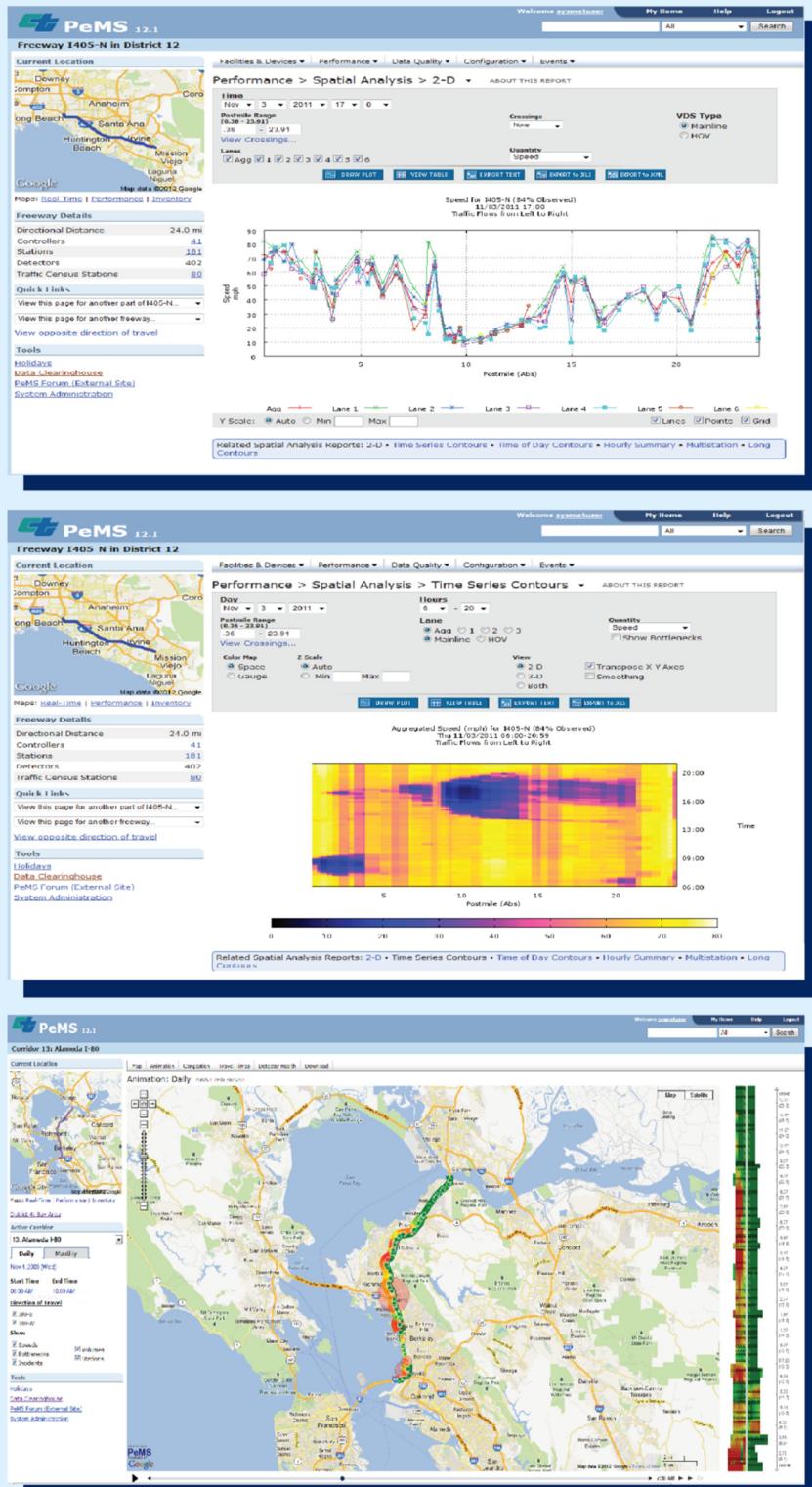


PeMS User Guide

An Introduction to the California Department of Transportation Performance Measurement System (PeMS)



May 2013

PEMS USER GUIDE

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Chapter 1

Introduction to PeMS

CHAPTER 1

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This manual serves as a basic introduction to the California Department of Transportation (Caltrans) Performance Measurement System (PeMS). This manual is intended to be a resource for new users who need help in using PeMS for the first time, as well as existing users who need some additional guidance. This manual does not cover every single report or feature within PeMS, but it does provide basic information about what types of data can be found in PeMS, and how to access these data. As PeMS was first developed as a freeway analysis tool, and the majority of the data available in PeMS is from freeways, this manual focuses on freeway data and analysis. It briefly touches on other data sets that are becoming available in PeMS.

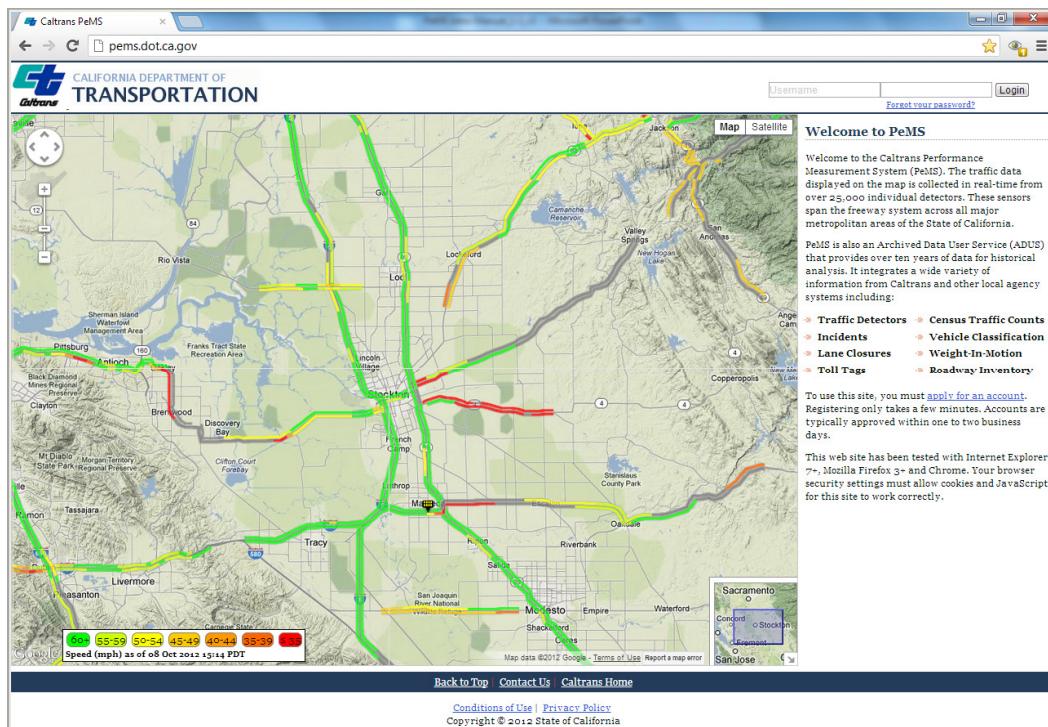
Please note that the PeMS support team in the Caltrans Division of Traffic Operations in Sacramento is available to answer additional questions and provide additional assistance. Their contact information is as follows: Jane Berner, jane.berner@dot.ca.gov or 916-654-2843, and Tim Hart, timothy.hart@dot.ca.gov or 916-651-5324.

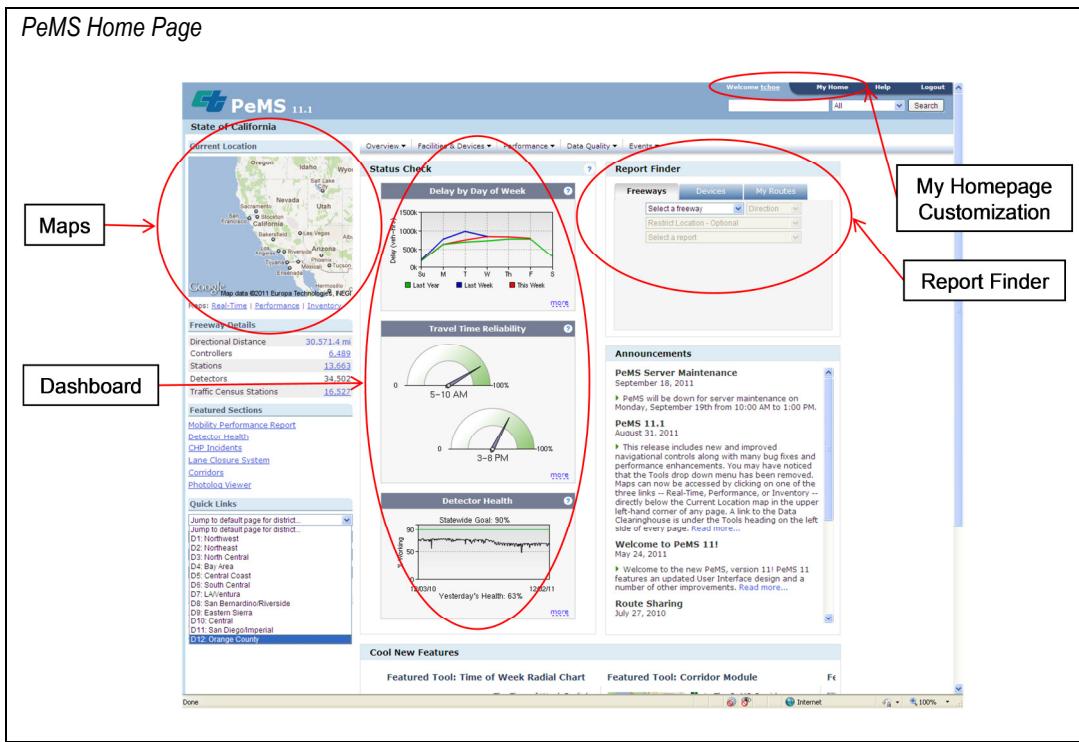
This chapter presents an overview of PeMS and provides basic guidance on system navigation. Users will learn what PeMS is and how it works to have a better understanding of how this tool can help with freeway performance analysis.

I. About PeMS

PeMS provides access to real-time and historical performance data in many useful formats and presentation styles to help managers, engineers, planners, and researchers understand transportation performance, identify problems, and formulate solutions. With PeMS, users can conduct a uniform and comprehensive assessment of freeway performance, base operational decisions on knowledge of the current state of the freeway network, analyze congestion bottlenecks to determine potential remedies, and make better overall decisions.

PeMS utilizes a web-based interface that allows anyone with an Internet connection and a standard web browser (e.g., Microsoft Internet Explorer, Mozilla Firefox, and Google Chrome) to access the system. There is no charge to use PeMS. However, users are required to establish an on-line account through the PeMS homepage at <http://pems.dot.ca.gov>.





What is PeMS?

Caltrans PeMS is a software tool designed specifically for Caltrans. It is the centralized repository for all of Caltrans' real-time traffic data, enabling easy access to these data that might otherwise be dispersed across multiple districts and more difficult to obtain. PeMS provides a consolidated database of traffic data collected by Caltrans placed on state highways throughout California, as well as other Caltrans and partner agency data sets. The data collected by vehicle detectors are relayed from the field to Caltrans Transportation Management Centers (TMCs) and then sent to PeMS. In more technical terms, PeMS is a real-time Archive Data Management System (rt-ADMS) that collects, stores, and processes raw data in real-time. PeMS can be accessed via a standard Internet browser and contains a series of built-in analytical capabilities to support a variety of uses.

FACT CHECK

- PeMS started in 1999 as university research project
- Now deployed statewide across California
- Over 35,000 detectors report data every 30 seconds
- Currently has over 12TB of data
- Data is stored from inception (detector added) and never deleted



PeMS gets its data from:

Intelligent Transportation System (ITS) Vehicle Detector Stations (VDS)

Traffic Counters

- Traffic Census Stations
- Weight-In-Motion (WIM) Sensors

Other Data Sets

- California Highway Patrol (CHP) Incident data

- The Caltrans Traffic Accident Surveillance and Analysis System (TASAS) accident data (for Caltrans users only)
- The Caltrans Photolog
- Lane Closure information from the Caltrans Lane Closure System
- Electronic Toll Collection (ETC) Reader data (Bay Area only)
- Changeable Message Signs (real-time information only)
- Arterial Detector data and Timing Plans (limited data in District 11)
- Transit data such as routes and schedules, Automated Vehicle Location (AVL) and Automated Passenger Count (APC) data (limited data in District 11)

Why Use PeMS?

PeMS allows users to query freeway traffic data (both current and archived), compute freeway performance measures, and conduct various analyses. Users can view summary reports on current freeway conditions, past system performance, detection system health, and incidents. Various performance data are available, such as volumes, speeds, delay, vehicle miles traveled (VMT), vehicle hours traveled (VHT), travel times, and annual average daily traffic (AADT). The data can be used for simulation model input and for completing Project Study Reports and other types of transportation planning and analysis documents. Users can compute performance measures for model calibration, verification of external study findings, and assessment of overall traffic conditions to determine appropriate operational or capital improvements. PeMS can assist with conducting simple to advanced traffic analyses, including Highway Capacity Manual analyses, Synchro analyses, and computer simulation. In summary, PeMS can help provide valuable evidence of actual traffic conditions that will lead to project recognition, support, approval, and funding.

Below are some examples of what PeMS can do.

- Computes standard transportation performance measures, such as VMT, VHT, Delay (expressed in vehicle-hours), and Level of Service (LOS)
- Calculates travel time and travel time reliability measures, such as the Buffer Time Index, Travel Time Index, and other descriptive statistics
- Produces summary reports, such as locations with low traffic flow or high VMT over several years
- Imputes (i.e., uses an algorithm to approximate) data for missing or bad detector data in real-time
- Provides speed as reported by detectors, or computed speed (using an algorithm) based on flow and occupancy if the detector does not report speed
- Enables exporting of data in several formats including plots, HTML tables, CSV text files, and XLS spreadsheets
- Supports integration with common Internet-based mapping services (e.g., Google Maps, Google Earth)
- Computes special performance measures (e.g., travel time ratio, VMT ratio) by vehicle occupancy for managed lane facilities (i.e., High Occupancy Vehicle lanes) through a managed lanes interface
- Allows users to incorporate incidents from third-party sources through a modular framework
- Identifies bottlenecks through a special algorithm that can spot and quantify recurrent congestion
- Provides animated graphics to help visualize freeway conditions, including incidents, for any day in the past when data was being collected
- Supports engineering analyses, such as the identification of bottlenecks, non-recurrent congestion, and traffic safety problems
- Supports special applications including managed facility performance measures, Lane Closure System (LCS) analysis, Corridor System Management Plan (CSMP) analysis, and in some cases arterial and transit system analysis.

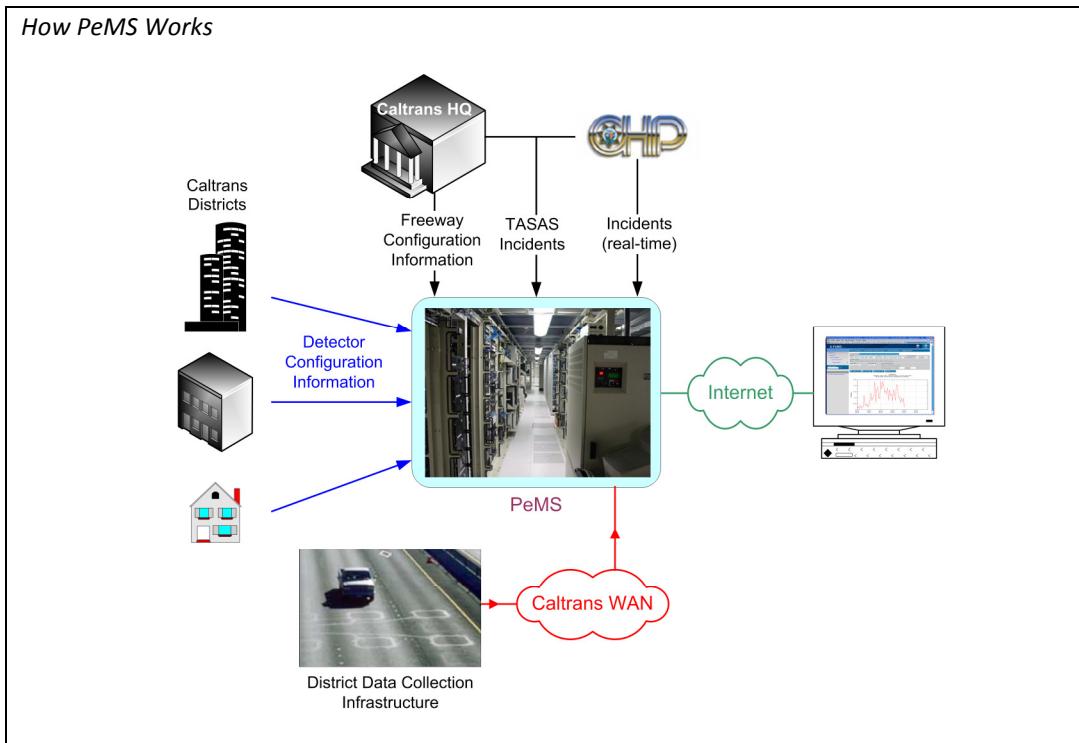
How Does PeMS Work?

PeMS collects data from various types of vehicle detector stations, including inductive loops, side-fire radar, and magnetometers. To explain how the data flow from the field into PeMS, we will provide an example using

inductive loops, the most common type of detection device currently used by Caltrans. A machine in a cabinet at the side of the road (a controller) records data from loops installed at specific locations on the freeway. The machine senses when vehicles travel over the loops by reading the number of times (flow) and for how long the inductance of the loops changes (occupancy). The controller sends this information to the District TMC via modem every 30 seconds.

At the TMC, a Front End Processor (FEP) collects the data from the controllers. Then, a router sends the data via the Caltrans Wide Area Network (WAN) to PeMS. This data is the primary traffic data in PeMS.

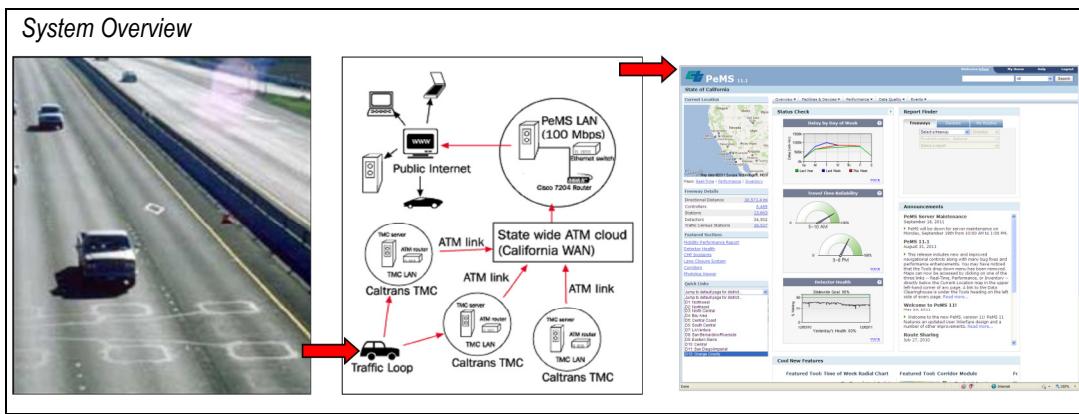
The PeMS database integrates other data sets to make the sensor information particularly useful for managers, planners, and engineers. Caltrans Districts provide the detector configuration information (i.e., location and detector identification numbers). Caltrans Headquarters provides freeway configuration information (i.e., number of lanes and postmiles), as well as other data such as TASAS data (i.e., number of collisions and types of collisions), Lane Closure System data, and Caltrans Photolog. In addition, the CHP provides incident data from its computer-aided dispatch (CAD) system. Collectively, these data make up the PeMS database.



II. Overview of PeMS

System Overview

As described in the previous Section, the primary data source is the vehicle detector stations (VDS), providing real-time flow and vehicle occupancy data that are used to calculate multitude of performance measures and produce various reports. In order to accurately calculate and present roadway segment lengths, PeMS converts Caltrans postmiles into absolute postmiles to compute distances between detectors. In addition, actual data from a VDS can often have gaps (missing data sets, errors, etc.) when they malfunction, stop working, or cease sending data. Since performance measures cannot be estimated without complete set of data, PeMS uses its various algorithms to estimate for these data gaps. As such, PeMS reports include calculations from a mixture of actual data and PeMS estimated or imputed data. Explanations of absolute postmiles and system calculations are provided below.



Absolute Postmile

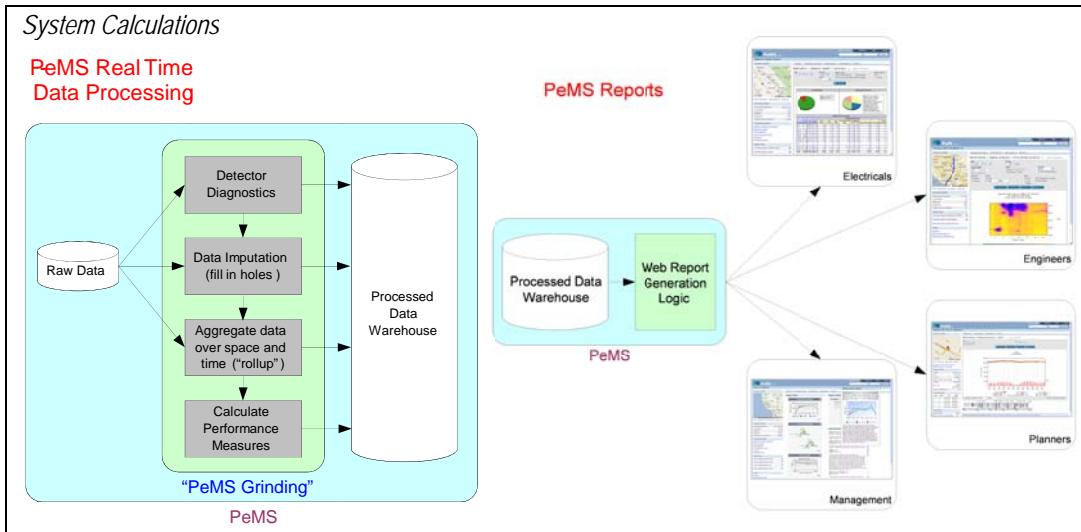
PeMS uses postmiles to measure locations on state highways. The system uses two types of postmiles: jurisdictional (Caltrans) postmiles and absolute postmiles. Caltrans postmiles are assigned to physical boxes and geometric features on freeways when they are built. Caltrans postmile re-set to zero at every county line. Once these postmiles are assigned, they do not change except in the areas where there is an alignment change. This means that when freeways are lengthened or shortened through reconstruction, the postmiles downstream and upstream of the construction area are not changed – even though the distance from the county line has changed. Instead, equations are used, from which true distance can be determined. The PeMS system converts Caltrans postmiles into ***absolute*** postmiles. Absolute postmiles reflect the actual distance along a freeway from its beginning to its terminus. These postmiles change as the length of the freeway changes. PeMS uses absolute postmiles to compute the distances between detectors.

System Calculations

The automated detectors deployed around the state that report data to PeMS measure the amount of time it takes for a vehicle to pass over them. This measure is called occupancy. PeMS takes occupancy and uses it to calculate other performance measures, such as speed and delay.

To calculate speed, it is necessary to know distance and time. PeMS measures the length of time a detector is activated when a vehicle passes over it. To estimate the speed, PeMS needs the length of the vehicle. This length must be calculated using real-world data because detectors vary in tuning and each lane has a different composition of traffic. The result of these calculations is called the g-factor. PeMS calculates a g-factor for each

detector and for each time of day. With the g-factor and the time measured by the sensor, PeMS calculates the speed and summarizes the estimated speeds over time and space.



