIA	4735-------003.000	HENRY LYNCH-SILER	1000-3800-5700
			AGUA FRIA	CL49006--003.000	LOPEZ	1000-4400
			AGUA FRIA	4725--------000.500	IRVINE	1000-4200
			AGUA FRIA	4735--------001.400	BACA-HICKOX	1000-1450-3850
Airport Road	1500	1600	AIRPORT	4726--------000.250	LOPEZ-ATAJO	1500-4400-1350
			AIRPORT	4726--------000.420	ZEPOL-PASEO DEL SOL	1500-6150-5100
			Airport Rd	4726--------000.166	Jct Zepol	1500-6150
			AIRPORT RD	4726--------000.100	CERRILLOS-LOPEZ	1500-2500-4400
Alameda Street	2000	900	Alameda	5758-------000.300	Jct CM Carlos Rael west of	2000-1850
			ALAMEDA	4805--------000.100	ST FRANCIS-SOLANA	2000-7500-5750
			ALAMEDA	4805--------000.500	SOLANA-ST FRANCIS	2000-5750-7500
			ALAMEDA	4805--------000.800	CATHEDRAL PLACE	2000-2350
Cerrillos Road	2500	100	CERRILLOS RD	CNM0014048.350	JAGUAR-CN ENTRADA	2500-4250-2600
			CERRILLOS RD	CNM0014052.000	LUJAN-OSAGE	2500-4450-4800

Labeling (Sheet 2):