Data Diagnostics and Data Imputation

Individual detectors (e.g., loops) or detector stations (VDS) occasionally malfunction, stop working, or cease sending data. These errors can occur for various reasons, including faulty connections, loss of communications, or controller malfunctions. Whenever these errors occur, there are gaps in the data set. Performance measures cannot be estimated without a complete set of data – at least not without significant inaccuracies.

To account for these detection errors, PeMS conducts diagnostic tests to determine whether or not detectors are working. PeMS considers detectors to be working if certain criteria are met. If detectors are not providing “good” data or data is missing, PeMS estimates data (in order to calculate performance measures) using a process called data imputation. The process includes comprehensive algorithms to fill gaps in the dataset with accurate estimates.

There are four main imputation methods. These methods are applied in the following standard order until valid data is produced:

- *Linear regression from neighbors based on local coefficients* - Data gaps are filled using information from the detectors in neighboring lanes at the same location and from detectors in locations immediately upstream and downstream.
- *Linear regression from neighbors based on global coefficients* - When PeMS determines that some detectors never report reasonable data, the system looks at general relationships in the detector data throughout the district to fill in gaps.
- *Temporal medians* - PeMS looks at data values at similar times and days of week over a long period of time. The medians of those data values are used to fill gaps.
- *Cluster medians* - PeMS examines data from detectors with similar traffic patterns over a typical week to fill data gaps.

Once PeMS finishes compiling the 30-second data sets without any gaps, the data is aggregated or “rolled up” into 5-minute increments. PeMS uses this information to calculate certain performance measures, so the information is readily available when requested by users. The processed data is stored on PeMS servers. Less commonly used measures are not pre-processed and may take several minutes to calculate when requested by users.

III. Basic Navigation

In this section, users will learn how to access PeMS and be introduced to basic navigation features. As with most software tools, it is necessary to practice before one becomes fully proficient with the many features and navigational options available in PeMS. This section highlights some basic ways to find the various features and reports available. In many cases, PeMS has several ways to get to the same reports and users are encouraged to explore different options and decide which method they prefer.

Items Needed to Access PeMS

- Computer (desktop, laptop, tablet) with keyboard or mouse/touchpad
- Internet connection (cable or WiFi – faster connection is better)
- Internet browser (current version of Microsoft Explorer, Mozilla Firefox, Google Chrome, etc.)



Some Key Terminology

- *Home page* – opening page of a web site
- *PeMS home page* – opening page of the PeMS web site
- *District home page* – opening page of a District PeMS web site
- *Pull down menu* – also called a drop-down menu; a menu of options that appears when you select an item from the menu bar at the top of the display screen; goes to another web page when an option is selected
- *Link or hyperlink* – graphic or piece of text that goes to another web page
- *Tab* – another layer or level of content on the web site; goes to that active tab level when selected

PeMS Access

Using an Internet browser, type in the web site address (URL) <http://pems.dot.ca.gov/>.

This will bring up the PeMS Access Log-in page (rather than the PeMS home page). At the PeMS Access Log-in page, type in a Username and Password. An account may be established by clicking on the **apply for an account** link and filling in the requested fields (Name, E-mail Address, Company/Institution Name, and Reason for Use). Users must read and agree to the PeMS terms of use. Once a new account has been approved, the system will send a confirmation email along with a password for accessing the system to the new user. That user can then access PeMS.

Once users type their Username and Password in the designated boxes in the upper right-hand corner of the PeMS Access Log-in page, they will be logged in and taken to the PeMS home page. Once logged in, users can edit their account information by clicking on their username link at the top right of the screen. This takes users to their account maintenance page, where they can select **Edit Profile** or **Change Password**.

PeMS Navigation Guide

At the end of this Chapter is the PeMS Navigation Guide. It is an illustrative example for how to start using PeMS. It provides some step-by-step guide to basic navigation, including logging in, understanding the PeMS home page, navigating to a district home page and accessing freeway data. It does not provide instructions for all possible navigational methods. Users are encouraged to use the Help features in PeMS and participate in the PeMS Forum to attain more information on using PeMS to its full capabilities.

IV. Help Resources

In this section, various PeMS help resources are presented and described.

Help (link)

PeMS provides help resources so users can better navigate and utilize the system. Any user logged into PeMS has access to these resources. At the top right of the screen, between My Home and Logout, there is a link to the **Help** page. The **Help** page provides a list of subject areas from which users can choose to obtain more information. There is also a Frequently Asked Questions (FAQ) and Glossary that can be accessed from this Help page that answer many basic questions.

The screenshot illustrates the PeMS 11.1 interface with two main views of the 'Help' resource.

Top View: Shows the main PeMS dashboard. A red box highlights the 'Help' link in the top navigation bar. Another red box highlights the 'Help' link in the sub-navigation bar below the main menu. A red arrow points from the top 'Help' link to the bottom 'Help' link.

Bottom View: Shows the 'Help' page content. A red box highlights the 'Help' link in the top navigation bar. The page content includes sections like 'Introduction', 'System Calculations', 'Common Analysis', 'Frequently Asked Questions (FAQ)', and 'Glossary'. A sidebar on the left lists links such as 'Methodology', 'Topics', 'Reference', 'Conditions of Use', and 'Value Added Resellers'.

About This Report

When users access PeMS to obtain summary statistics, there is a link next to the title of the data being shown called **About This Report**. This link provides details about how the data in that specific report page are calculated.

The screenshot shows two views of the PeMS 11.1 interface. The top view is a 'Time Series' plot for Mainline VDS 1201100 - IRVINE C1. It displays flow data over time with a red arrow pointing to the 'ABOUT THIS REPORT' link in the top right corner of the header. The bottom view is a detailed 'About This Report' page for the same location, with a red arrow pointing to the 'About This Report: Aggregates' section. Both views include a map of the Irvine area and various configuration options like date ranges and lane selection.

PeMS Forum

PeMS also provides an online forum for users to ask questions about the system, share tips on how to use it better, recommend improvements to PeMS functionality, and connect with other users with similar data needs. The **PeMS Forum** is available at <http://pemsforum.dot.ca.gov/>. Users can also access the PeMS Forum from the link on the PeMS homepage. Click to the PeMS Forum (External Site) link under Tools on the PeMS home page.

PeMS Forum

The screenshot shows the PeMS Forum interface. On the left, a sidebar titled "Tools" lists "Holidays", "Data Clearinghouse", and "PeMS Forum (External Site)". The "PeMS Forum (External Site)" link is circled in red. A large arrow points from this circled link to the main content area. The main content area displays the PeMS 11.1 dashboard for the State of California. It includes a map of California, a "Status Check" section with a line graph showing "Delay by Day of Week" (Last Year, Last Week, This Week), a "Travel Time Reliability" chart, a "Detector Health" chart, and a "Report Finder" section. Below these are "Announcements" and "Cool New Features". At the bottom, there's a "Corridor Module- Congestion: Overview" section showing a map of Orange County, SR-91, and a grid-based congestion overview.

Conditions of Use (Caltrans Terms of Use)

At the bottom of the PeMS home page, there is a link titled **Conditions of Use**. Clicking on this text link will open the Caltrans Terms of Use and Use Policy information. By visiting the PeMS web site, users are accepting the policies and practices described in the Terms of Use. This Terms of Use covers the following topics:

- Personal Information and Choice
- A Special Note about Children
- Information Collected and How it is Used
- What Happens to Information You Submit to Us
- Use of Internet Request for Assistance Form Information
- Surveys
- If You Send Us E-mail
- Order Forms
- Public Disclosure
- Automatic Collection of Information/Cookies
- Security
- Links to Other Sites
- Limitation of Liability
- Ownership

Please note that this Use Policy is subject to change without notice, and that it reflects the State's current business practices. This Use policy is dated December 7, 2000. Also note that each department within the State may have additional privacy and use policies specific to the mission and needs of their work.

Contact (Contact Us and Email Technical Support)

Users can contact PeMS technical support and provide feedback or ask questions by using the **Email Technical Support** link at the bottom of any PeMS page. Just click on the link and a pop-up window will appear where feedback/questions may be entered. Please be as specific as possible when entering a question so that the support team will fully understand the issue. Users can also email the PeMS Program Manager at Caltrans Headquarters by clicking on the **Contact Us** link on the PeMS Access Log-in page.

PeMS Navigation Guide

Instructions for accessing PeMS and navigating to the starting pages of the most commonly used PeMS reports are presented here. The main purpose of the illustrations in this section is to provide a few examples of how to get around in PeMS and demonstrate the variety of resources available in PeMS. There are often several ways to access the same pages in PeMS. Users are encouraged to try out on their own or with others the many different ways to navigate within PeMS and query different types of reports.

For illustrative purposes, District 12: Orange County was selected to provide some of the examples for district home page, facilities, and devices. To access performance measures, this guide uses the Freeways inventory listing under the Facilities & Devices pull down menu in order to navigate to reports. While other navigational tools, such as the Inventory Map or the Report Finder, can sometimes be faster options for accessing reports, the Freeways inventory is primarily used here for consistency and to build a standardized routine for new users. If users ever forget the short cuts that they have learned, they can always rely on this standard navigational approach.

Below is an example of the illustrations shown in this navigation guide, and in other illustrative pages of this manual. Please review and familiarize it in order to understand how this guide is presented. Each illustration includes series of steps to follow in order to successfully navigate to a particular page or report.

HOW TO USE THIS GUIDE

1. In Mainline VDS 1201100 – IRVINE C1 page,
Move mouse pointer to Performance > Planning Analysis > AADT
(click AADT)

Topic
Subtopic
PeMS location

2. Select Jan 2009 under From **3.** Select Jan 2011 under To

Highlighted pull-down menu

4. Click VIEW TABLE

Steps to follow or description

Starting Month	CA Avg.	VDS Name	Type	Arithmetical Mean	ASTM Std.	Cared.	Prop.	Sum of Annual Avg.	Mod. Avg.	Mod. Conv.	Mod. Prev.	% Data Used
01/01/2009	1405.9	93.0	1201100	IRVINE Mainline C1	75.032	75.315	75.313	75.474	75.314	75.315	75.315	75.474
02/01/2009	1405.9	93.0	1201100	IRVINE Mainline C1	74.654	75.289	75.299	75.081	75.440	75.289	75.289	75.361
03/01/2009	1405.9	93.0	1201100	IRVINE Mainline C1	75.694	75.371	75.472	75.511	75.578	75.371	75.472	63.6794
04/01/2009	1405.9	93.0	1201100	IRVINE Mainline C1	75.320	75.536	75.536	75.430	75.731	75.536	75.536	63.6411
05/01/2009	1405.9	93.0	1201100	IRVINE Mainline C1	75.397	75.605	75.603	75.114	75.766	75.603	75.605	62.6827
06/01/2009	1405.9	93.0	1201100	IRVINE Mainline C1	75.381	75.741	75.741	75.840	75.744	75.741	75.741	75.840
07/01/2009	1405.9	93.0	1201100	IRVINE Mainline C1	75.128	75.887	75.887	75.887	75.887	75.887	75.887	74.8872
08/01/2009	1405.9	93.0	1201100	IRVINE Mainline C1	74.915				75.724	75.695	74.936	75.695
09/01/2009	1405.9	93.0	1201100	IRVINE Mainline C1	74.840				75.722			60.835
10/01/2009	1405.9	93.0	1201100	IRVINE Mainline C1	74.691				75.746			55.6880
11/01/2009	1405.9	93.0	1201100	IRVINE Mainline C1	74.912				75.591			53.872
01/01/2010	1405.9	93.0	1201100	IRVINE Mainline C1	75.616				75.616			52.6772
02/01/2010	1405.9	93.0	1201100	IRVINE Mainline C1	75.918				76.207			49.6833

As shown, the table presents the AADT for each month from January 2009 to the last available data for AADT at this station. The AADT_1 (Arithmetic Mean) is about 75,000 for data available in 2009 and 2010. Note that for the other methods there is insufficient data points (note % Data Used column) to calculate their values; hence they are shown blank.

Enter parameter input value per step instruction

Plot or Table query result

Data report summary and discussion points

Section I – Freeway Station Level Analysis 4-I-9 Chapter 4 (PeMS Example 1)

Section number
Page no. (Ch-Sec-#)
Chapter number

Section III – Basic Navigation

14

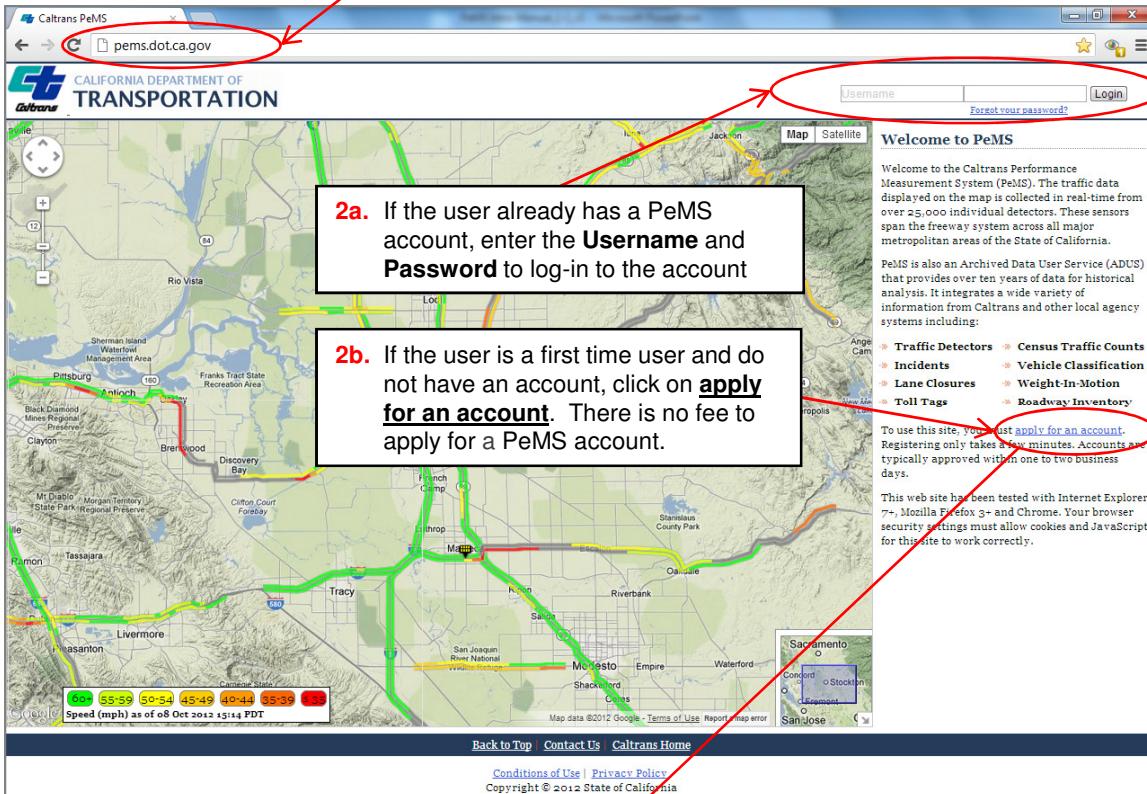
Chapter 1 (PeMS Example)

Navigating PeMS PeMS Access

PeMS Log-in (<http://pems.dot.ca.gov>) page

PeMS Access (Account Log-In)

- 1.** In the user's Internet browser address window, type in the PeMS web site address: **<http://pems.dot.ca.gov>**



Apply for an Account

All pages on this site, other than the front pages, are restricted to users with valid accounts. Please fill out the following application to obtain a user account. Account applications are reviewed within 1-2 business days by project personnel. Once approved, you will receive a computer-generated password via email (you can change it to something more of your liking once you log in).

Our policy is to provide web accounts for all users, including members of the public, academia, private firms and public institutions. Some account features are restricted to users with valid Caltrans email addresses. If you have any questions regarding account types, or account approval practices, please contact [Jane Berner](#) at Caltrans.

Value Added Reseller

If you are a Value Added Reseller and you'd like to get the real-time data feed from Caltrans then please contact [Jane Berner](#) at Caltrans via email and get approval. You can not extract the real-time data via the web site. Please read the terms of use for the site for details.

To apply for an account, please enter some information about yourself. Upon account approval your password will be sent to the given e-mail address.

First Name	Last Name
<input type="text"/>	<input type="text"/>
E-Mail	
<input type="text"/>	
Verify E-Mail	
<input type="text"/>	
Company or Institution Name	
<input type="text"/>	
Reason for Use	
<input type="text"/>	

Junk Mail/Spam Filters

Upon approval of your account, the system will send an email confirmation with a password to the address entered here. This notice will have a return-to address of jane_berman@dot.ca.gov. If you have a junk mail filter, classifier, or other anti-spam technology enabled then the email may never reach your Inbox.

Hence we recommend that you take the appropriate steps to ensure the successful delivery of the notification message.

Navigating PeMS Manage Account

To get back to the *main home page* at any time, click on the **PeMS home page** icon link

When the user logs into his/her account, the very first page is the **PeMS home page** (statewide level). The users will know when they are on the PeMS home page if they see "State of California" under the PeMS logo.

The screenshot shows the PeMS 11.1 home page. At the top left is the PeMS logo with a red circle around it. Below it is the text "State of California". The dashboard includes a map of California, a "Status Check" section with a line graph titled "Delay by Day of Week" showing traffic delay over a week, and a "Freeway Details" section with directional distance and controllers information. A "Report Finder" sidebar on the right allows selecting a freeway, direction, and report type. A red arrow points from the "PeMS home page" icon link in the first section to the PeMS logo on the home page.

Click on the user's **name** link to manage the account (change preferences, edit profile, etc.)

The screenshot shows the "Manage Account" page. On the left is an "Account Summary" panel with user details like name, email, and member since. In the center is an "Edit Preferences" form. The "My Home Page" dropdown is set to "Preferred District Home". The "Preferred District" dropdown is set to "LA/Ventura (D7)". A red arrow points from the "My Home" link in the first section to the "My Home" link in the top right of this page. Another red arrow points from the "Edit Preferences" section to the "Edit Profile" link in the "Actions" panel at the bottom left.

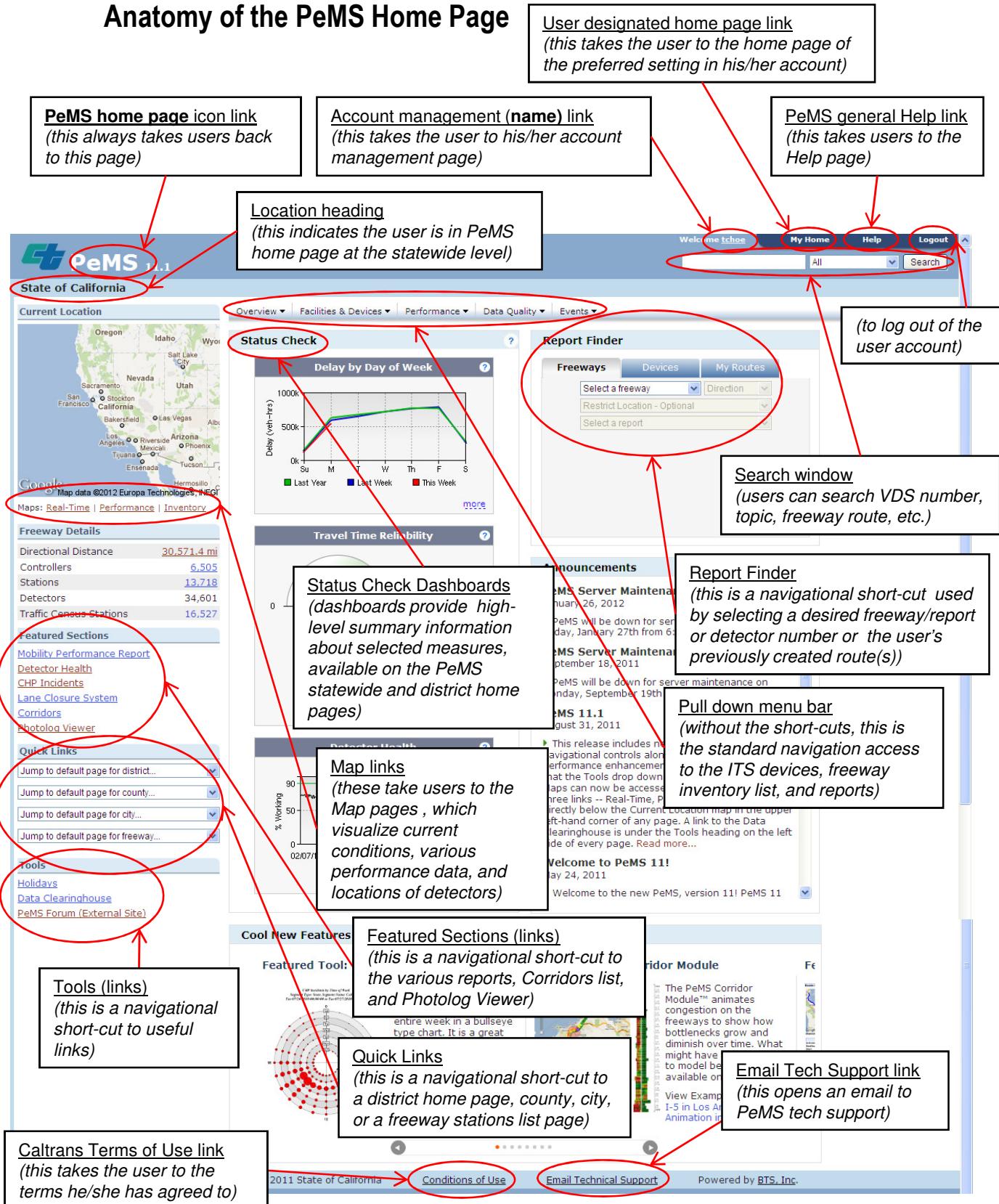
Users can set/edit Preference for their home page (**My Home**) with District home page or District Map page

Click on **My Home** link to go to the user designated preferred Home page

Change preferences, edit account profile, change password by clicking on these links

When the user is done with his/her account management, go back to the PeMS home page (click on the **PeMS home page** icon link)

Anatomy of the PeMS Home Page



District Home Page

From the PeMS home page (*click on PeMS icon upper left corner*)

1. Jump to the District 12: Orange County home page from the **Quick Links** pull down menu
(click on **Jump to default page for district...** pull down arrow, select and click on **D12: Orange County**)

The screenshot shows the main dashboard of the PeMS 11.1 District Home Page. At the top left, the 'PeMS' logo is circled in red. Below it, the 'State of California' map shows various locations with city names. The 'Current Location' sidebar on the left includes a 'Google Map' section and a 'Freeway Details' table. The 'Quick Links' dropdown is also circled in red, showing options like 'Jump to default page for district...', 'D12: Orange County', and other district codes. The central area features three main charts: 'Delay by Day of Week', 'Travel Time Reliability', and 'Detector Health'. To the right, there's a 'Report Finder' panel and an 'Announcements' section with news items about server maintenance and new features.

The user should see **District 12: Orange County** (District 12 home page),
(from here the user can navigate to other pages or go to reports)

This screenshot shows the District 12: Orange County home page. The 'District 12: Orange County' title is circled in red at the top left. The rest of the interface, including the map, sidebar, and central charts, is identical to the main PeMS dashboard shown in the previous screenshot.

District Freeways Inventory List

From the **District 12: Orange County** home page

2. Move mouse pointer to **Facilities & Devices > Freeways**

(click **Freeways**) – this will bring up the **Freeways inventory listing page**

Pull down menu
(the pull down menu provides the navigational access to the various reports; using the Facilities & Devices menu is a standard way to access the desired facility or device within the District to generate reports)

The user should see **District 12: Orange County** and the District 12 freeways inventory listing (**Facilities & Devices > Freeways**)
(from here the user can navigate to an ITS device such as VDS or freeway segment)

Mainline/HOV Facilities & Ramps
(click on any of the colored (non-black) highlighted text links to go to that device listing page; **Miles** will take the user to the Mainline/HOV facility segment)

ABOUT THIS REPORT link
(this will pop open a help window with a detailed explanation of this page)

Detection (LDS/VDS/Detectors)
LDS is the term used for the controller cabinets on the freeway to which VDS are connected. VDS is the term used for vehicle detector stations. Detectors are the individual lane detectors.
(click on any of the colored (non-black) highlighted text links to go to that device listing page)

Fwy	Detection			Mainline Facilities Detection Coverage			HOV Facilities Detection Coverage			Ramps Detection Coverage			
	# LDSs	# VDSs	# Detectors	Total Miles	# VDSs	Miles	Lane Miles	Miles	# VDSs	Miles	Lane Miles	Off Fwy	On Fwy
I5-N	83	319	733	44.4	102	44.4	202.7	36.8	36.8	90	36.8	44.3	44 59 20
I5-S	70	311	747	44.4	99	44.4	208.4	36.8	36.8	86	36.8	45.4	52 52 18
I405-N	41	181	402	23.9	57	23.9	107.8	50.5	50.5	55	23.9	24.2	21 30 11
I405-S	45	180	410	23.9	55	23.9	112.4	0	0.0	57	0.0	24.3	19 27 17
I605-N	1	5	11	2.0	2	2.1	8.2	22.3	22.3	1	2.1	2.1	1 1 0
I605-S	2	7	13	2.0	2	2.1	8.2	1.6	1.6	2	1.6	8.2	2 2 0
SR1-N	0	0	0	33.7	0	0	0.0	0	0.0	0	0	0.0	0 0 0
SR1-S	0	0	0	33.7	0	0	0.0	0	0.0	0	0	0.0	0 0 0
SR22-E	24	111	220	13.3	39	13.3	45.5	11.0	11.0	35	11.0	13.3	16 13 8
SR22-W	25	106	225	13.3	41	13.3	47.7	11.0	11.0	32	11.0	13.3	11 16 6
SR39-N	0	0	0	21.8	0	0	0.0	0	0.0	0	0	0.0	0 0 0
SR39-S	0	0	0	21.8	0	0	0.0	0	0.0	0	0	0.0	0 0 0
SR55-N	22	107	230	17.9	36	17.6	70.9	11.3	11.3	26	11.3	14.3	16 16 13
SR55-S	23	94	199	17.9	31	17.6	66.8	11.3	11.3	22	11.3	14.7	15 15 11
SR57-N	26	95	193	11.9	29	11.9	50.1	16.2	16.2	32	11.9	11.9	12 17 7
SR57-S	20	89	188	12.0	28	12.0	51.5	11.7	11.7	28	11.7	12.0	9 17 7
SR72-N	0	0	0	0.5	0	0	0.0	0	0.0	0	0	0.0	0 0 0
SR72-S	0	0	0	0.5	0	0	0.0	0	0.0	0	0	0.0	0 0 0

Navigating PeMS Help Resources

Help Resources

The screenshot shows the PeMS 11.1 interface with several help resources highlighted:

- From any page Click on the **Help** link**: A red arrow points from the top right corner of the main menu bar to the "Help" link.
- From any page Click on the **?** link**: Multiple red arrows point to question mark icons located in the "Status Check" chart, the "Report Finder" section, the "Detector Health" chart, and the "Lane Closure System" chart.
- From any page Click on the **PeMS Forum (External site)** link**: A red arrow points to the "PeMS Forum (External site)" link in the "Tools" sidebar.
- From any page Click on the **Email Technical Support** link**: A red arrow points to the "Email Technical Support" link at the bottom of the page.
- 3. Click on the **Help** link**: A callout box labeled "3." contains the instruction "Click on the Help link".
- Dashboard help**: A callout box contains the text "From the PeMS home page or District home page Click on the ? link (this will pop open a Dashboard help window that will provide more detailed information)".
- PeMS Help Page**: A large callout box highlights the "Help" page itself, showing sections like Methodology, System Calculations, Common Analysis, Topics, System Calculations, Common Analysis, Frequently Asked Questions (FAQ), Glossary, Conditions of Use, and Value Added Resellers.
- 5. Click on the **PeMS Forum** link**: A callout box labeled "5." contains the instruction "Click on the PeMS Forum link (this will open a new Internet window for the PeMS Forum external site where users can ask others questions, review an FAQ, etc.)".
- 6. Click on the **Email Tech Support** link**: A callout box labeled "6." contains the instruction "Click on the Email Tech Support link (this will open an email window to PeMS Technical Support)".

CHAPTER 1 EXERCISES

Basic Navigation

1. How did District 3 delay compare with District 7 delay on Fridays last year (hint: Dashboards)?
2. How many VDS locations are there on I-80W in District 4?
3. How many miles of HOV lane are there on I-80E in District 4?
4. How many Corridors are there in District 4?
5. How many stations are there in District 3?
6. What is a TMG Report (hint: Help page)?
7. How many PeMS designated holidays were there in 2010?

Answers are provided in the Appendix.

Chapter 2

PeMS Data Report Formats and Levels of Data Analysis

CHAPTER 2

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In this chapter, users will learn about the different types of reports in which PeMS presents data. PeMS presents the results of its calculations and analyses in various formats: dashboards, maps, plots and graphs, tables, spreadsheets, text files, and animation videos. Users will learn about each of these formats. This chapter will also discuss the Caltrans Photolog, which is available through PeMS.

This chapter also summarizes the different levels of analysis users can do in PeMS. PeMS generates reports at three geographical levels: the individual detector level (at a point along a freeway corridor), the spatial level (a freeway segment), and the geographical aggregate level (multiple freeways within a larger geographical area, such as a city, county, Caltrans District, or all of California). Each of these reporting levels is discussed at the end of the chapter.

I. PeMS Data Report Formats

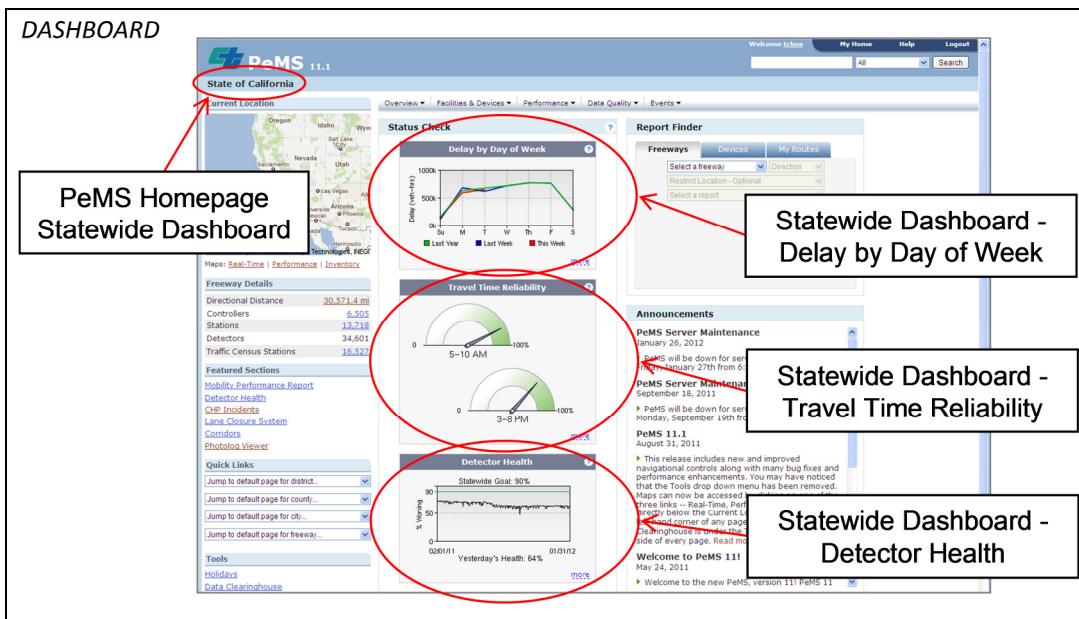
PeMS produces reports in various formats:

- Dashboards
- Maps
- Plots and graphs
- Tables
- Export to text/spreadsheet file
- Animation video.

PeMS also provides access to the Caltrans Photolog images. The Caltrans Photolog is the Department's photographic documentation of existing conditions on, and adjacent to, Caltrans right-of-way by digital camera. The Photolog is also discussed in this section.

Dashboards

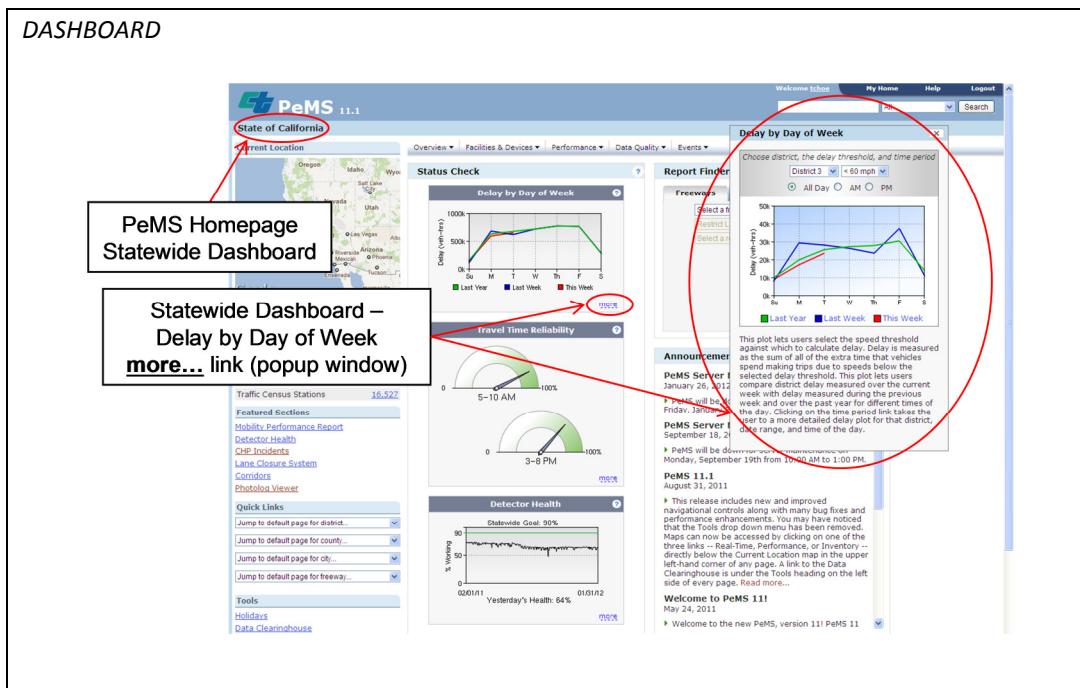
Dashboard charts and graphs are available only on the PeMS home page and the home pages of districts with real-time vehicle detector stations (i.e., all Districts except 1, 2, and 9). The Dashboard is intended to provide a universal snapshot or status report of performance measures for the District, county, or statewide freeway network. Users will see three primary performance measures on the home pages: Delay by Day of Week, Travel Time Reliability, and Detector Health.



The **Delay by Day of Week** dashboard shows the vehicle hours of delay (VHD) (district-wide or statewide) measured over each day of the current week, each day of the previous week, and the average for each day of the week over the past year. At a glance, users are able to see how the system (district-wide or statewide) is performing relative to the previous week and to trends over the past year. Users can also spot day-of-week congestion patterns. The VHD measure sums up the extra time that vehicles spend on the freeways (district-wide or statewide) relative to what they would spend traveling at a standard free-flow speed of 60 mph.

On the statewide home page, users can click on the **more** link on the lower right corner of the Delay by Day of Week dashboard to produce a pop-up window that refines the dashboard summary, showing statistics by District as well as by time period (i.e., AM, PM, or all day). This report also enables user to select their desired speed threshold against which delay will be computed – one can change the speed threshold from measuring delay below 60 mph to measuring it below 35, 40, 45, 50, or 55 mph. If the user changes the delay threshold, the extra time vehicles spend on the freeway will be compared to the new speed threshold (rather than 60 mph).

When on a District home page, the **more** link will bring up a similar pop-up window to the one found on the statewide home page, except this one presents delay information for each county within that District.

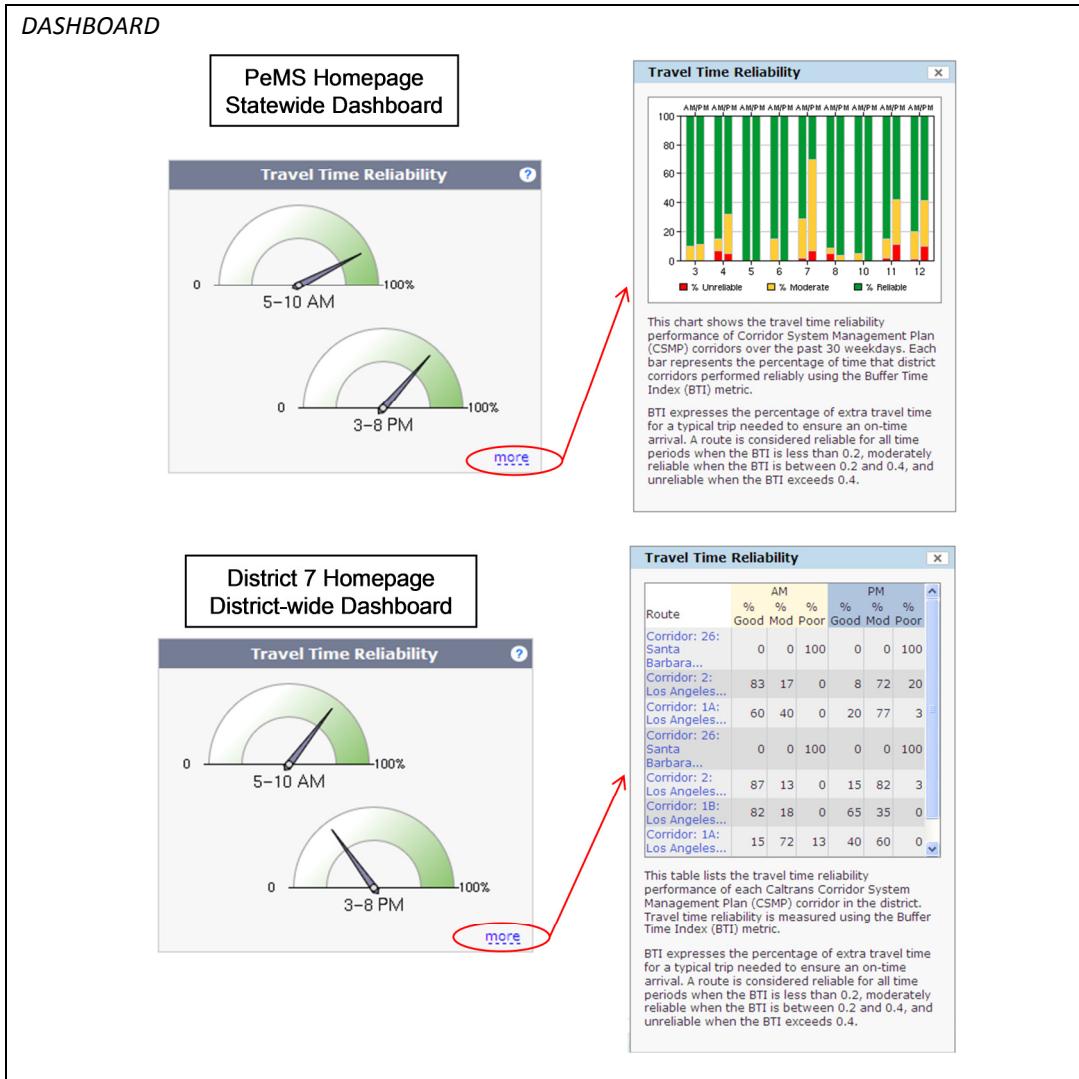


The **Travel Time Reliability** dashboard shows how reliable or consistent travel times are on district-wide or statewide corridors. Here, PeMS measures the travel time reliability of Caltrans Corridor System Management Plan (CSMP) routes during the AM and PM peak periods. PeMS uses the Buffer Time Index (BTI) to report its reliability statistics. The BTI indicates the percentage of extra travel time that travelers must add to planned trip times in order to arrive on time most days. BTI is defined as the buffer time (the 95th percentile travel time minus the median travel time) divided by the median travel time. You can think of this as how much extra time you need to give yourself so that you are late for work only one day a month.

To illustrate the concept, think of a person who commutes on a highway with an average travel time of 30 minutes and a BTI of 0.5. That person must add 15 minutes (0.5 times 30 minutes) to an average typical trip time to arrive at work on time most days (19 out of 20 weekdays) in a month. By planning for the trip to take 45 minutes, the commuter is late only one day a month. If transportation management is able to reduce this buffer time, the commuter benefits by not having to plan for so much extra travel time.

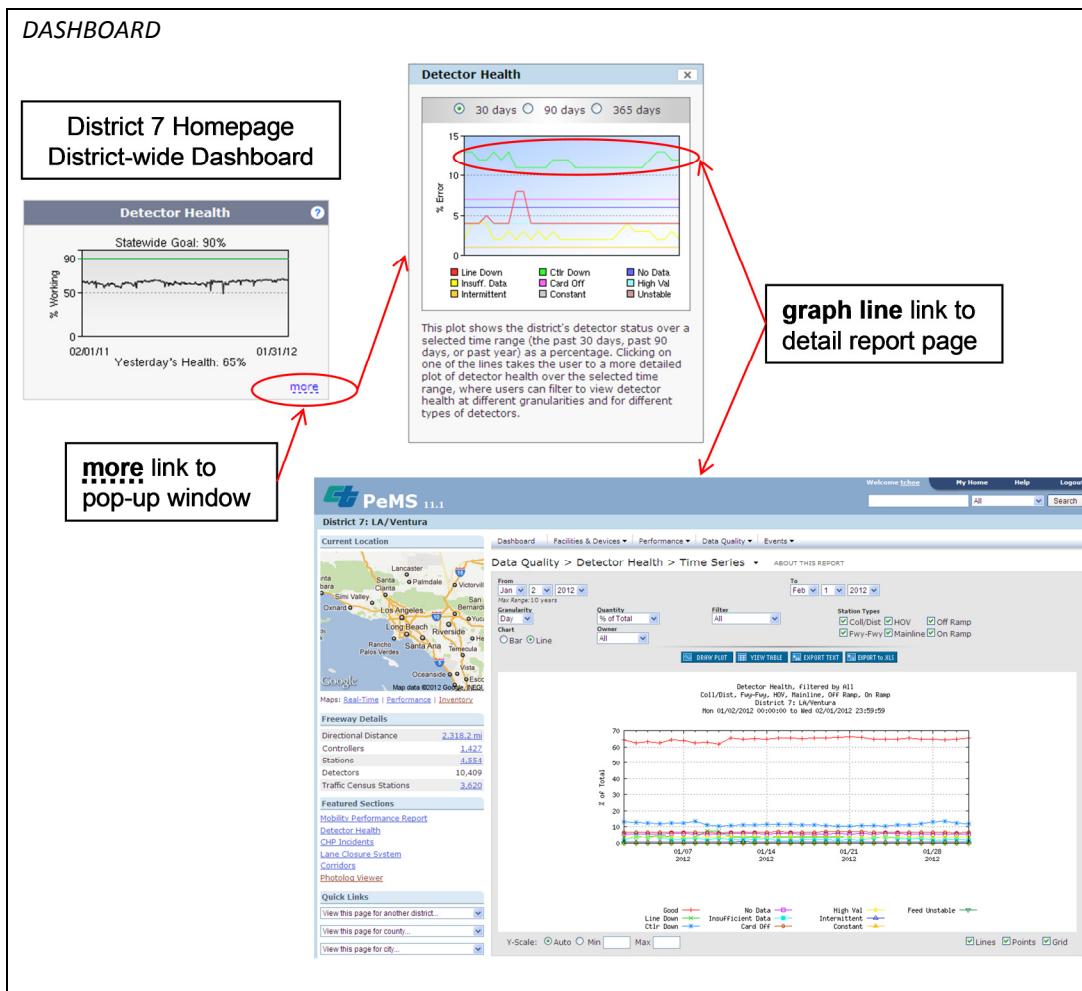
The PeMS dashboard calculates BTI for each 5-minute period over the past five weekdays for each CSMP route. A route is considered reliable when the BTI is less than 0.2 for the given time period. The route is moderately reliable when the BTI is between 0.2 and 0.4 and unreliable when the BTI exceeds 0.4. The commuter in the example in the preceding paragraph has an unreliable route (BTI of 0.5).

On the Statewide home page, clicking on the [more](#) link in the lower right corner of the Travel Time Reliability dashboard will open up a pop-up window that displays the reliability of the CSMP corridors in the AM and PM peak periods by Caltrans District. On a District home page, the [more](#) link provides information about the reliability of each individual CSMP corridor within that District. The reliability information in these dashboards is based on data from the previous 30 weekdays.



The **Detector Health** dashboard shows the percentage of detectors that were working and not working over the last year for the entire state (or district, if on a district home page), and explicitly lists yesterday's detector health percentage. Detector health is important because PeMS performance measures are more accurate when a higher percentage of detectors are working. PeMS evaluates detector health based on how much data is received from the field and whether the data seems correct by performing diagnostic checks.

On the PeMS (statewide) home page, users can click on the [more](#) link on the lower right corner of the Detector Health dashboard to view the percentage of detectors that were working and not working for each district over a selected time range (the past 30 days, past 90 days, or past year). Clicking on one of the bars takes you to a more detailed plot of detector health for that district over the selected time range. From there, users can filter the results to view detector health at different granularities (day, week, or month) and for different types of detectors (mainline, HOV, ramps, connectors, or collectors/distributors). On the District home page, the [more](#) link produces a dashboard that shows the district's detector status by the suspected type of error (e.g., no data being received, the controller is down, or the communication line is down) over a selected time range (the past 30 days, past 90 days, or past year) as a percentage. Clicking on one of the lines in the plot takes the user to a more detailed plot of detector health over the selected time range, where the user can filter for different time periods and types of detectors.



Maps

PeMS contains a wide range of information about the transportation network. The PeMS maps have been created to help users quickly understand and visualize the traffic data available in PeMS. There are four distinct maps in PeMS: the Real-Time Map, the Performance Map, the Inventory Map, and the Search Map. These maps are accessed from any PeMS report page that has a map in the upper left corner. Just under the map are links that show Inventory, Real-Time, Performance, and Inventory. Click on one of these links to be taken to that particular map. Each map utilizes a Google base map and overlays PeMS-specific information. Like any other Google base map, users can pan and zoom around the map.

The screenshot shows the PeMS 11.1 dashboard with the 'MAPS' section selected. At the top right, there is a search bar with dropdown menus for 'All' and 'Search'. Below the search bar, there are tabs for 'Overview', 'Facilities & Devices', 'Performance', 'Data Quality', and 'Events'. On the left, there is a map of California with various locations marked. Below the map, there is a 'Current Location' section. To the right of the map, there is a 'Status Check' section with three charts: 'Delay by Day of Week', 'Travel Time Reliability', and 'Detector Health'. Further down, there is a 'Report Finder' section with tabs for 'Freeways', 'Devices', and 'My Routes'. The 'Devices' tab is selected, showing dropdown menus for 'Select a freeway', 'Direction', and 'Restrict Location - Optional'. Below this is a 'Select a report' dropdown. On the far right, there is an 'Announcements' section with several entries. At the bottom left, there is a 'Quick Links' panel with a 'More...' button.