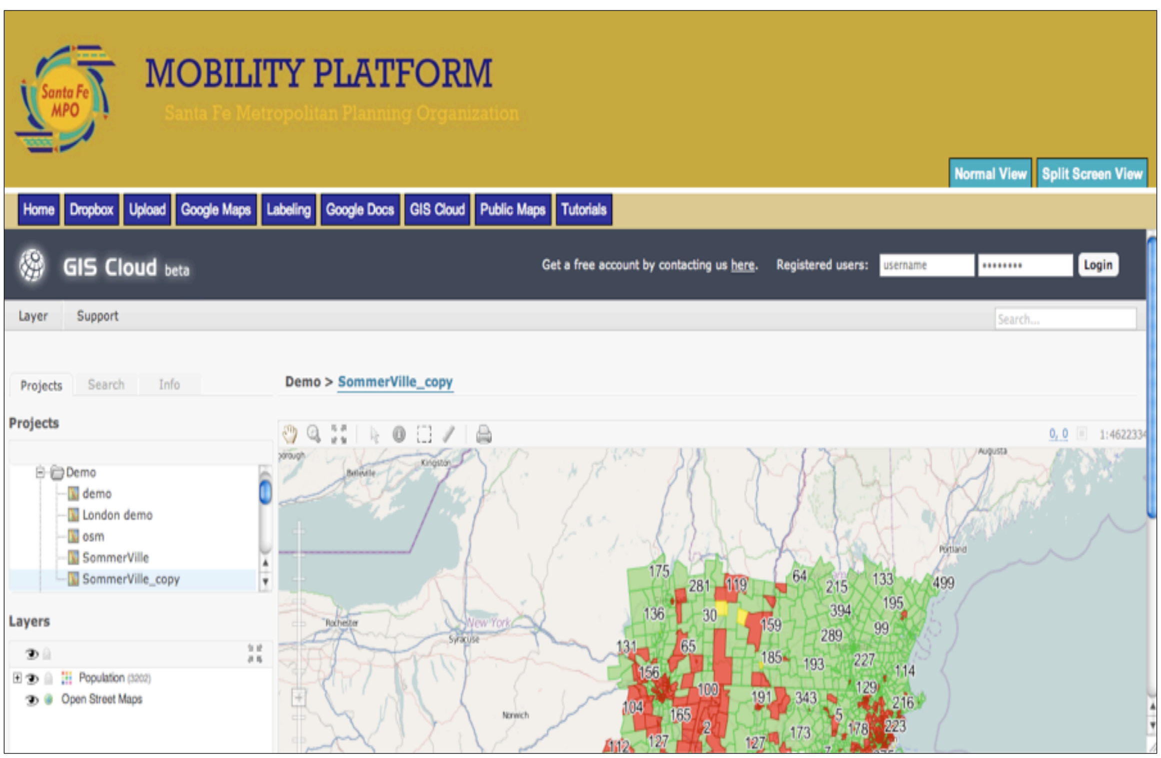


Street Name	Label ID
Agua Fria St	1000
Airport Road	1500
Alameda St	2000
5th Street	1100
6th Street	1150
ALAMO	1200
Alta Vista	1250
ARROYO CHAMISO	1300
Arroyo Chamiso	1300
ATAJO	1350
Atajo	1350
AVE DE AMERICAS	1400
BACA	1450
Bishops Lodge	1600
BISHOPS LODGE RD	1600

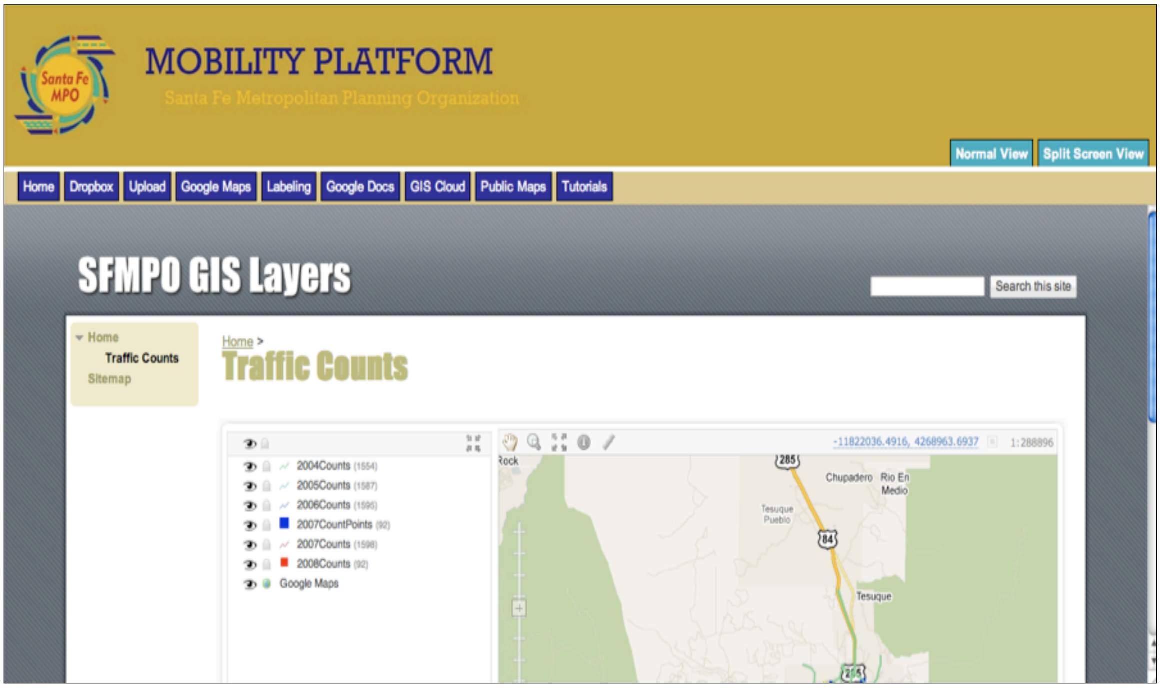
Google Docs:



GIS Cloud:

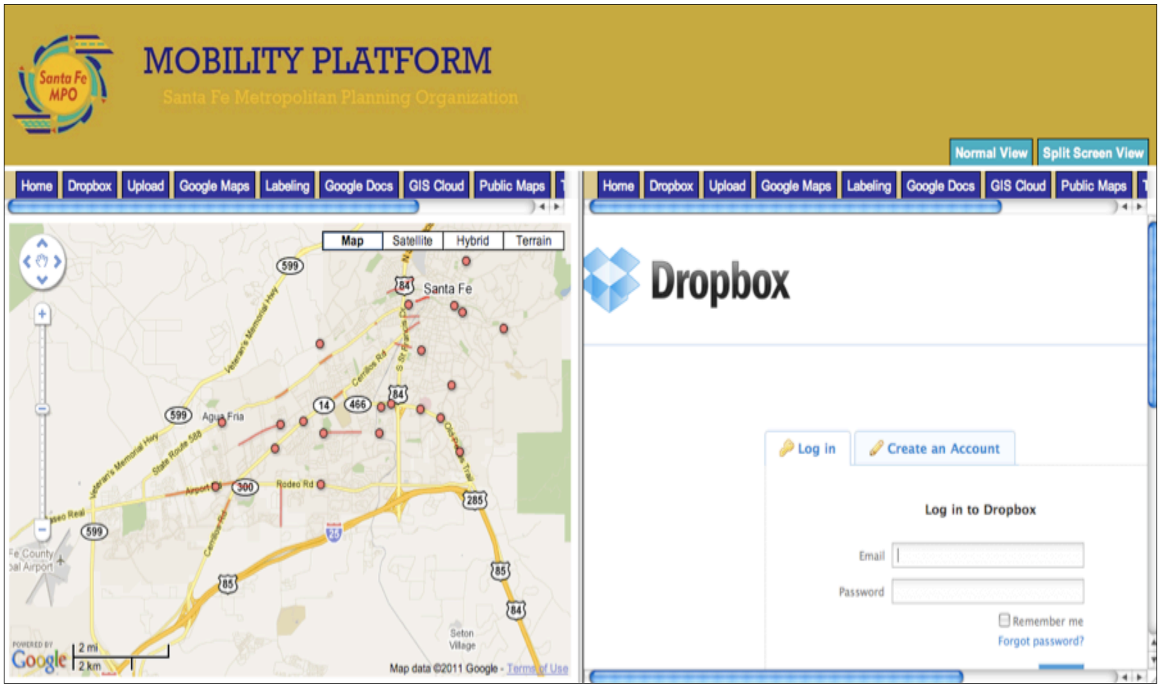


Public Maps:



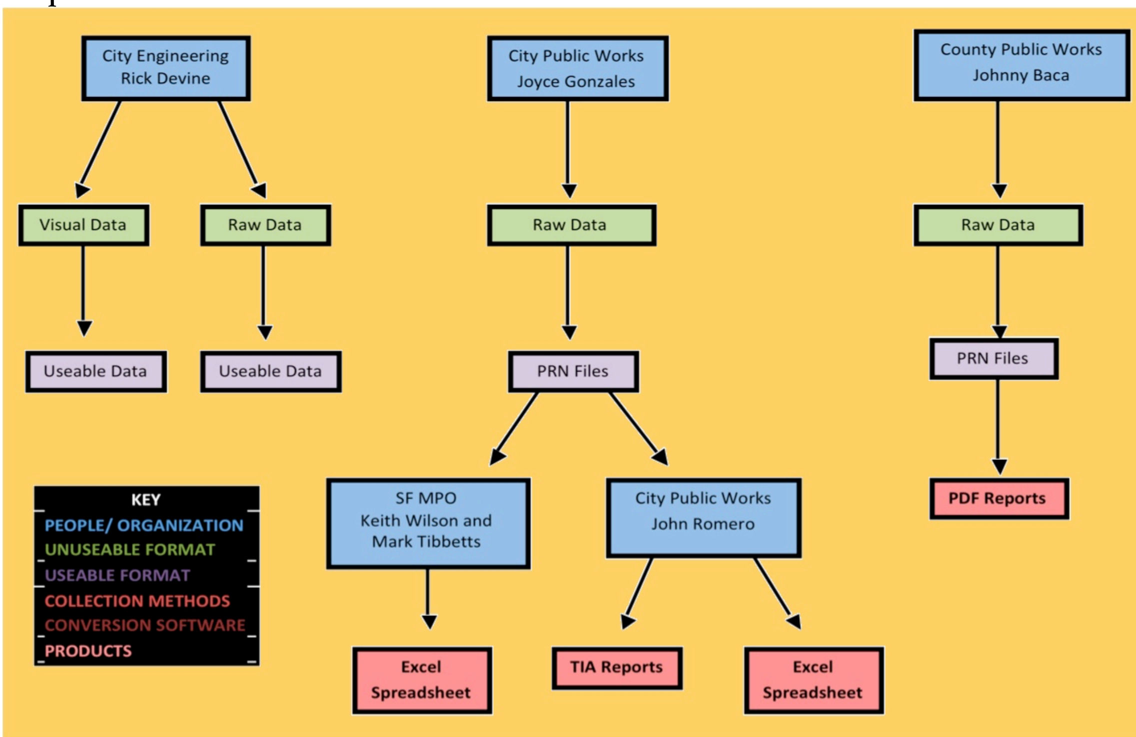
Tutorials:

Split Screen View:

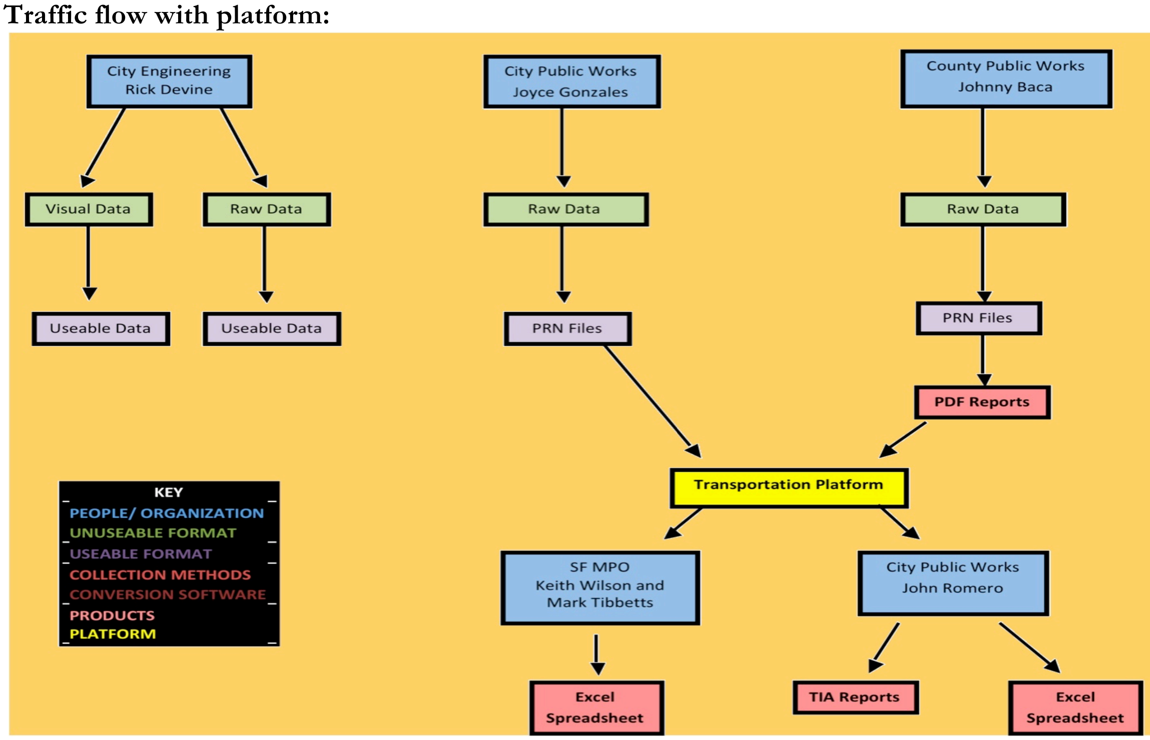


APPENDIX J: FLOW CHART OF TRAFFIC DATA

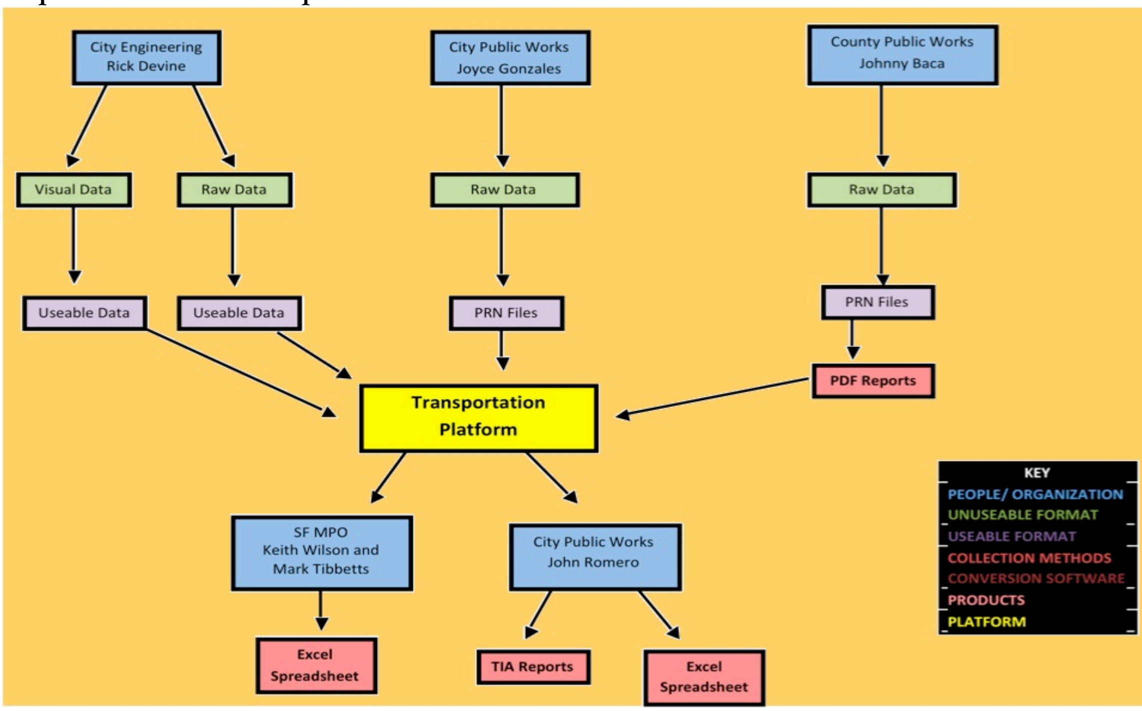
Pre-platform data flow:



Traffic flow with platform:



Proposed data flow with platform:



APPENDIX K: ACRONYMS

AADT – Average Annual Daily Traffic
ABM – Agent-Based Modeling
ADT – Average Daily Traffic
CHDB – Consolidated Highway Database
CSV – Comma Separated Values file
DOC – Word Document file
DOCX – Word Document file (used with Windows Vista and newer)
GIS – Geographical Information Systems
ITS – Intelligent Transportation Systems
JPEG – Joint Photographic Expert Group file
KML – Keyhole Markup Language file
LOS – Level of Service
NMDOT – New Mexico Department of Transportation
PCX – Personal Computer Exchange file
PDF – Portable Document Format file
PRN – Printer Text file
SFMPO – Santa Fe Metropolitan Planning Organization
SHP – Shape file
TAZ – Traffic Analysis Zones
TIA – Traffic Impact Analysis
TIP – Transportation Improvement Plan
UPWP – Unified Planning Work Program
XLS – Excel Spreadsheet file
XLSX – Excel Spreadsheet file (used with Windows Vista and newer)