When one performs a search using the search box in the upper right corner of any PeMS page, one is taken to the search results on the Search Map page.

Clicking on one of the map links to get to the selected map page, users can click on any of the other tabs in the upper left corner to switch to another map type. The map position and zoom level will remain the same. Users can view any desired freeway corridor, either by panning/zooming the map or by jumping to the appropriate District. The setting controls in the active tab on the left side of the page are there to set the map content (find the desired elements to view and check the corresponding check box to view them). Just below the tabs are the expand/collapse links that allow users to expand and collapse control sections. Users can also expand or collapse a particular section in the control panel by clicking on the blue band that is the section header. In many sections, expanding the control panel will reveal additional filtering options for that element.

The icon will hide the control panel and expand the map to the full page width. The icon will restore the control panel.

The hyperlink entitled [Link](#) located just above the upper right hand corner of the map displays a dialog box containing a URL. This URL can be pasted into a browser window, e-mail message, or IM. It will display the map with the current control settings. (Note that this does not always work by cutting and pasting the URL displayed in the browser window.)

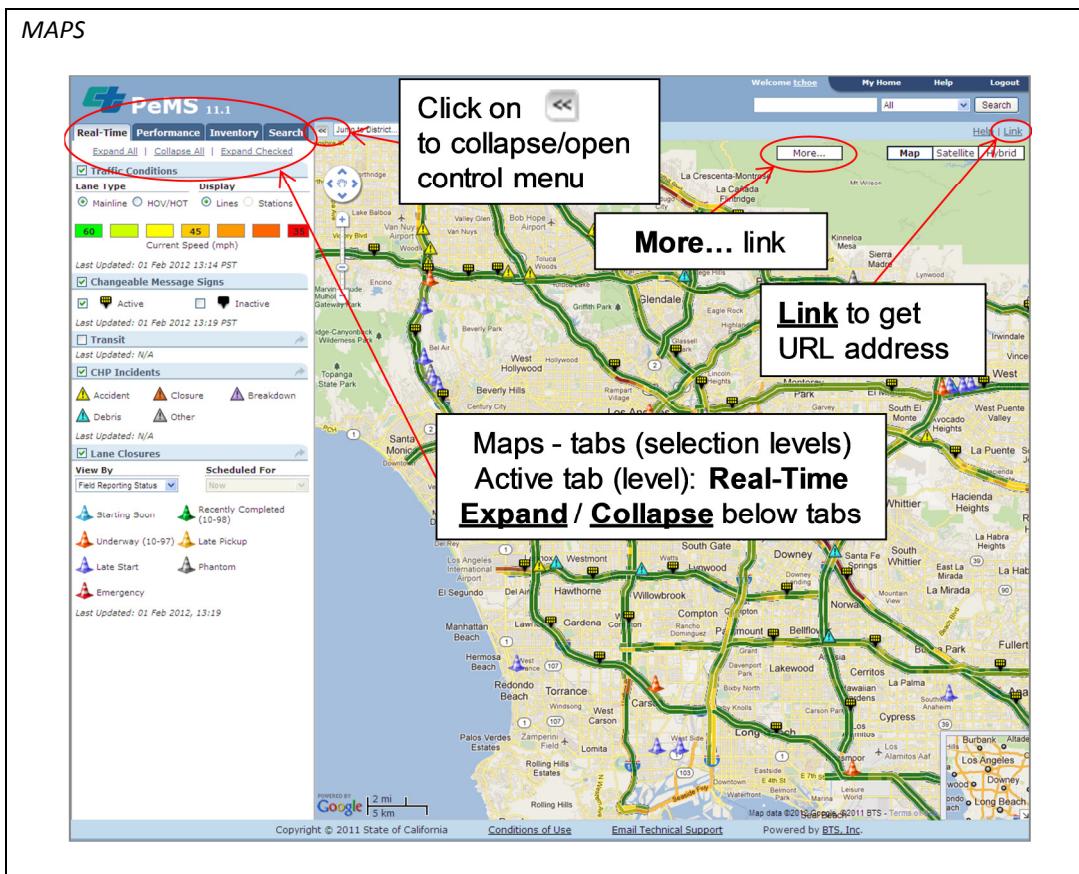
Placing the mouse cursor over the **More...** button reveals a list of available overlays. These overlays include roadway characteristics as well as performance-related items, such as PeMS routes (which are freeway segments defined by users) and corridors (which are the defined Corridor System Management Plan corridors). Users can use this information to augment the map view. For example, to see mainline detection coverage over user-defined

routes, users can go to the Inventory Map and turn on the Mainline VDSs, and then go to the More button and select My Routes.

Within any of these various maps, users can click on an icon in the map to get a popup window with specific information about that particular item. Depending on the context, the popup window may provide additional text or links that will take the user to report pages. Below is more specific information about what is in each map.

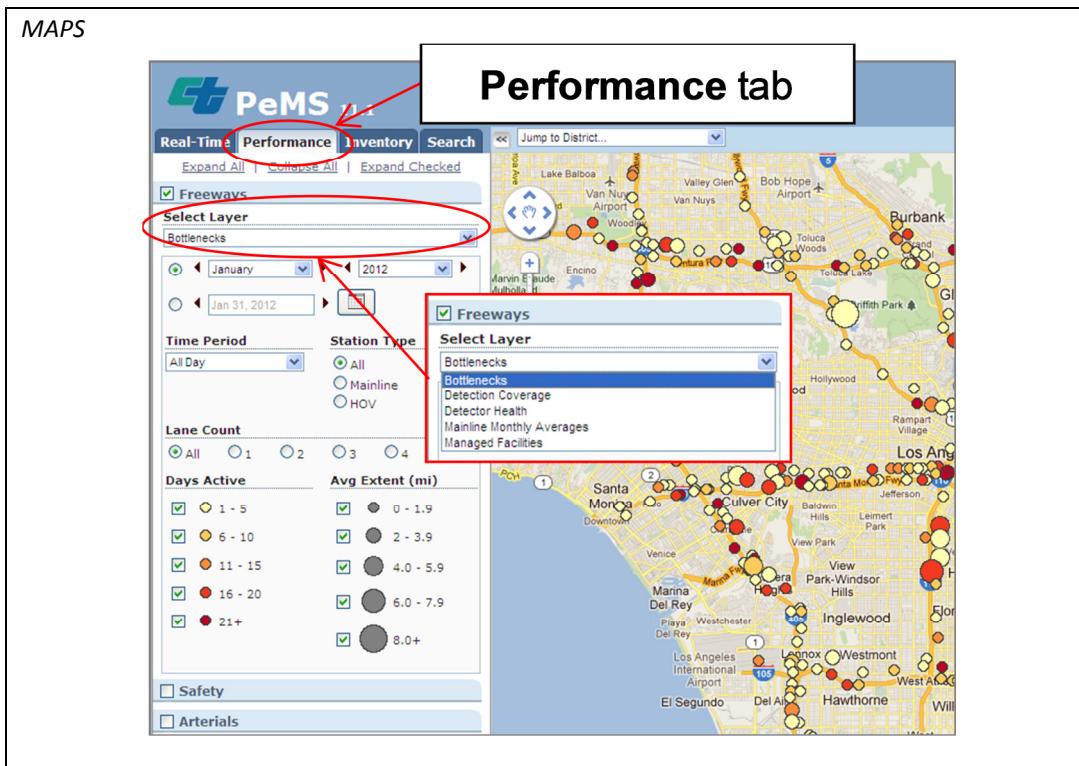
The Real-Time Map

The Real-Time view shows the current activity on the roadway network. Use the controls to view current roadway speeds as lines or individual stations. You can also select between speeds for mainline lanes or HOV/HOT. Dedicated HOV/HOT lanes that operate 24 hours per day are always displayed. Time-based HOV/HOT lanes are shown only when they are active. User can also select active Changeable Message Signs to view current messages displayed, CHP Incidents to view incident locations by type and incident information by clicking on a displayed incident icon, and Lane Closures to view lane closure location by type and closure information by clicking on a displayed lane closure icon.



The Performance Map

The Performance view shows a variety of historical performance measures as map overlays. The controls on the left side of this page are divided into the following categories: Bottlenecks, Detection Coverage, Detector Health, Mainline Monthly Averages, and Managed Facilities. Within each category is a list of overlays that can be displayed. After selecting an overlay, the control panel will refresh to display the date ranges, metrics and filters appropriate for that category.



The Inventory Map

The Inventory Map is a tool for becoming familiar with the various types of sensors that Caltrans receives data from, and where these sensors are located. The Inventory Map enables one to see the geographical location of each of the following elements:

- Vehicle Detector Stations (VDSs) by type: Mainline, Ramp, and HOV. The VDSs provide the main dataset in PeMS. There are over 6,700 VDSs in the state, each reporting flow and occupancy data every 30 seconds, all day, every day. When looking at these icons in the map, clicking on an icon opens up a pop-up window that reveals information about each station, such as its county, route, and postmile location, the date it was activated, and how many lanes it covers. Links at the bottom of the pop-up window take users to reports that contain information specific to that station. The Aggregates link will take users to the **Performance > Aggregates > Time Series** report, which is one way to start analyzing the data from that station.
- Controllers, which also go by the name of Loop Detector Stations (LDSs).
- Traffic Census Stations by type: Mainline and Ramp. If the user expands the Traffic Census Station sections, a filter called Reported Data is visible. This filter enables users to view Traffic Volumes, Vehicle Classification, or Truck Weights. Selecting the Truck Weights category will display the Weigh-in-Motion (WIM) stations in the map.
- Arterial data (controllers and stations). Currently, arterial data is only available for one arterial corridor in District 11.
- Transit Stops (information on transit is only available in District 11).
- Electronic Toll Collection (ETC) data, which is data from FasTrak readers that is only available in District 4.

Use the checkbox in the section title to show/hide the corresponding type. In many cases, users can filter the map icons displayed using the forms that appear under each section. (Note that some types are restricted by zoom level due to their density.)

MAPS

The screenshot shows the 'Inventory' tab selected in the top navigation bar. On the left, there is a sidebar with several checkboxes for filtering data types. The map on the right displays the city of Los Angeles with numerous colored dots representing different types of traffic monitoring infrastructure.

Search Tab

The Search view allows users to perform text and location searches over all of the metadata stored in the PeMS database. A search can be performed in two ways: (1) by entering a search in the box that appears at the top right of every page, or (2) by clicking the Search tab from a map page.

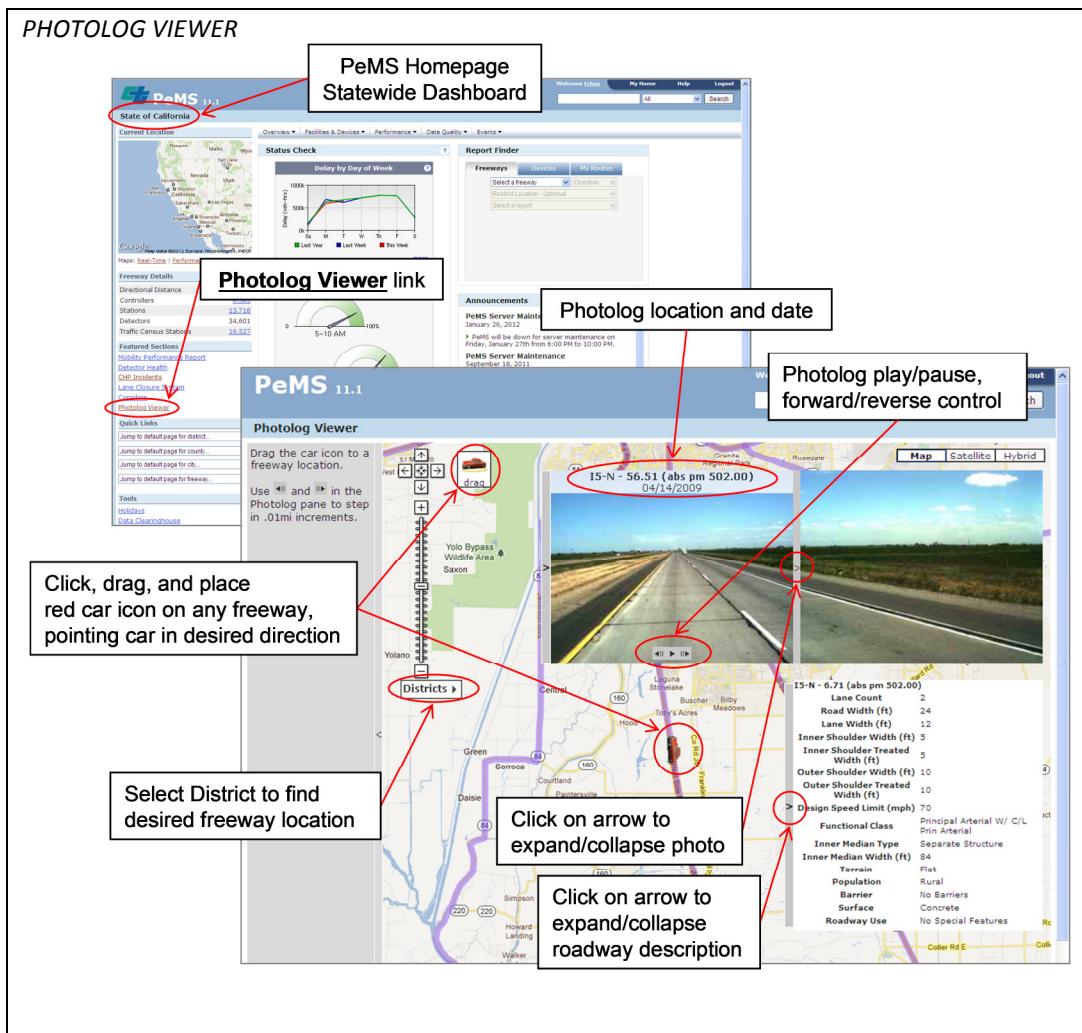
MAPS

The screenshot shows the 'Search' tab selected in the top navigation bar. On the left, there is a sidebar with fields for 'Keywords' and 'Category'. Below these are sections for 'Suggestions', 'Keyword Search', 'ID Search', and 'Postmile (CA) Search'. The map on the right shows the city of Los Angeles with a search bar at the top.

Photolog Viewer

The Photolog Viewer link is available on the left side, under Featured Sections, of the PeMS home page or any District home page. Clicking on this link takes users to the Caltrans Photolog Viewer page. Users can view any freeway photolog by finding the desired freeway corridor (either by panning/zooming the map or by selecting the appropriate District button) and dragging (clicking and holding the mouse button and moving) the red car icon to the desired freeway location on the map, with the car pointed in the desired direction of travel. These actions trigger the photolog video for the location where the car is on the map.

PeMS provides the photolog identifier (i.e., description at the top of the photolog window) along with the Caltrans and absolute postmile and the date of the recording. There are standard video control buttons (i.e., play/pause, forward, and reverse) at the bottom of the video window. The forward and reverse buttons move the video in 0.1 mile increments.



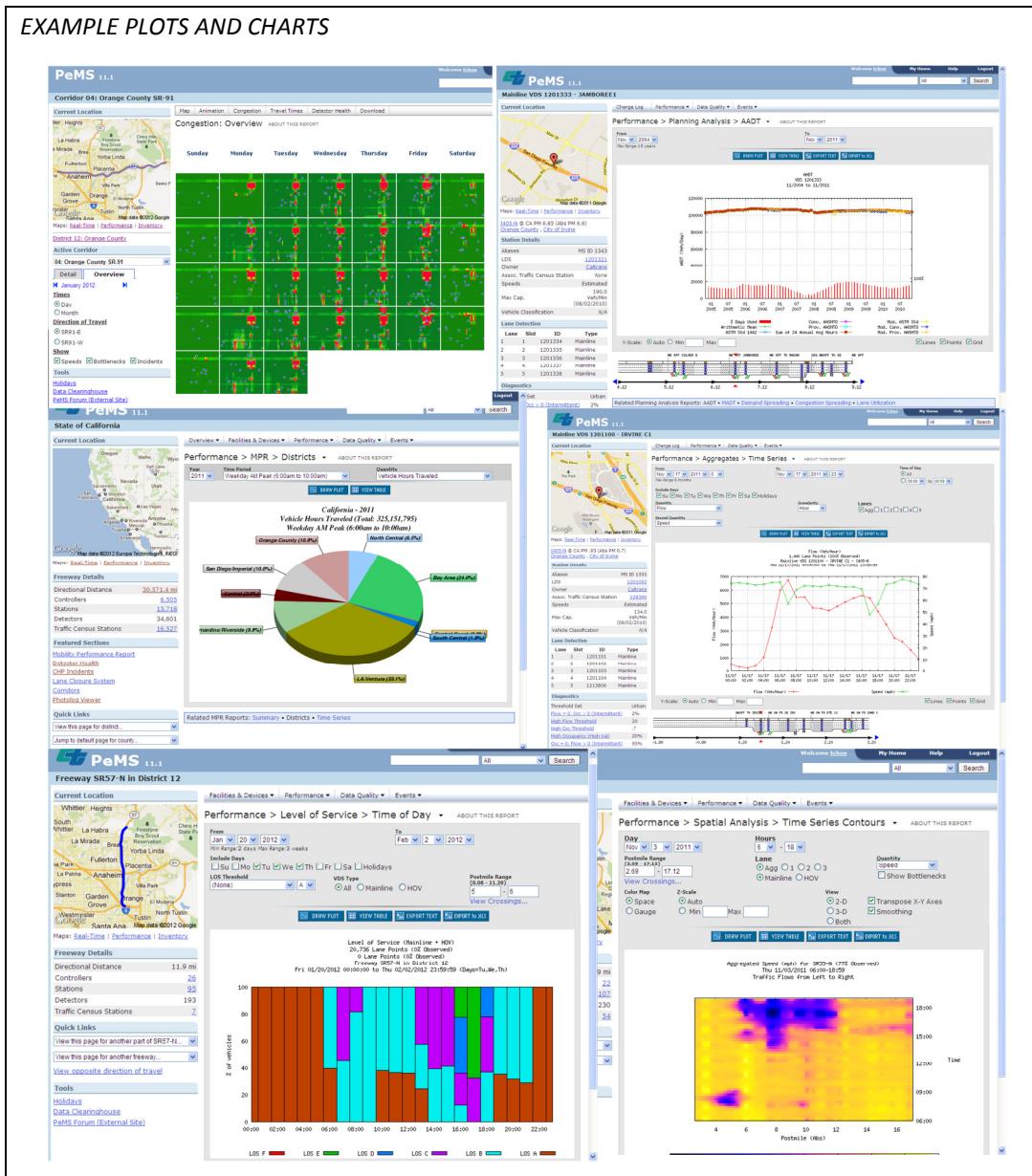
PeMS Photolog Viewer Guide

And the end of this Chapter is the PeMS Photolog Viewer Guide that provides illustrative examples of using the PeMS Photolog Viewer.

Plots and Charts

Performance measure plots and charts are the cornerstone of PeMS. They allow users to examine detector data at many different levels of aggregation as well as averages over various time periods. PeMS can generate plots for a number of different performance measures. Most PeMS reports have a **DRAW PLOT** button that generates a plot or chart of the data query. However, the measures available in a report depend on which geographic level the user is analyzing. At the lowest level (the individual station) users can see all of the quantities (e.g., speed, flow, occupancy, and delay). When data are aggregated spatially across a region (e.g., a county or Caltrans district), some of the quantities are not available for plotting.

PeMS provides many types of performance measure plots and charts, such as Aggregate plots of flow or speed, Level of Service bar charts, regional quantity pie charts, speed contour plots, and congestion overview plots. These various plots and graphs are discussed in more detail in Chapter 4.

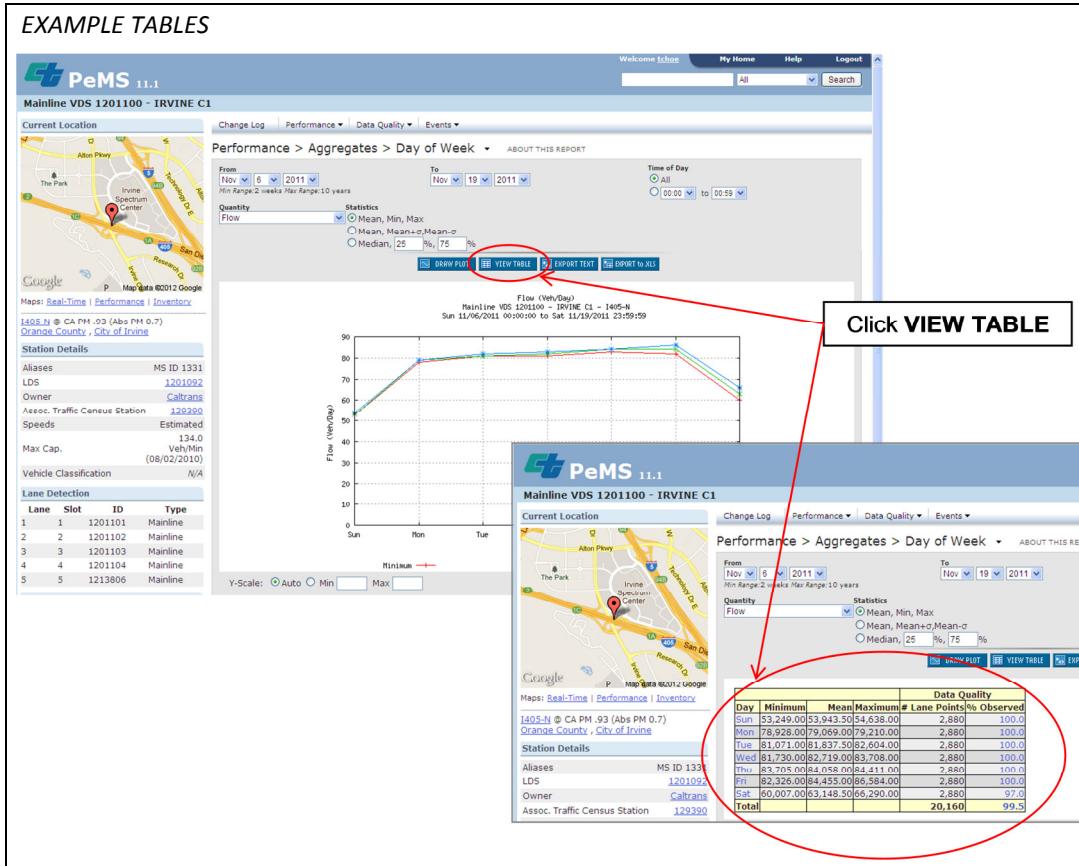


Tables

Almost all PeMS reports available in plot or chart form are also available as tables. While the plots and charts provide visual representations of the data, the tables provide the exact data values for further analysis. In most reports, the default output formats are plots or charts. In order to generate a table, users must select the table output option by clicking on the  **VIEW TABLE** button.

For more information on performance measure tables, see Chapter 4.

EXAMPLE TABLES

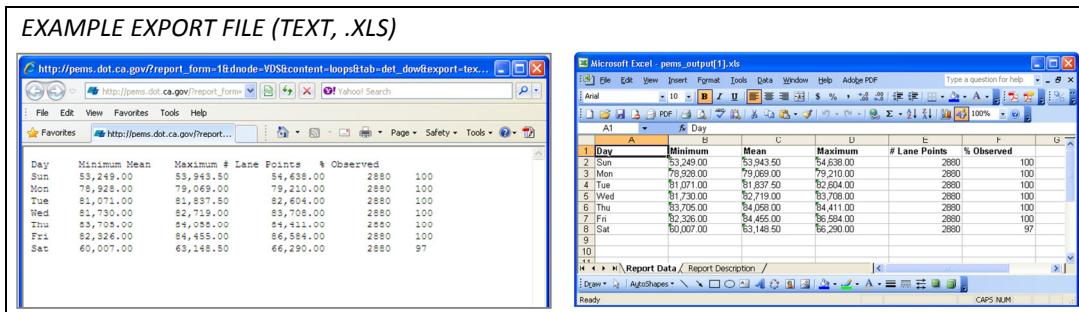


Day	Minimum	Mean	Maximum	# Lane Points	% Observed
1 Sun	53,249.00	53,943.50	54,638.00	2,880	100
2 Mon	78,928.00	79,069.00	79,210.00	2,880	100
3 Tue	81,071.00	81,357.50	82,604.00	2,880	100
4 Wed	80,007.00	81,455.00	82,630.00	2,880	100
5 Thu	83,705.00	84,058.00	84,411.00	2,880	100
6 Fri	82,326.00	84,455.00	85,584.00	2,880	100
7 Sat	60,007.00	63,148.50	66,290.00	2,880	97
Total				20,160	99.5

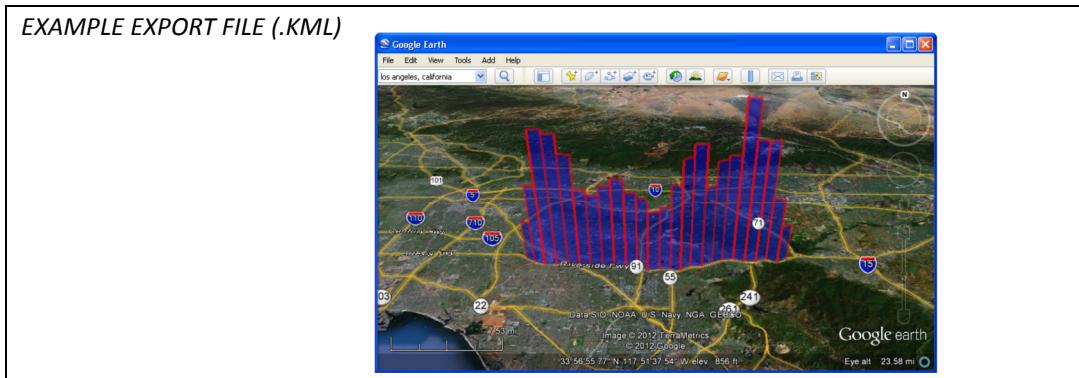
Export to Text/Export to Spreadsheet File/Export to Aerial Map Overlay

PeMS allows users to export the data from most reports into separate text files or spreadsheet files (Microsoft Excel .XLS). Users can also export spatially defined reports into geographic annotation in Google Earth via Keyhole Markup Language (.KML).

EXAMPLE EXPORT FILE (TEXT, .XLS)



Day	Minimum	Mean	Maximum	# Lane Points	% Observed
Sun	53,249.00	53,943.50	54,638.00	2,880	100
Mon	78,928.00	79,069.00	79,210.00	2,880	100
Tue	81,071.00	81,357.50	82,604.00	2,880	100
Wed	80,007.00	81,455.00	82,630.00	2,880	100
Thu	83,705.00	84,058.00	84,411.00	2,880	100
Fri	82,326.00	84,455.00	85,584.00	2,880	100
Sat	60,007.00	63,148.50	66,290.00	2,880	97



Keyhole Markup Language (KML) is an XML notation for expressing geographic annotation and visualization within Internet-based, two-dimensional maps and three-dimensional Earth browsers. KML was developed for use with Google Earth that allows for viewing and graphically editing KML files.

Animation Videos

When doing a spatial-level analysis on a freeway segment or corridor, users can generate an animation video. Animation videos offer a way to view changes in traffic conditions as they occurred on specific dates and times. Simply select the date, start and end times, and the desired postmile limits. Users have the option of displaying the following data elements: Speeds, Bottlenecks, Incidents, Volumes, and Stations.

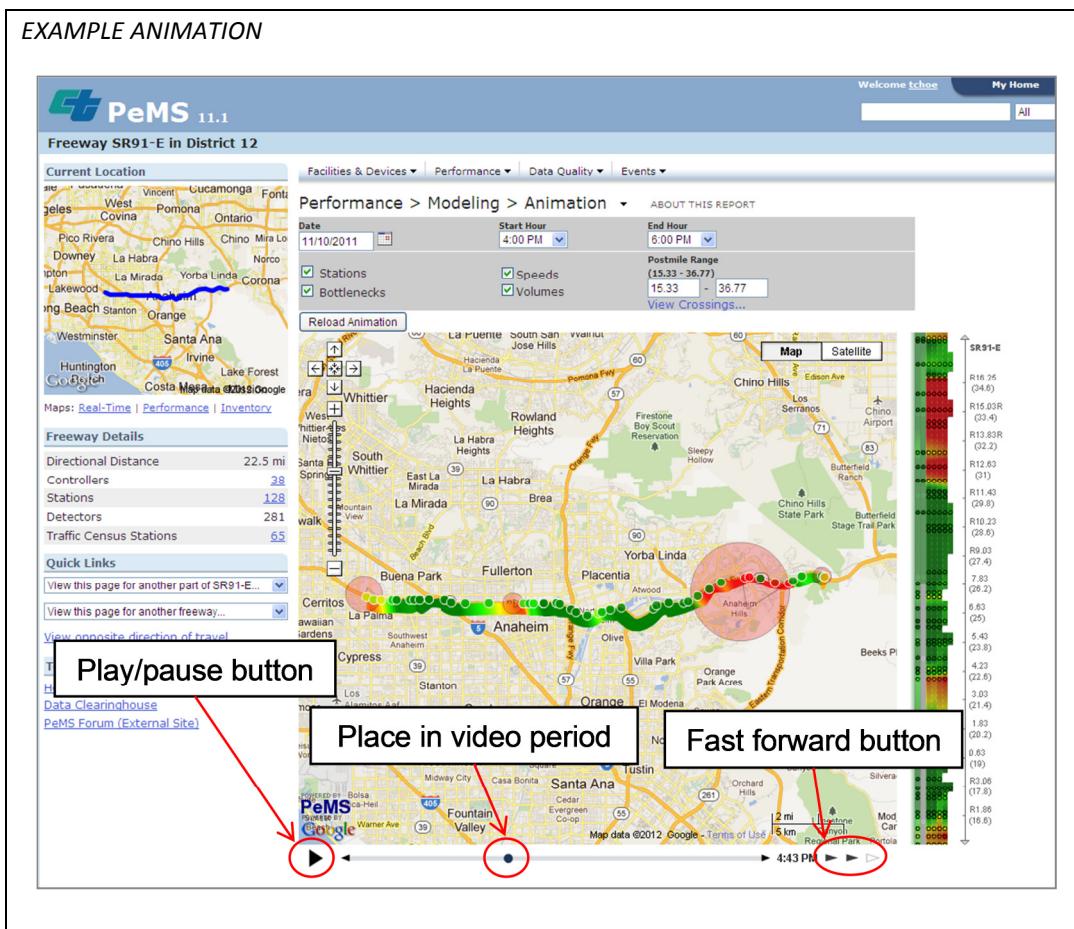
Clicking the play button allows users to see an animation of traffic conditions over time. To control the animation speed, select or deselect the arrows on the bottom right-hand corner of the map. The animation can be paused to allow users to make a more detailed investigation of the data at a given moment. Users can also click on the animation bar to fast-forward or rewind the animation to the desired point in time. Users can zoom in and out during the animation by double-clicking on a location, using the mouse scroll wheel, or using the zoom scale buttons to the top left of the map.

The data is displayed in the following ways:

- **Speeds:** The color of the freeway represents the speed. Speed data by lane is displayed on the lane configuration diagram on the right side of the page. The display colors are on a continuum, but, in general, colors correspond with speeds as follows:
 - Dark green: >60 mph
 - Light green: 50-60 mph
 - Yellow: 40-50 mph
 - Orange: 30-40 mph
 - Red: 0-30 mph.
- **Volumes:** The thickness of the line overlaying the freeway indicates the traffic volume in vehicles per hour. Thicker lines indicate higher volumes. The thickness serves as a visual tool to show relative volume changes over time. The best way to obtain precise volumes at the desired location and time period is to scroll over the freeway. This action will display the estimated flow in vehicles per hour in addition to the other data described above.
- **Bottlenecks:** The locations of bottlenecks are displayed as translucent circles overlaying the freeway, with center triangles pointing in the direction of travel. Moving upstream, the circles begin at the furthest downstream detector that recorded a drop in speed and continues to the farthest upstream detector that experienced that speed reduction.

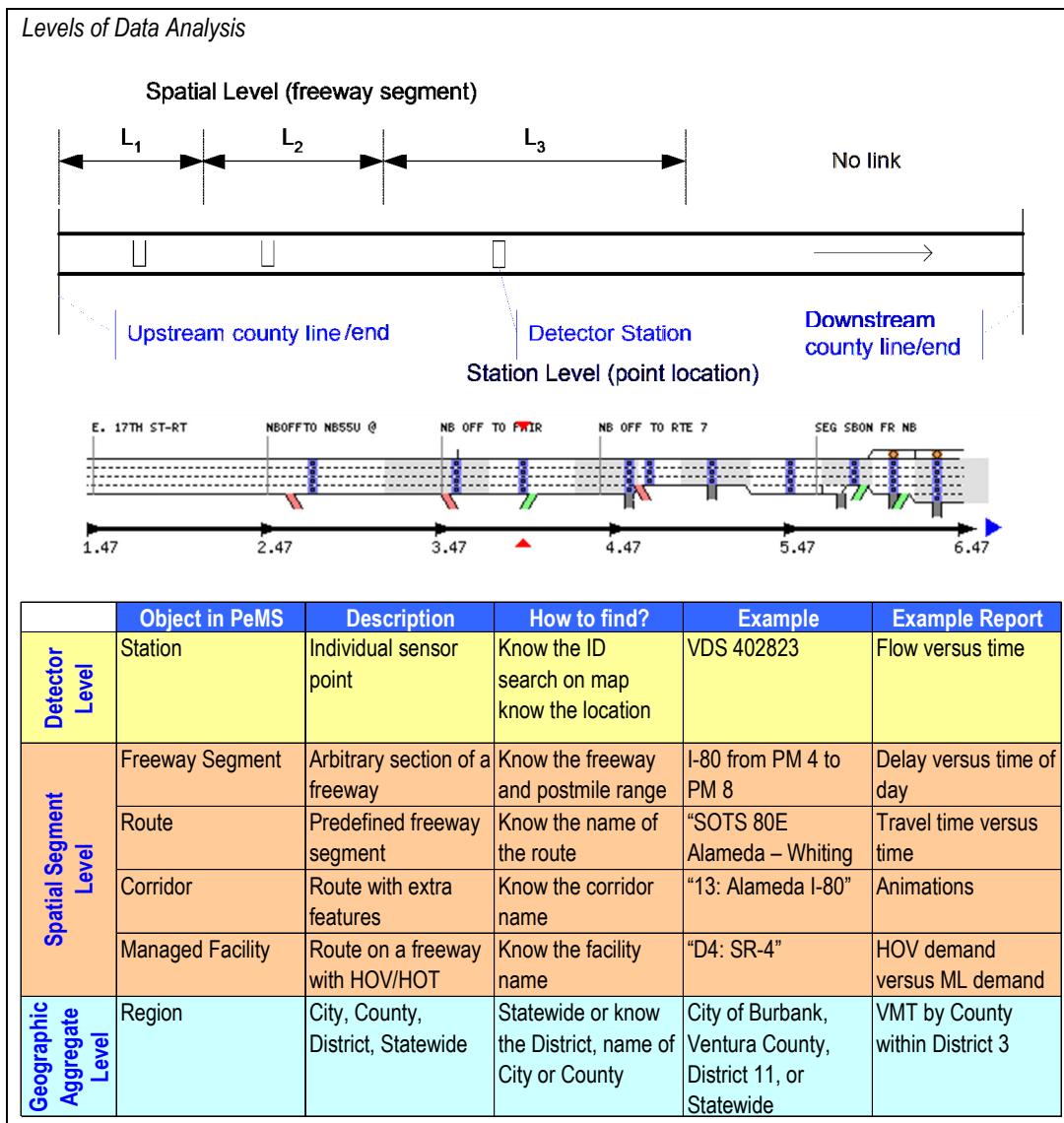
- Stations: The station circles appear on the lane configuration diagram at detector locations and in the animation itself, if one selects the “Stations” checkbox. The colors of the circles denote the travel speeds for each detector at that moment. The color scheme matches the one described above, under the Speeds bullet point.
- Incidents: These are displayed as blue diamonds on the route map. Scrolling over an incident diamond displays the incident's location on the freeway relative to the nearest ramp or overpass, the incident's start date and time, and its estimated duration in minutes. The shading of the blue diamond varies in intensity over the incident's duration – as the speed impacts of the incident decrease, the diamond fades out.

Chapter 4 discusses the animation tool in more detail.



II. PeMS Levels of Data Analysis

PeMS reports are generated for three geographical levels: the individual detector station level (a point location along a freeway corridor), the spatial level (a freeway segment), and the geographical aggregate level (multiple freeways within a larger geographical area like a city, county, Caltrans District, or statewide).



Freeway Station Level (Point Location)

The freeway station level is the lowest level of performance measurement. In the diagram above, a station is depicted by the small rectangular boxes on the freeway (upper-most figure) and by the blue lines across the freeway (the middle figure that is a freeway schematic diagram). At the station level, PeMS identifies each station with a VDS ID number. A particular station can be found in one of three ways: 1) by searching for the VDS ID number in the Search box or entering it in the Report Finder, 2) from the **Facilities & Devices > Field Elements > Stations** list of VDS locations, or 3) from the Inventory Map. Once the user finds the correct station, the user can jump to the station page using the provided link.

For each freeway station or VDS, PeMS allows users to report on many performance measures, including:

- Flow
- Occupancy
- Speed
- Vehicle Miles Traveled
- Vehicle Hours Traveled
- Travel Time Index
- Delay
- Lost Productivity

Users can find information on the calculation methodology for each performance measure in the Help section of PeMS (described in Chapter 1 of this manual). These station-level performance measures are discussed in more detail in Chapter 4.

Freeway Segment Level (Spatial Analysis)

At the spatial segment level (freeway segment or corridor), performance measures are calculated across freeway segment lengths. Users can use either fixed/pre-determined lengths (e.g., a Route, Corridor or Managed Lane) or user-defined lengths (by postmile) to generate reports. In PeMS, one VDS's length is equal to half the distance to the nearest downstream VDS plus half the distance to the nearest upstream VDS (depicted as L2 in the figure above). Freeway segments are comprised of these individual VDS lengths. Within a user-specified range of postmiles, PeMS adds up the data from the various VDS lengths within the postmile range. For the end of a freeway, PeMS applies a two and a half miles as the length associated with the far side of the last VDS (depicted as L1 and L3 in the figure above). Users can find spatial segments in one of three ways: 1) entering the freeway number and direction in the Report Finder or in the Search box, 2) under the **Facilities & Devices** listing of freeways/routes/corridors/managed lanes, or 3) from the Inventory Map.

At the spatial segment level, users can generate all the performance measures available for freeway stations (although note that speed is called Q in spatial aggregate reports, and flow becomes VMT), plus the following additional performance measures:

- Travel time
- Level of service
- Spatial AADT

PeMS can also be used to identify and analyze bottleneck locations along a freeway segment and to find information on incidents and lane closures that occurred on the freeway segment. The PeMS Animation videos described earlier in this chapter are also available for freeway-level analysis.

These spatial-level performance measures are discussed in more detail in Chapter 4.

Geographical Aggregate Level

At the geographical aggregate level, users can summarize performance measures across multiple freeway corridors within a larger geographical area (e.g., city, county, District, or statewide). Most of the spatial-level performance measures also can be reported at the geographical aggregate level.

PeMS Levels of Data Analysis Guide

At the end of this Chapter is the PeMS Levels of Data Analysis Guide that provides illustrations of locating a detector station, spatial segment, and geographic area for conducting data analysis.

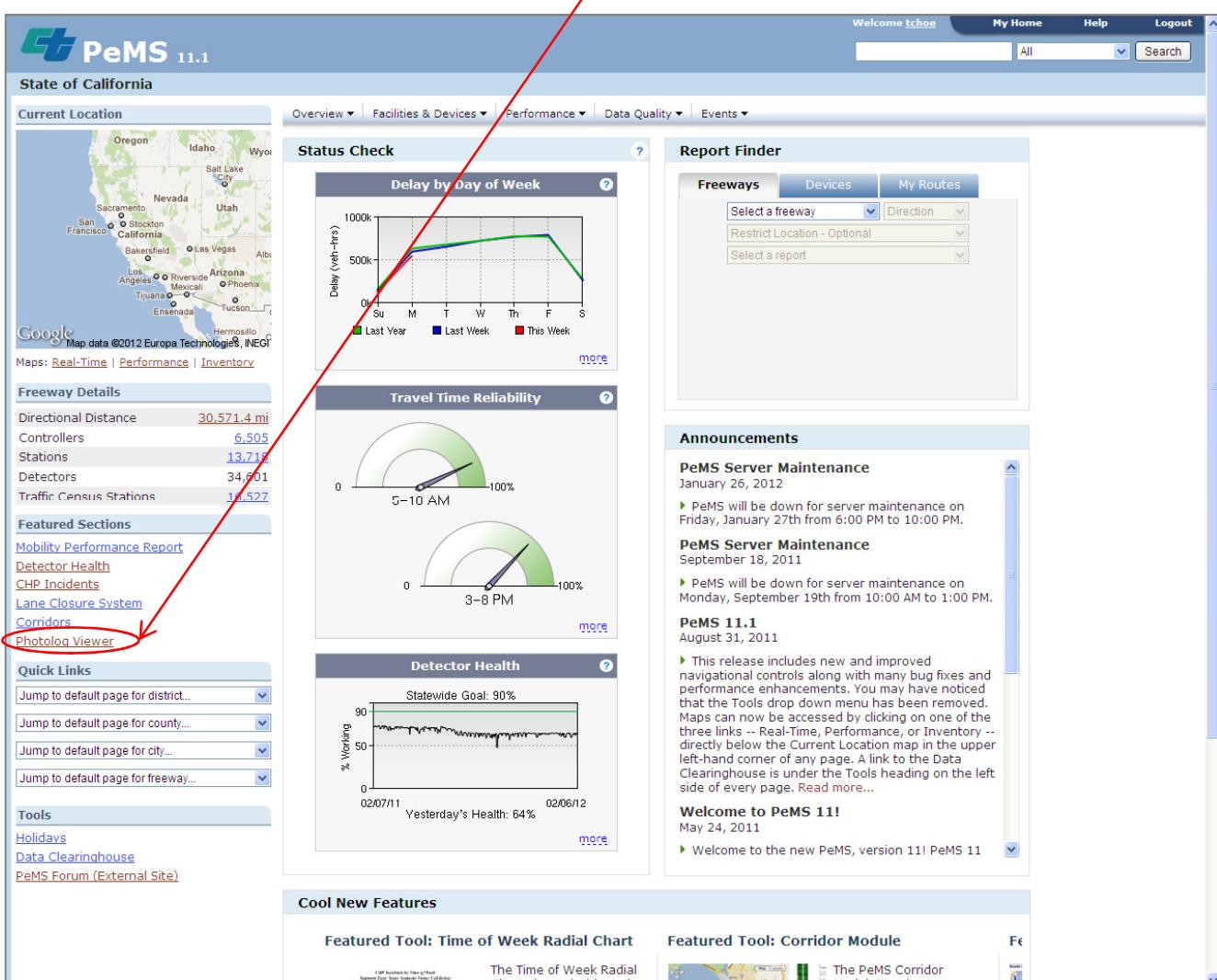
PeMS Photolog Viewer Guide

Instructions for accessing and using the PeMS Photolog Viewer are presented here. The main purpose of the illustrations in this section is to provide a few examples of how to use the Photolog Viewer. For instructions on how to use this guide, see Chapter 1 examples illustration (page 1-I-1).

For illustrative purposes, SR99-N and SR99-S in District 6: Fresno were selected to provide examples.

To access PeMS Photolog Viewer, start from the PeMS home page. Click on the Photolog Viewer link from the Featured Sections control menu on the left side:

From the PeMS home page,
1. Click on the **Photolog Viewer link in the Featured Sections control menu**



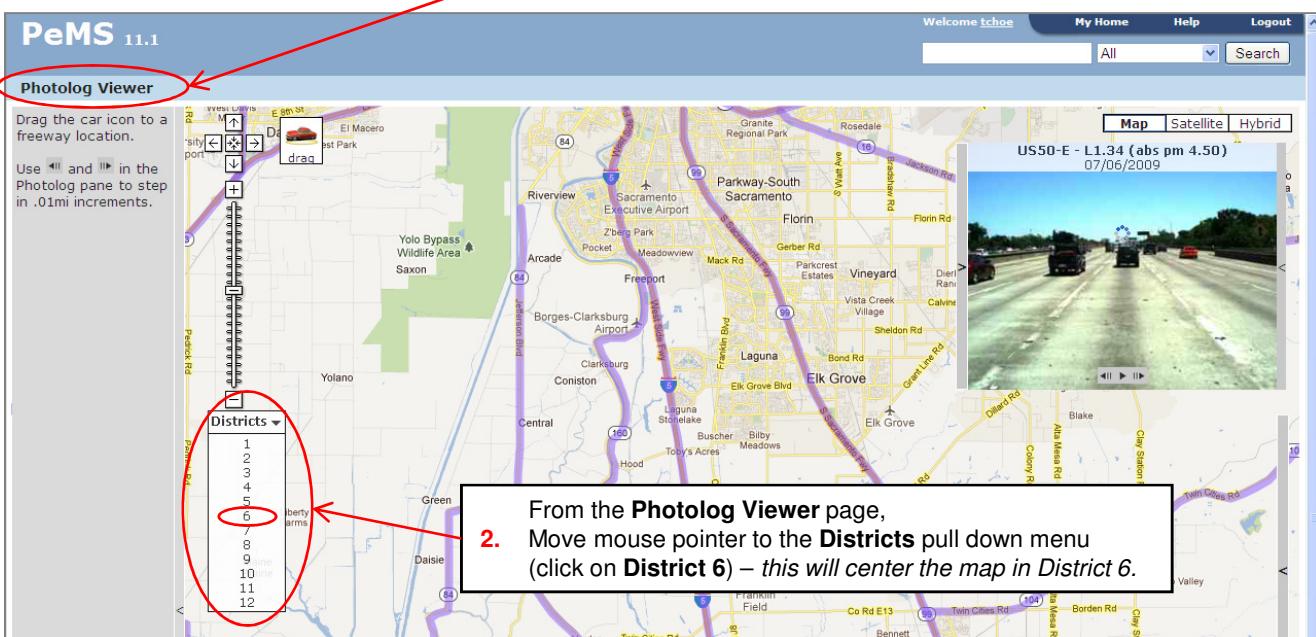
The screenshot shows the PeMS 11.1 home page with various sections and tools. A red arrow points from the callout box to the 'Photolog Viewer' link in the 'Featured Sections' menu on the left sidebar. The 'Photolog Viewer' link is circled in red.

PeMS 11.1 Home Page Features:

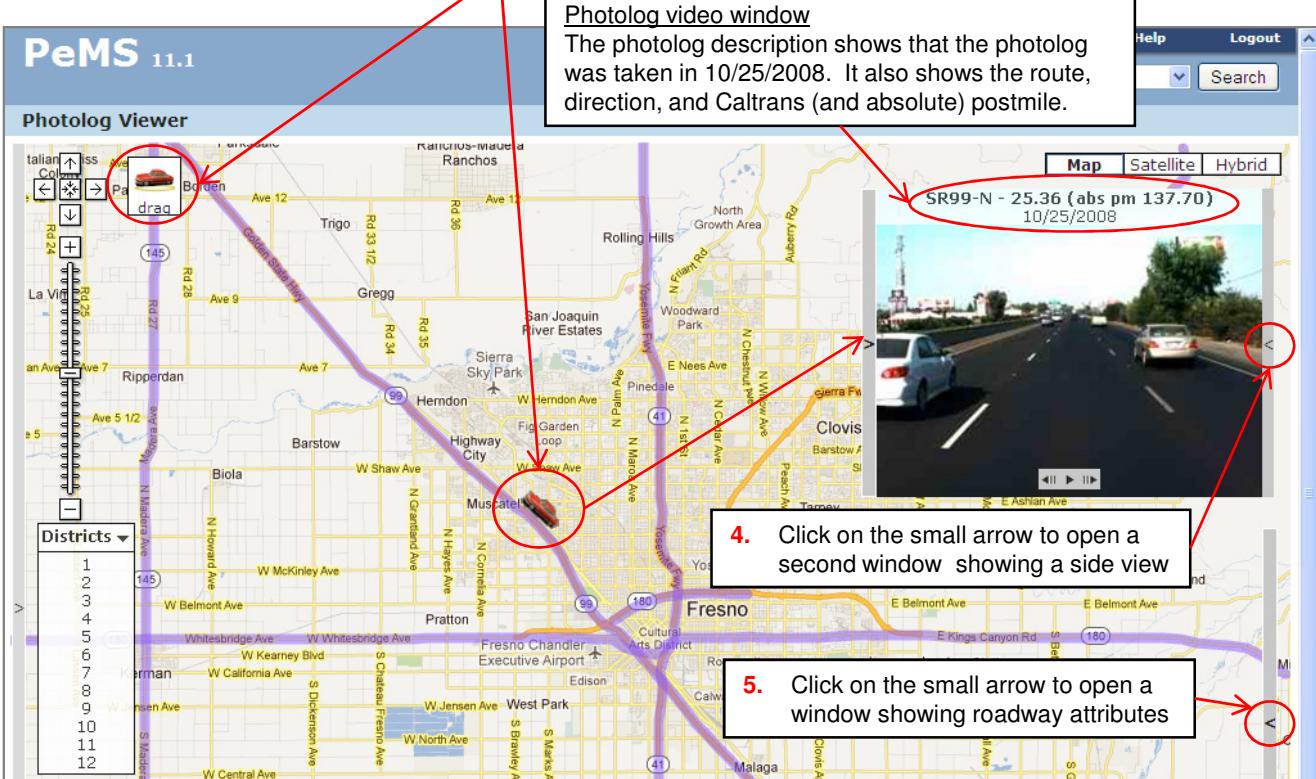
- Current Location:** Map of California and surrounding states.
- Freeway Details:** Shows directional distance (30,571.4 mi), controllers (6,505), stations (13,711), detectors (34,001), and traffic census stations (11,527).
- Featured Sections:** Includes links to Mobility Performance Report, Detector Health, CHP Incidents, Lane Closure System, and Corridors. The 'Photolog Viewer' link is highlighted with a red circle.
- Status Check:** Three charts: Delay by Day of Week, Travel Time Reliability (5-10 AM and 3-8 PM), and Detector Health (Statewide Goal: 90%, Yesterday's Health: 64%).
- Report Finder:** Allows selecting a freeway, direction, and report type.
- Announcements:** Lists PeMS Server Maintenance (January 26, 2012), PeMS Server Maintenance (September 18, 2011), and PeMS 11.1 (August 31, 2011) with details about the release.
- Cool New Features:** Includes 'Featured Tool: Time of Week Radial Chart' and 'Featured Tool: Corridor Module'.

PeMS Output Photolog Viewer

You should see **Photolog Viewer**
(from here you can navigate to the desired District freeway)



3. From the District 6 Photolog Viewer (map) page
Click and drag the red car to the SR99-N freeway on the map (vehicle pointing upwards) – you will then see the photolog video in the window



PeMS Output Photolog Viewer

Photolog Viewer

SR99-N - 25.36 (abs pm 137.70)
10/25/2008

SR99-N - 25.36 (abs pm 137.70)	Lane Count	3
	Road Width (ft)	36
	Lane Width (ft)	12
	Inner Shoulder Width (ft)	7
	Inner Shoulder Treated Width (ft)	7
	Outer Shoulder Width (ft)	8
	Outer Shoulder Treated Width (ft)	8
	Design Speed Limit (mph)	70
Functional Class	Principal Arterial W/ C/L	
Inner Median Type	Prin Arterial	
Inner Median Width (ft)	16	Paved - No Roadway Use
Terrain	Flat	
Population	Urbanized	
Barrier	Concrete Barrier	
Surface	Concrete	
Roadway Use	No Special Features	

6. Click and drag the red car to the southbound side of the freeway (vehicle pointing downwards) to view the other direction

Photolog video play button
You can play/pause and advance forward/reverse with these video buttons.

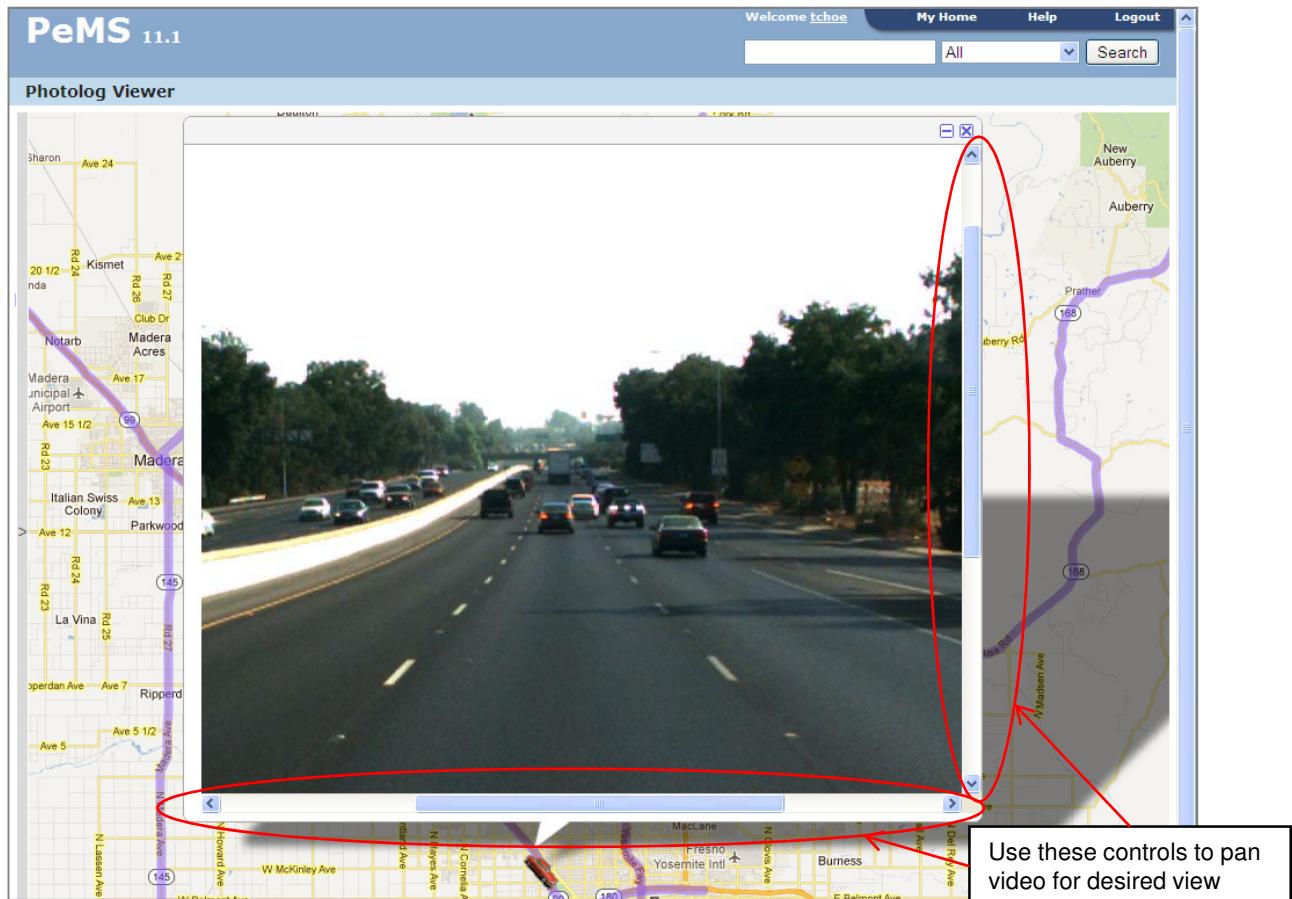
PeMS 11.1

Photolog Viewer

SR99-S - R23.81 (abs pm 136.14)
10/25/2008

SR99-S - 23.80 (abs pm 136.14)	Lane Count	3
	Road Width (ft)	36
	Lane Width (ft)	12
	Inner Shoulder Width (ft)	7
	Inner Shoulder Treated Width (ft)	7
	Outer Shoulder Width (ft)	18
	Outer Shoulder Treated Width (ft)	8
	Design Speed Limit (mph)	70
Functional Class	Principal Arterial W/ C/L	
Inner Median Type	Prin Arterial	
Inner Median Width (ft)	16	Paved - No Roadway Use

7. Click on the window to pop open a larger size window for a close up view



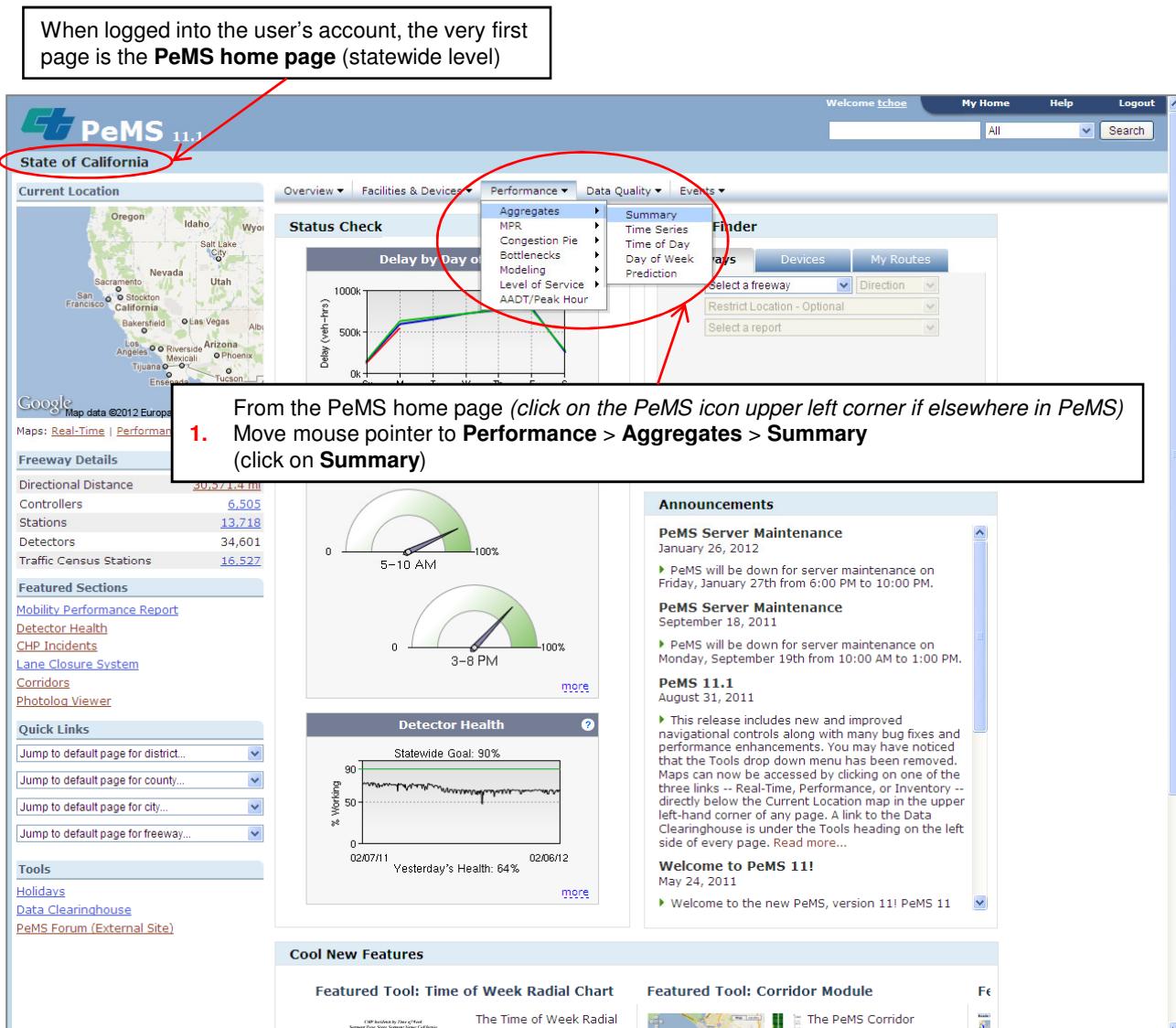
PeMS Levels of Data Analysis Guide

Instructions for navigating to the three different geographical levels of data analysis within PeMS are presented here. The main purpose of the illustrations in this section is to demonstrate how to get to the starting pages for each type of analysis (the next step – getting from these starting pages to performance reports – is described in more detail in Chapter 4). There are many ways to get to these starting pages in PeMS. Users are encouraged to spend time trying out different navigational tools in PeMS to determine their personal preferences. For instructions on how to use this guide, see Chapter 1 examples – PeMS Navigation Guide (page 1-I-1).

For illustrative purposes, District 7: LA/Ventura and its I605-N and I710-N freeways were selected to provide the examples for this exercise.

As a starting point for accessing performance measures, demonstration of how to use the Freeways inventory listing under the Facilities & Devices pull down menu is provided. While other navigational tools, such as the Inventory Map or the Report Finder, can sometimes be faster options for accessing reports, the Freeways inventory is primarily used here for consistency and to build a standardized routine for new users. Should the user ever forget the short cuts learned, the user can always go back to this standard navigational approach.

When logged into the user's account, the very first page is the **PeMS home page** (statewide level)



From the PeMS home page (click on the PeMS icon upper left corner if elsewhere in PeMS)

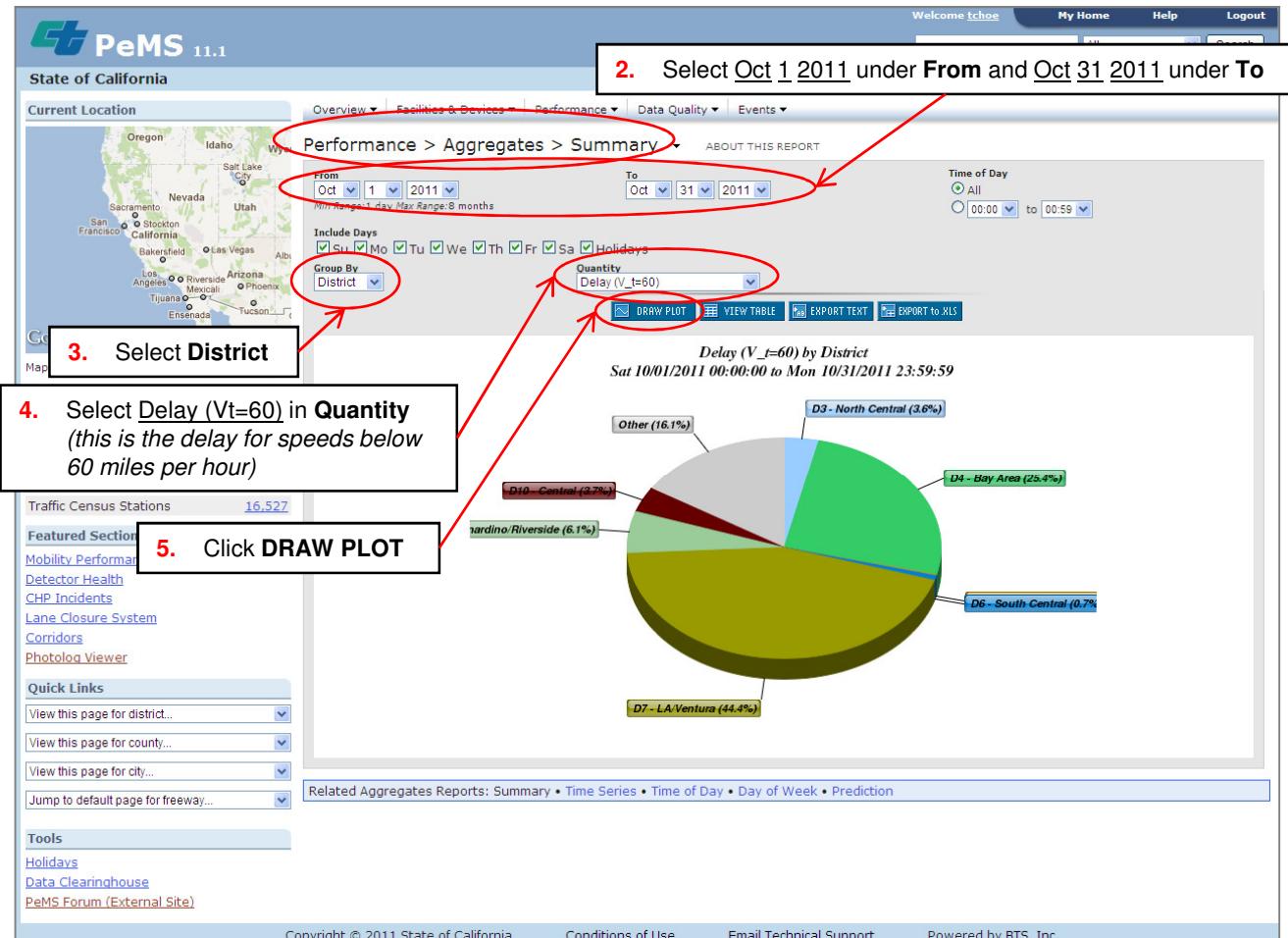
- Move mouse pointer to **Performance > Aggregates > Summary** (click on **Summary**)

PeMS 11.1 Home Page Overview:

- Top Navigation Bar:** Welcome to PeMS, My Home, Help, Logout.
- Map:** Current Location (State of California) with a red circle around it.
- Facilities & Devices:** Overview, Performance, Data Quality, Events.
- Status Check:** Delay by Day chart.
- Performance Drop-down:** Aggregates, MPR, Congestion Pre, Bottlenecks, Modeling, Level of Service, AADT/Peak Hour, Summary, Time Series, Time of Day, Day of Week, Prediction.
- Finder:** Select a freeway, Direction, Restrict Location - Optional, Select a report.
- Freeway Details:** Directional Distance (40,571.4 mi), Controllers (6,505), Stations (13,718), Detectors (34,601), Traffic Census Stations (16,527).
- Featured Sections:** Mobility Performance Report, Detector Health, CHP Incidents, Lane Closure System, Corridors, Photolog Viewer.
- Quick Links:** Jump to default page for district..., county..., city..., freeway..., Tools, Holidays, Data Clearinghouse, PeMS Forum (External Site).
- Cool New Features:** Featured Tool: Time of Week Radial Chart, Featured Tool: Corridor Module.
- Announcements:**
 - PeMS Server Maintenance:** January 26, 2012. PeMS will be down for server maintenance on Friday, January 27th from 6:00 PM to 10:00 PM.
 - PeMS Server Maintenance:** September 18, 2011. PeMS will be down for server maintenance on Monday, September 19th from 10:00 AM to 1:00 PM.
 - PeMS 11.1:** August 31, 2011. This release includes new and improved navigational controls along with many bug fixes and performance enhancements. You may have noticed that the Tools drop down menu has been removed. Maps can now be accessed by clicking on one of the three links -- Real-Time, Performance, or Inventory -- directly below the Current Location map in the upper left-hand corner of any page. A link to the Data Clearinghouse is under the Tools heading on the left side of every page. Read more...
 - Welcome to PeMS 11!** May 24, 2011. Welcome to the new PeMS, version 11! PeMS 11

In this example, look at data at the geographically aggregate level (by city, county, district, or statewide). Here is a district-level example: to know how much delay occurred in District 7 for the month of October 2011.

PeMS Levels of Analysis Geographical Aggregate Level



The above result is a plot of statewide delay, defined as that from speeds below the threshold speed of 60 miles per hour, by district in the month of October 2011. As shown, District 7 had about 44% of the statewide total delay, but not enough to know how much of this delay is in Los Angeles County or Ventura County (the two counties in District 7).

In this example, drill a level deeper and find out how much delay occurred in Ventura County in October 2011.

PeMS Levels of Analysis Geographical Aggregate Level

6. In the Quick Links control menu Click on the pull down menu and select and click on D7: LA/Ventura (this will take users to District 7 page for the same report)

The screenshot shows a pie chart titled 'Delay ($V_t=60$) by District' for the period from Saturday, October 1, 2011, to Monday, October 2, 2011. The data is as follows:

District	Percentage
D7 - LA/Ventura	44.2%
D4 - Bay Area	24.9%
D3 - North Central	3.7%
Other	17.2%
D10 - Central	2.5%
San Bernardino/Riverside	6.7%
D6 - South Central	0.7%

District 7: LA/Ventura

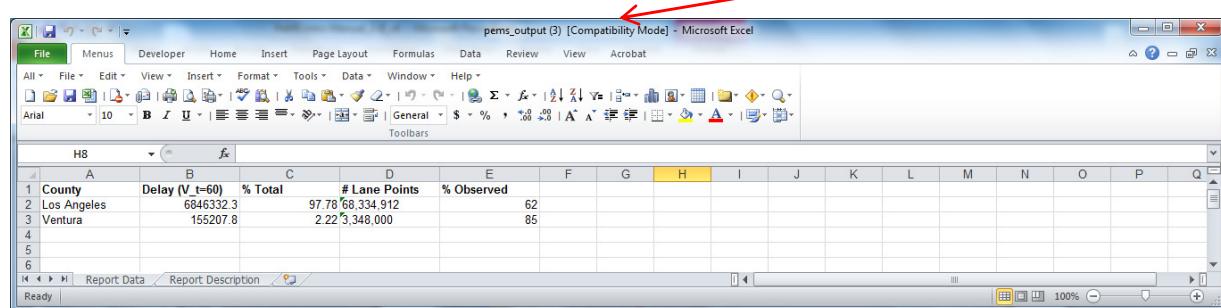
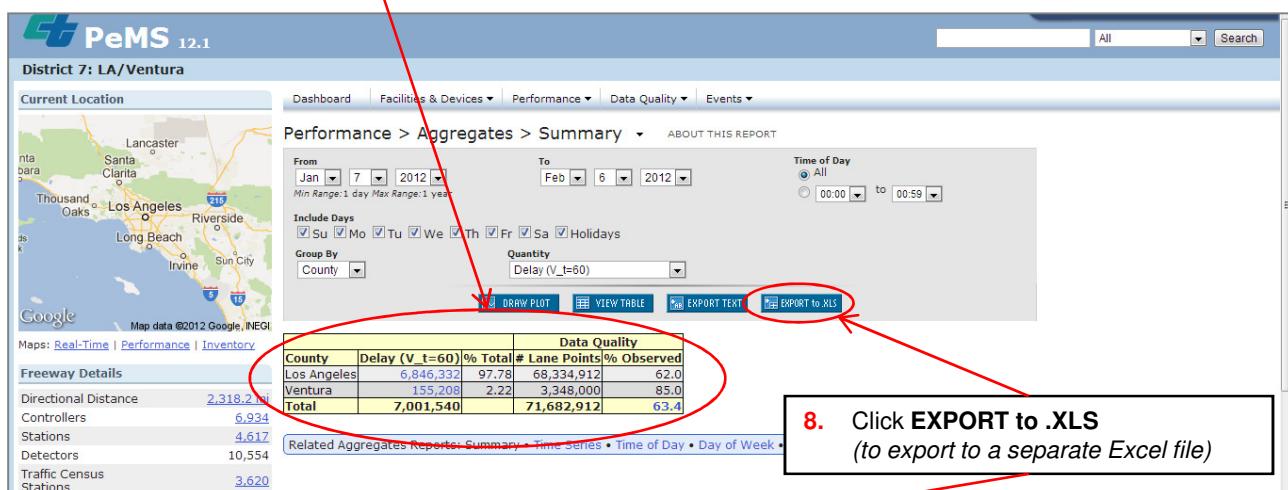
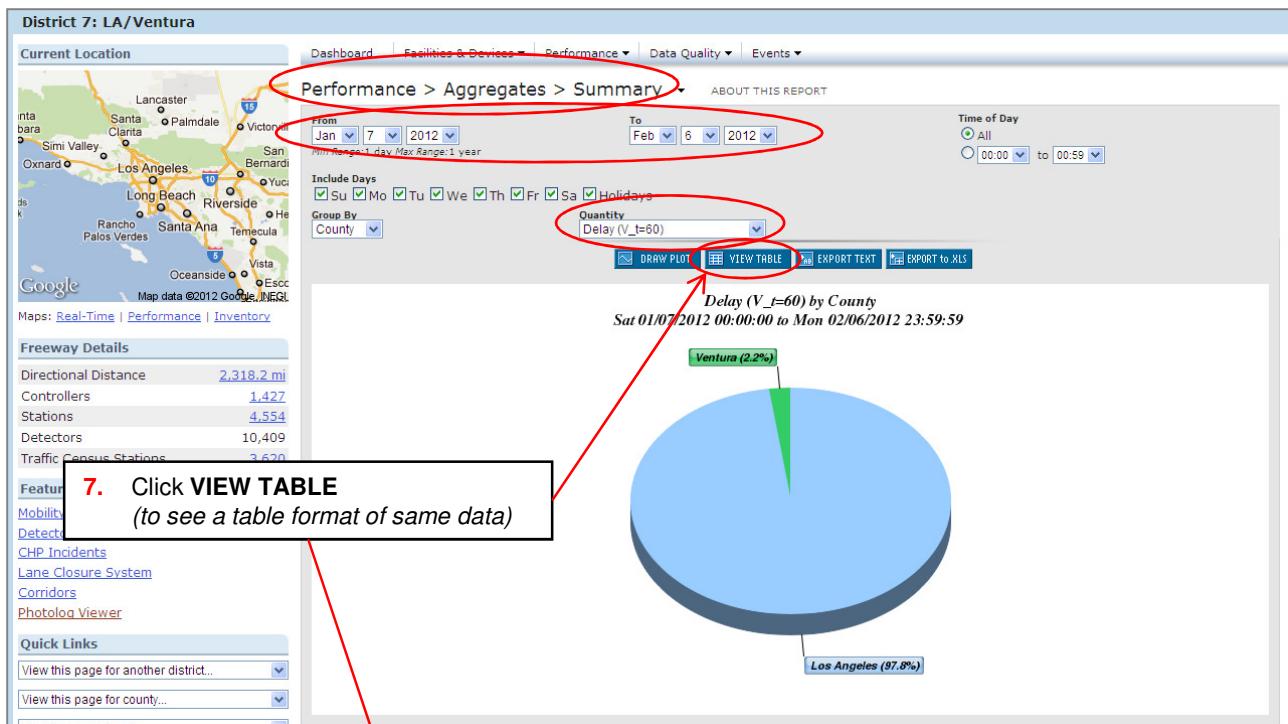
The screenshot shows a pie chart titled 'Delay ($V_t=60$) by County' for the period from Saturday, January 7, 2012, to Monday, February 6, 2012. The data is as follows:

County	Percentage
Los Angeles	97.8%
Ventura	2.2%

This plot shows that Ventura County accounts for only 2.2% of District 7's total delay, or roughly 1% of the total statewide.

In this example, the delay data is reported in several formats including pie chart plot, table, and exported Excel file.

PeMS Levels of Analysis Geographical Aggregate Level



The above result is a plot, table, and Excel file that shows Los Angeles and Ventura County delay total for a one month period.

In this next example, how to get to spatial-level (freeway segment) reports (e.g., I605-N weekday a.m. peak hour speed plot) is presented.

PeMS Levels of Analysis Spatial (Freeway Segment) Level

From the District 7: LA/Ventura home page

9. Move the mouse pointer to **Facilities & Devices > Freeways**
(click **Freeways**) – this will take users to the *Freeways inventory listing page* (note, you can also select Routes, Corridors, and Managed Facilities for spatial- level reports for those facilities)

Freeway	Detection			Mainline Facilities Detection Coverage			HOV Facilities Detection Coverage			Ramps Detection Coverage				
	# LDSs	# VDSs	# Detectors	Total Miles	# VDSs	Miles	Lane Miles	Miles	# VDSs	Miles	Lane Miles	Off	On	Fwy Fwy
I5-N	74	207	503	88.5	93	71.5	289.0	6.0	6	6.0	9.6	45	50	12
I5-S	87	229	564	88.6	105	56.8	273.0	6.0	2	6.0	7.1	38	73	8
I10-E	92	286	671	46.8	116	46.8	199.4	30.6	36	25.4	25.8	57	64	6
I10-W	88	301	701	46.8	119	46.8	194.3	20.7	43	20.7	26.3	56	63	7
I105-E	40	110	201	18.1	39	18.1	60.7	15.9	34	15.9	18.1	9	24	4
I105-W	30	111	214	18.1	40	18.1	61.5	15.9	34	15.9	18.1	14	17	6
I110-N	33	97	239	31.8	42	31.8	122.9	10.7	8	10.7	21.2	16	27	4
I110-S	28	83	204	31.8	34	25.7	97.4	10.7	14	10.7	25.1	14	19	2
I210-E	82	243	518	52.4	86	52.4	202.8	42.2	53	29.8	29.8	41	56	7
I210-W	74	265	561	52.4	92	52.4	203.9	27.4	55	27.4	29.5	46	62	9
I405-N	76	286	626	48.5	94	48.5	215.9	10.0	10	10.0	43.0	46	61	5
I405-S	82	319	688	48.5	103	48.5	210.3	68.4	68.4	97	48.5	48	62	7
I605-N	44	144	334	26.1	57	26.8	107.8	0	0	0	22.8	17	29	3
I605-S	38	152	336	26.1	55	26.8	107.6	20.7	41	20.7	23.3	19	30	7
I710-N	22	64	142	24.2	24	21.9	88.3	0	0	0	0.0	18	20	2
I710-S	27	65	154	24.2	26	22.4	91.6	0	0	0	0.0	15	21	2
ISS-N	0	0	0	2.4	0	0	0.0	0	0	0	0.0	0	0	0
ISS-S	0	0	0	2.5	0	0	0.0	0	0	0	0.0	0	0	0
I105-E	0	0	0	11.6	0	0	0.0	0	0	0	0.0	0	0	0
I105-W	0	0	0	11.6	0	0	0.0	0	0	0	0.0	0	0	0
SR1-N	0	0	0	0.0	0	0	0.0	0	0	0	0.0	0	0	0
SR1-S	0	0	0	0.0	0	0	0.0	0	0	0	0.0	0	0	0
SR2-E	0	0	0	0.0	0	0	0.0	0	0	0	0.0	0	0	0
SR2-W	8	34	84	73.8	14	12.4	38.6	0	0.0	0	0.0	6	7	7
SR14-N	9	36	53	52.2	10	26.2	67.8	35.9	35.9	9	21.2	8	9	0
SR14-S	9	33	50	52.2	10	25.1	65.1	35.9	35.9	9	20.1	5	9	0
SR18-N	0	0	0	4.5	0	0	0.0	0	0.0	0	0.0	0	0	0
SR18-S	0	0	0	4.5	0	0	0.0	0	0.0	0	0.0	0	0	0
SR19-N	0	0	0	8.7	0	0	0.0	0	0.0	0	0.0	0	0	0
SR19-S	0	0	0	8.7	0	0	0.0	0	0.0	0	0.0	0	0	0
SR22-E	0	0	0	1.5	0	0	0.0	0	0.0	0	0.0	0	0	0

- 10.** Click on any of these links to go to the desired freeway segment for spatial level reports (See Chapter 4 for more information on this topic)

PeMS Levels of Analysis

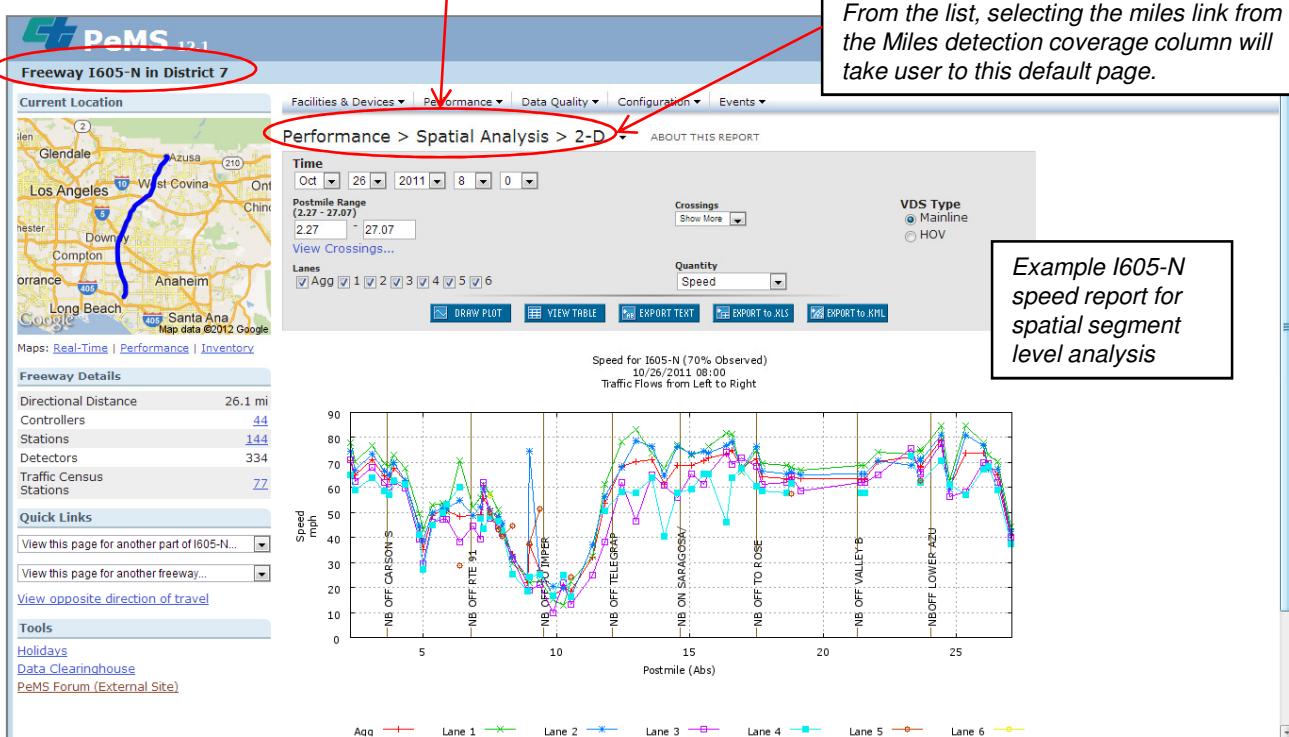
Spatial (Freeway Segment) Level

From the Freeway I605-N in District 7 page

12. Move the mouse pointer to Performance > Spatial Analysis > 2-D (click 2-D)

The screenshot shows the PeMS 12.1 interface with the 'Freeway I605-N in District 7' page selected. The 'Performance' menu is open, and the '2-D' option under the 'Spatial Analysis' submenu is highlighted. A red box surrounds the '2-D' button in the main toolbar.

Fwy	Dist	County	City	CA PM	Abs PM ID	Name	Line	Drop MS ID
I605-N	7	Los Angeles	Seal Beach	R.23	2.28 715161	SPRING 1	12	4 3435
			Long Beach	R1.03	3.08 715703	WARDLOW	12	17 2137
				R1.5	3.55 773714	223RD STREET	57	2 2659
				R1.68	3.73 715162	CARSON EB	12	5 3436
						CARSON 2	12	6 3437
						ENTRALIA	12	18 2138
						EL AMO 1	12	14 3438
						EL AMO 2	12	15 3439
						5TH STREET	57	3 2660
						SOUTH 1	12	9 3440
				R3.82	5.87 715167	SOUTH 2	12	10 3441
				R5.1	7.15 773738	ROUTE 605 / ROUTE 91	57	4 2450
				R5.2	7.25 773744	ROUTE 605 / ROUTE 91	57	5 2439
				R5.77	7.82 715000	ALONDRA 1	15	14 3244
				R5.93	7.07 715001	ALONDRA 2	15	15 3245



In this next example, how to get to a station level report (e.g., I710-N weekday flow plot near the Rosecrans interchange) is presented.

PeMS Levels of Analysis Station Level

From the District 7: LA/Ventura home page

13. Move mouse pointer to Facilities & Devices > Freeways
(click **Freeways**) – this will take users to the *Freeways inventory listing page* (note, you can also select *Field Elements > Stations* to get to station level reports)

Freeway Inventory Listing
From this list, users can also get to station level reports

Fwy	Detection			Mainline Facilities Detection Coverage			HOV Facilities Detection Coverage			Ramps Detection Coverage				
	# LDSs	# VDSs	# Detectors	Total Miles	# VDSs	Miles	Lane Miles	# VDSs	Miles	Lane Miles	Off	On	Fwy	
I5-N	74	207	503	88.5	93	71.9	289.0	6.0	6	6.0	9.6	45	50	12
I5-S	87	229	564	88.6	105	66.8	273.0	6.0	6.0	2.0	7.1	58	73	8
I10-E	92	286	671	46.8	116	46.8	199.4	30.6	36	25.4	25.8	57	64	6
I10-W	88	201	701	46.8	119	46.8	194.3	20.7	43	20.7	26.3	56	63	7
I105-E	40	110	201	18.1	39	18.1	60.7	15.9	34	15.9	18.1	9	24	4
I105-W	30	111	214	18.1	40	18.1	61.5	15.9	34	15.9	18.1	14	17	1
I110-N	33	97	239	31.8	42	31.8	122.9	10.7	8	10.7	21.2	16	27	1
I110-S	28	83	204	31.8	34	25.7	97.4	10.7	14	10.7	25.1	14	19	2
I210-E	82	243	518	52.4	86	52.4	202.8	42.2	53	29.8	29.8	41	56	7
I210-W	74	265	561	52.4	92	52.4	203.9	27.4	55	27.4	29.5	46	62	9
I405-N	76	286	626	48.5	94	48.5	215.9	10.0	79	10.0	43.0	46	61	5
I405-S	82	319	688	48.5	103	48.5	210.3	68.4	97	48.5	48.5	48	62	7
I605-N	44	144	334	26.1	57	26.8	107.8	0	0	0	22.8	17	29	3
I605-S	38	152	336	26.1	55	26.8	107.6	20.7	41	20.7	23.3	19	30	7
I710-N	22	64	142	24.2	24	21.9	88.3	0	0	0	0.0	18	20	2
I710-S	27	0	154	24.2	26	22.4	91.6	0	0	0	0.0	15	21	2
ISS-N	0	0	0	2.4	0	0	0.0	0	0	0	0.0	0	0	0
ISS-S	0	0	0	2.5	0	0	0.0	0	0	0	0.0	0	0	0
I10S-E	0	0	0	11.6	0	0	0.0	0	0	0	0.0	0	0	0
I10S-W	0	0	0	11.6	0	0	0.0	0	0	0	0.0	0	0	0
SR1-N	0	0	0	0	0	0	0.0	0	0	0	0.0	0	0	0
SR1-S	0	0	0	0	0	0	0.0	0	0	0	0.0	0	0	0
SR2-E	13	35	0	0	0	0	0.0	0	0	0	0.0	5	7	5
SR2-W	8	34	0	0	0	0	0.0	0	0	0	0.0	6	7	6
SR14-N	9	36	0	0	0	0	0.0	0	0	0	0.0	8	9	0
SR14-S	9	33	0	0	0	0	0.0	0	0	0	0.0	5	9	0
SR18-N	0	0	0	0	0	0	0.0	0	0	0	0.0	0	0	0
SR18-S	0	0	0	0	0	0	0.0	0	0	0	0.0	0	0	0
SR19-N	0	0	0	0	0	0	0.0	0	0	0	0.0	0	0	0
SR19-S	0	0	0	0	0	0	0.0	0	0	0	0.0	0	0	0
SR19-S	0	0	0	0	0	0	0.0	0	0	0	0.0	0	0	0
SR22-F	0	0	0	0	0	0	1.5	0	0	0.0	0.0	0	0	0

14. Click on any of these links to go to the desired freeway detector station list to select the appropriate station for station level reports (See Chapter 4 for more information on this topic)

15. Click on 64 (I710-N row - #VDSs column) - this is the total number of available vehicle detector stations (VDS) on the selected roadway facility

PeMS Levels of Analysis Station Level

You should see **Freeway I710-N in District 7** in
Facilities & Devices > Field Elements > Stations page

Facilities & Devices > Field Elements > Stations

Fwy	Dist	County	City	CA PM	Abs PM	Length	ID	Name	Lanes	Type	HOV	MS ID	IRM
I710-N	7	Los Angeles	Long Beach	6.8	1.84	0.000	772982	W/B ANAHEIM- N/B 710	1	On Ramp	No	3089	
				6.8	1.84	1.840	772689	E/B ANAHEIM - N/B710	4	Mainline	No	3086	
				6.8	1.84	2.100	772980	W/B ANAHEIM- N/B 710	4	Mainline	No	3089	
				6.8	1.84	0.000	772981	W/B ANAHEIM- N/B 710	1	Off Ramp	No	3089	
				6.8	1.84	0.000	772691	E/B ANAHEIM - N/B710	1	Off Ramp	No	3086	
				6.8	1.84	0.000	772690	E/B ANAHEIM - N/B710	1	On Ramp	No	3086	
				9.72	4.76	0.000	737211	PACIFIC	1	On Ramp	No	3450	
				10.69	5.73	0.000	718319	DEL AMO EB	1	Off Ramp	No	3451	
				10.69	5.73	0.000	718318	DEL AMO EB	1	On Ramp	No	3451	
				11	6.04	2.665	717962	DEL AMO 2	4	Mainline	No	3452	
				11	6.04	0.000	717961	DEL AMO WB	1	Off Ramp	No	3452	
				11	6.04	0.000	716844	DEL AMO WB	1	On Ramp	No	3452	
				12.13	7.17	0.000	717965	LONG BEACH NB	1	Off Ramp	No	3453	
				12.13	7.17	1.145	717966	LONG BEACH	5	Mainline	No	3453	
				12.13	7.17	0.000	716846	LONG BEACH NB	1	On Ramp	No	3453	
				13.29	8.33	0.985	717968	ATLANTIC	3	Mainline	No	3454	
				14.1	9.14	0.000	716850	ALONDRA	1	On Ramp	No	3455	
				14.1	9.14	0.545	761734	ALONDRA	1	Off Ramp	No	3455	
				14.1	9.14	0.000	761735	ALONDRA	5	Mainline	No	3455	
				14.38	9.42	0.400	718488	COMPTON	6	Mainline	No	2209	
				14.9	9.94	0.000	716852	ROSECRAINS EB	1	On Ramp	No	3456	
				14.9	9.94	0.360	717770	ROSECRAINS 1	4	Mainline	No	3456	
				14.9	9.94	0.000	717974	ROSECRAINS EB	1	Off Ramp	No	3456	
				R15.1	10.14	0.200	718102	ROSECRAINS 2	4	Mainline	No	3457	
				R15.1	10.14	0.000	716854	ROSECRAINS WB	1	On Ramp	No	3457	
				R15.3	10.34	0.400	718492	S OF 105	4	Mainline	No	2647	
				R15.9	10.94	0.400	717977	KING 1	4	Mainline	No	3458	

Mainline VDS 717770 - ROSECRAINS 1

Change Log

Date	Status	Name	Lanes	CA PM	Abs PM	Length	Lat	Lng
06/01/2000	Active	ROSECRAINS 1	1 2 3 4	14.9	9.94	0.36	33.902585	-118.185914
02/23/2007	Active	ROSECRAINS 1	1 2 3 4	14.9	9.94	0.36	33.902585	-118.185914
09/01/2011	Active	ROSECRAINS 1	1 2 3 4	14.9	9.94	0.36	33.902585	-118.185914

Lane Detection

Lane	Slot	ID	Type
1	1	761723	Mainline
2	2	761724	Mainline
3	3	761725	Mainline
4	4	761726	Mainline

PeMS Levels of Analysis Station Level

You should see **Freeway I710-N in District 7** in
Facilities & Devices > Field Elements > Stations page

Mainline VDS 717770 - ROSECRANS 1

Change Log | **Performance** ▾ | **Data Quality** | **Events**

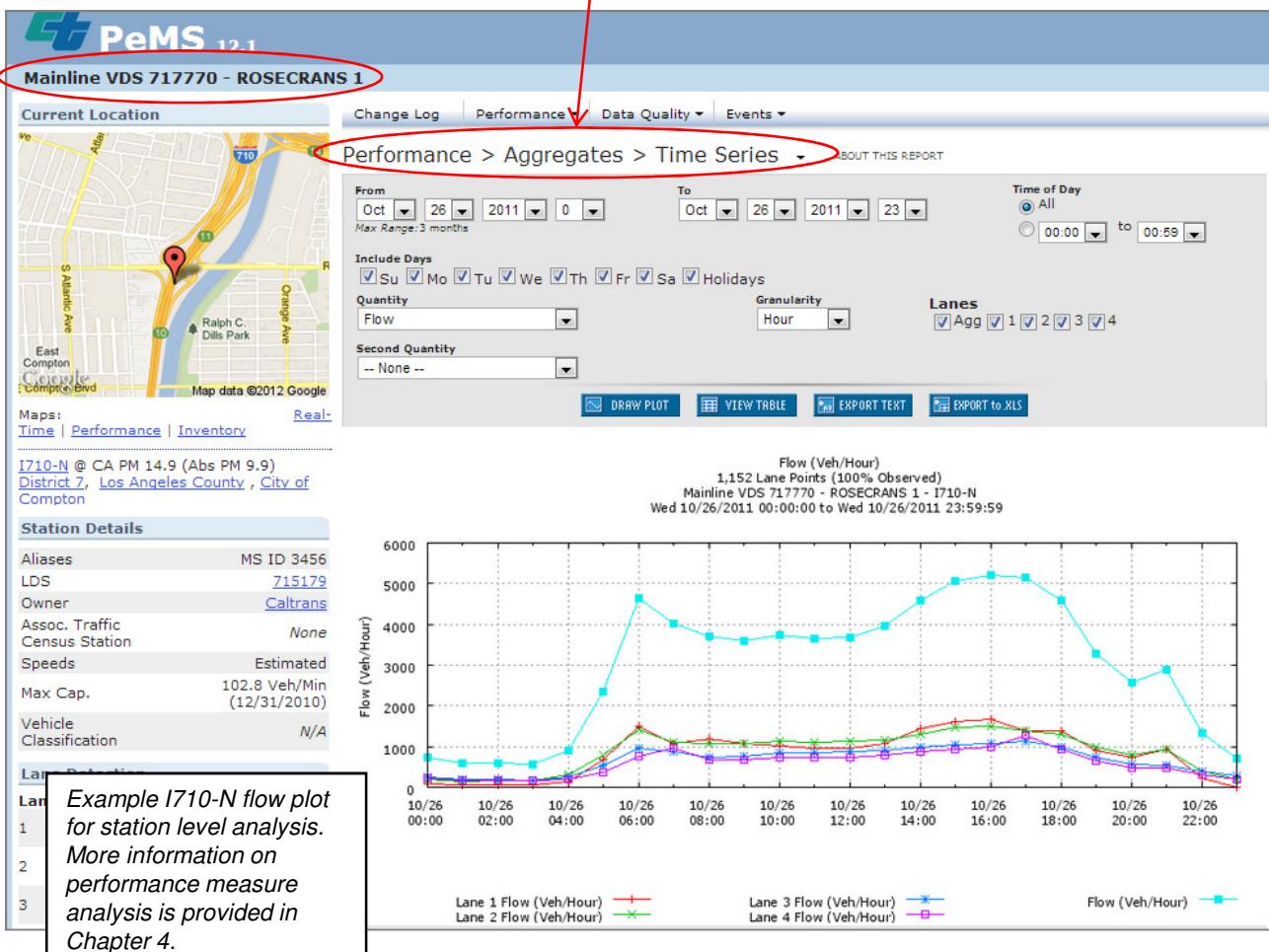
Roadway Info

Road Width	72 ft
Lane Width	12.0 ft
Inner Shoulder Width	4 ft
Inner Shoulder Treated Width	4 ft
Outer Shoulder Width	10 ft
Outer Shoulder Treated Width	10 ft
Design Speed Limit	70 mph
Functional Class	Principal Arterial W/ C/L Prin Arterial
Inner Median Type	Paved - No Roadway Use
Inner Median Width	16 ft
Terrain	Flat
Population	Urbanized

From I710-N Mainline VDS 717770 – ROSECRANS 1 configuration page

17. Move mouse pointer to **Performance > Aggregates > Time Series**
(click **Time Series**) – this will take users to **Time Series** reports for station level analysis

Date	Status	ROSECRANS 1	1 2 3 4	14.9	9.94	0.36	33.902585	-118.185914
06/01/2000	Active	ROSECRANS 1	1 2 3 4	14.9	9.94	0.36	33.902585	-118.185914
02/23/2007	Active	ROSECRANS 1	1 2 3 4	14.9	9.94	0.36	33.902585	-118.185914
09/01/2011	Active	ROSECRANS 1	1 2 3 4	14.9	9.94	0.36	33.902585	-118.185914
02/23/2012	Active	ROSECRANS 1	1 2 3 4	14.9	9.94	0.36	33.902585	-118.185914



Chapter 3

Detector Health

CHAPTER 3

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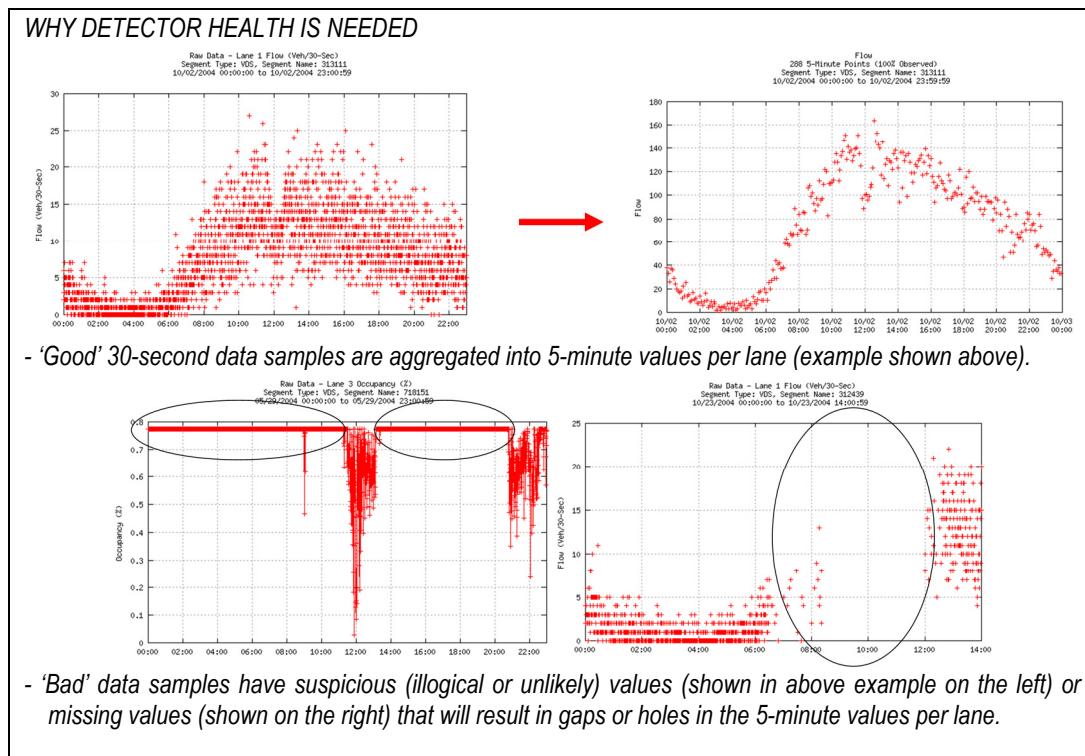
Vehicle detectors are the main source of data in PeMS. The system records data from the detectors, adds appropriate information about the detectors (i.e. detector identification number, location name, postmile, etc.), and calculates transportation performance measures. Since the detector data is the basis for most of the performance calculations, the resulting performance measures are only as accurate as the underlying data. In this chapter, users will learn about how PeMS tests for the “health” or accuracy of the vehicle detectors and provides diagnostics so they can consider the quality of the data used to calculate the performance measures. For any analysis in PeMS, confirming the data quality is essential.

Why is it necessary to monitor detector health?

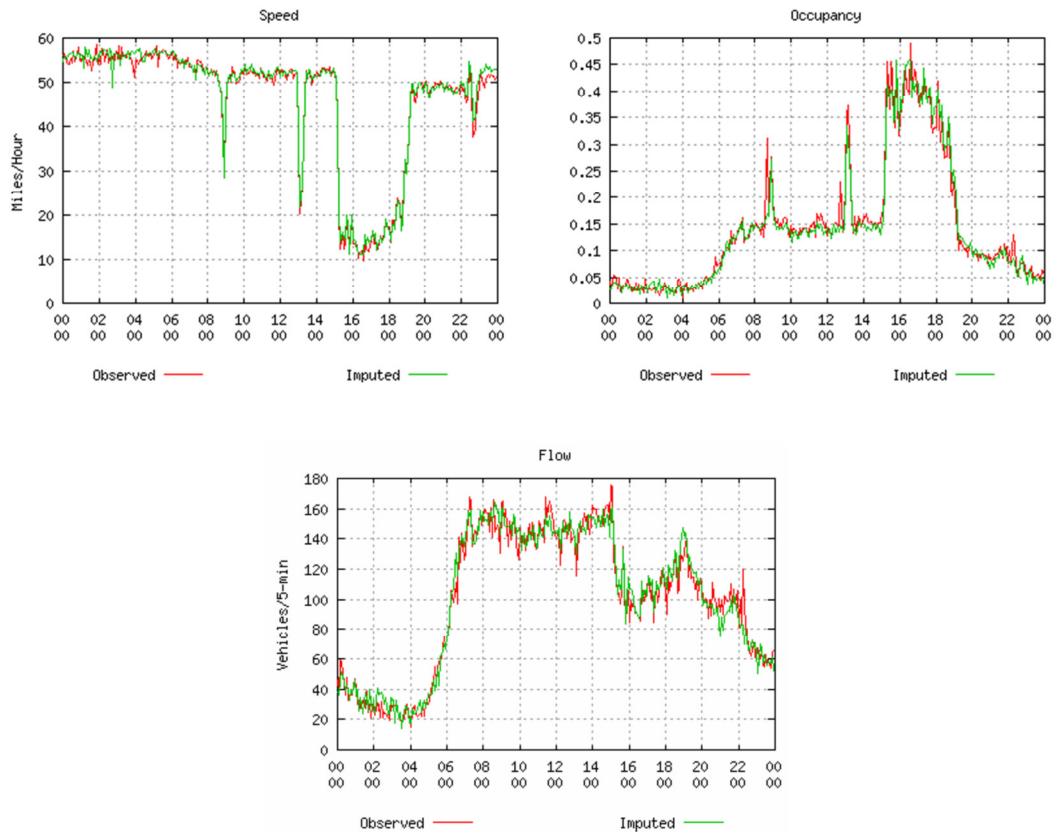
Vehicle detectors provide the best source of real-time traffic data available to Caltrans. The Department has installed detectors to cover most urban freeways on the State Highway System. The data stream, however, can contain “holes” (missing values) or “bad” (incorrect) values that require careful analysis to produce reliable results.

PeMS uses algorithms to detect when data is bad and does not use bad data to compute performance measures. Instead of using bad data, PeMS develops estimated or imputed values to fill holes and replace bad data in the data stream. The resulting database of complete and reliable data ensures that analyses produce meaningful results. Although no estimation approach is perfect, PeMS relies on extensive analysis of all of the detectors in the state to help approximate what the true values would be had the faulty detectors been working properly and sending good data. The ability of PeMS to adjust for missing data is a real advantage in using PeMS for performance measurement.

The PeMS algorithms have been tested, adjusted, and re-adjusted to yield effective results. The algorithms have their historical roots in a paper by Chen, Kwon, Skabardonis and Varaiya (members of the PeMS original development team). This paper, *“Detecting errors and imputing missing data for single loop surveillance systems,”* is available on the Internet at http://pems.dot.ca.gov/Papers/loops_asv2.pdf. The algorithms that PeMS use have been modified from the original version described in the paper as a result of Caltrans’ experience operating PeMS for more than a decade.



WHY DETECTOR HEALTH IS NEEDED

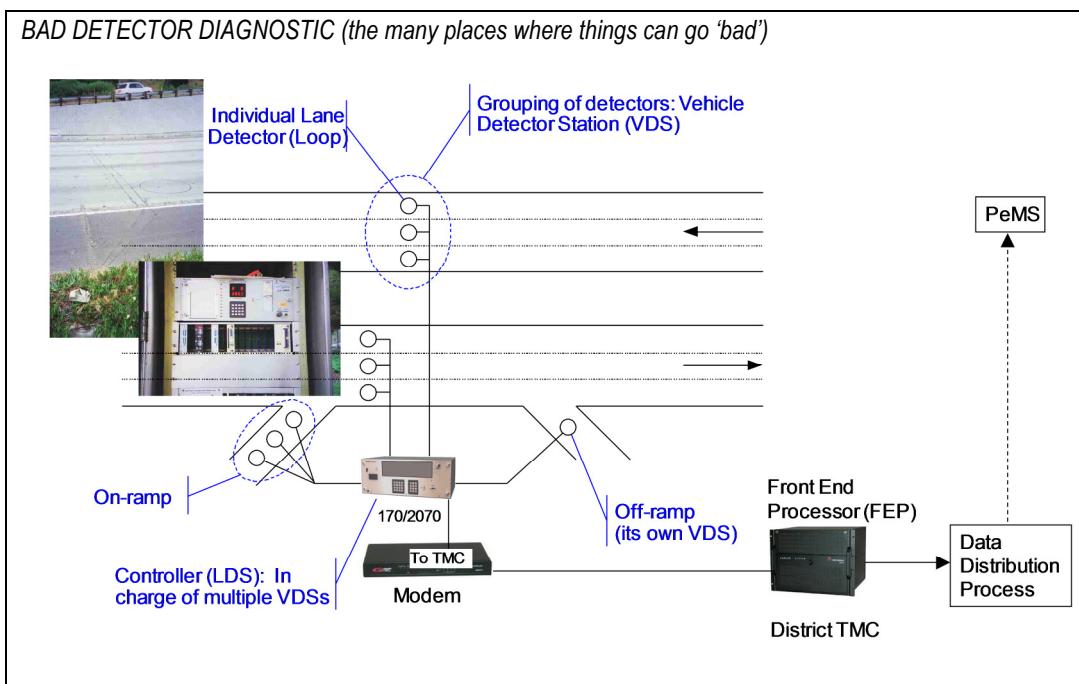


- These holes need to be filled with imputed values (example shown in above image in green) for complete and meaningful performance measures. Observed data (shown in red) are the actual 'good' data that passed all the PeMS diagnostic tests.

I. Detector Health

Detectors can go ‘bad’ or malfunction for many reasons. For some detectors, this is an intermittent problem. For other detectors, the problem is recurrent. PeMS devotes a large amount of its computing resources to identifying bad detectors and calculating health diagnostics to help users evaluate data quality and to help those responsible for detector maintenance.

Caltrans has a complex data collection system to measure traffic performance for transportation system management purpose. The figure below provides an overview of the data collection and distribution process. There are many potential points of failure in this process, including the detection devices themselves to the controllers and the communications links to PeMS. Although the cause of “bad” detector data is often physical (i.e., hardware, equipment, or device), it can also involve non-physical, “human error,” such as making errors in the configuration of the device, associating the wrong county, route and postmile with a station, or assigning the wrong identification number to a station. These human errors can be difficult to diagnose.



The PeMS procedure for identifying bad detectors is based on observed measurements of volume and occupancy. The system computes summary statistics from the measurements recorded every day. PeMS performs a number of simple filters on individual data samples to make sure that they make sense (e.g., no values are less than zero, values fit the PeMS database fields, etc.). The concept is that when detectors are broken (or gone bad), they stay broken until fixed or corrected and determined to be good. The goal is to find bad detectors rather than bad data.

The PeMS detector health reports allow users to examine in detail which detectors PeMS has determined to be faulty using diagnostic algorithms. Every day, PeMS subjects each lane detector in the system to diagnostic tests and determines whether the detector produced good or bad data on that particular day. If a detector is determined to be faulty, PeMS tries to deduce the cause from patterns in the data and the health of nearby detectors. For example, if all detectors tied in to the same controller are down, PeMS deduces that there’s a problem with the controller. If all of the detectors tied into the same communications line are down, it deduces there’s a problem with the communications. If just one detector is sending data that does not make sense, but other detectors in the same station are fine, it will deduce the problem is with the individual detector.

Diagnostic tests are applied to all types of detectors in the system, including on- and off-ramp detectors. PeMS applies tests tailored for each detector type. Since ramp detectors usually report only flow and most mainline detectors report flow and occupancy, PeMS uses a subset of the mainline detector tests for ramp detector testings.

The table below lists the tests that are applied to the data from each detector at the end of the day. PeMS uses the tests in the order listed. PeMS applies most of these tests to the 30-second data but some are applied to the 5-minute data. For all of these tests, PeMS determines whether there are too many samples that match a certain criterion.

Test Num	Det Types	Condition	Description	Diagnostic Test	Data Used	Diagnostic
1	ML, HOV, Ramp	Never receive any data samples	PeMS break down this condition into three bins based on the communication infrastructure. The first bin indicates that none of the detectors on the same communication line as the selected detector are reporting data. Note that information about communication lines is not always available. In this case, this test is omitted.	Number of samples received is equal to zero for all detectors on the same communication line.	30-sec	Line Down
			The second bin indicates that none of the detectors attached to the same controller as the selected detector are reporting data. This probably indicates no power at this location or the communication link is broken.	Number of samples received is equal to zero for all detectors attached to the controller. If communication line information is available, then at least one other controller on the same line is reporting data.	30-sec	Ctrl Down
			The third bin indicates that the individual detector is not reporting any data, but other detectors on the same controller are sending samples. This most likely indicates a software configuration error or bad wiring.	Number of samples received is equal to zero, but other detectors on the same controller are reporting data.	30-sec	No Data
2	ML, HOV, Ramp	Too few data samples	PeMS received some samples but not enough to perform diagnostic tests. Other detectors reported more samples (so the data feed did not die).	# of samples < 60% of the max collected samples during the test period.	30-sec	Insufficient Data
3	ML, HOV, Ramp	Zero occ or flow	There are too many samples with an occupancy (ML only) or flow (RM only) of zero. PeMS suspects that the detector card (in the case of standard loop detectors) is off.	ML: # zero occ samples > % of the max collected samples during the test period. RM: # zero flow samples > % of the max collected samples during the test period.	30-sec	Card Off
4	ML, HOV, Ramp	High values	There are too many samples with either occupancy above 0% (ML only) or flow above veh/30-sec (ramps only). The detector is probably stuck on.	ML: # high occ samples > % of the max collected samples during the test period. RM: # high flow samples > % of the max collected samples during the test period.	30-sec	High Val
5	ML, HOV	Flow-Occ mismatch	There are too many samples where the flow is zero and the occupancy is non-zero. This could be caused by the detector hanging on.	# flow-occ mismatch samples > % of the max collected samples during the test period.	30-sec	Intermittent
6	ML, HOV	Occupancy is constant	The detector is stuck at some value for some reason. PeMS knows that occupancy should have some variation over the day. PeMS counts the number of times that the occupancy value is non-zero and repeated from the last sample (is exactly the same as the last sample).	# repeated occupancy values > 5-min samples.	5-min	Constant
7	ML, HOV, Ramp	Not enough data samples received	Data feed itself died and PeMS could not collect enough data samples during the day to run the tests. On days where this occurs PeMS marks the detectors that were previously good as good and ones that were previously bad as <i>Feed Unstable</i> .	# of raw data samples collected during the test period received is less than 60% of total expected during test period.	30-sec	Feed Unstable

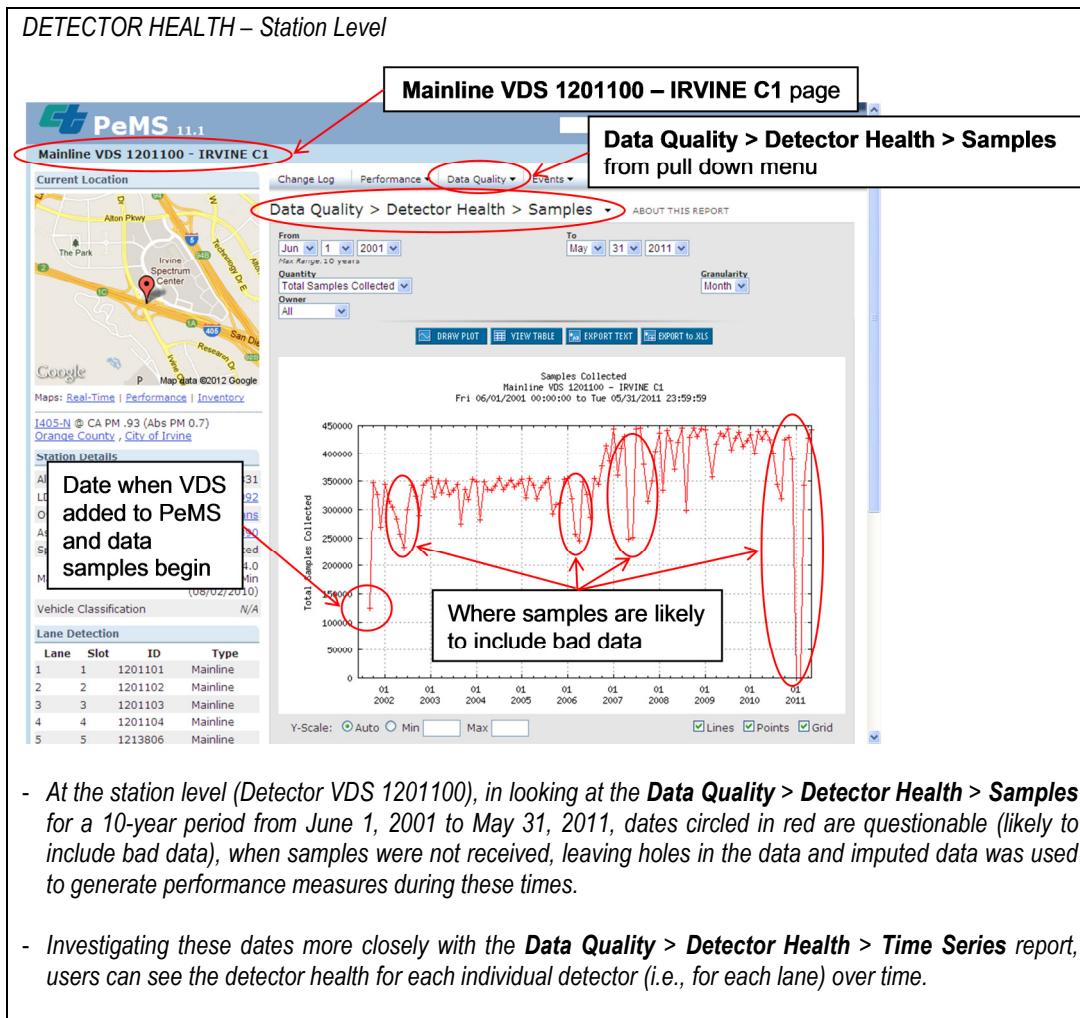
Assessing Data Quality

There are three main detector health reports available in PeMS to assess data quality: Summary, Time Series, and Samples. There are also three geographic levels: the station level, freeway segment level, and geographical aggregate level. Below is more information on the different geographic levels.

Station Level Analysis

At the individual detector station level, users can assess the health and data quality of the detectors within one station. At this level, there are two types of conditions: stations with all bad detectors and stations with some good and some bad detectors. This is useful information to consider when reviewing performance measures. If one or two lanes of good data can reasonably represent overall traffic conditions, users may find that data from a partially good detector station is sufficient for analysis. If not, users will need to select a date or time when the entire station was working.

If PeMS marks a detector as “bad” for a particular date or time, users can check what PeMS has deduced is the likely cause. If having “good” data at a particular location is important to the user, the PeMS diagnostics will help to find the best quality data available.



DETECTOR HEALTH – Station Level

Mainline VDS 1201100 – IRVINE C1 page

Data Quality > Detector Health > Time Series from pull down menu

bad data

> Detail

Freeway	VDS	Type	Lane	Status	Recv'd	Occupied	High Flow	High Occupancy	Flow=0	Occ<0	Rpt
I-405	93	1201100	1	Insufficient Data	1,127	0	0	18	19	0	0
I-405	93	1201100	2	Insufficient Data	1,127	547	547	0	1	0	0
I-405	93	1201100	3	Insufficient Data	1,127	0	1	6	1	1	0
I-405	93	1201100	4	Insufficient Data	1,127	4	4	1	1	0	0
I-405	93	1201100	5	No Data	0	0	0	0	0	0	0

- At the station level (Detector VDS 1201100), in looking at **Data Quality > Detector Health > Time Series** from September 15, 2010 to September 30, 2010, it is revealed that lane 5 (outermost lane) had no data (indicated in light blue) or unstable feed (indicated in purple) from 09/15/2010 to 09/27/2010. On 09/27/2010, detectors were bad in all lanes, but lanes 1 to 4 had insufficient data (indicated in dark blue).
- In looking at **Data Quality > Detector Health > Detail** for September 27, 2010, users can see more information about the type of error and the flow and occupancy values received (see inset example above).

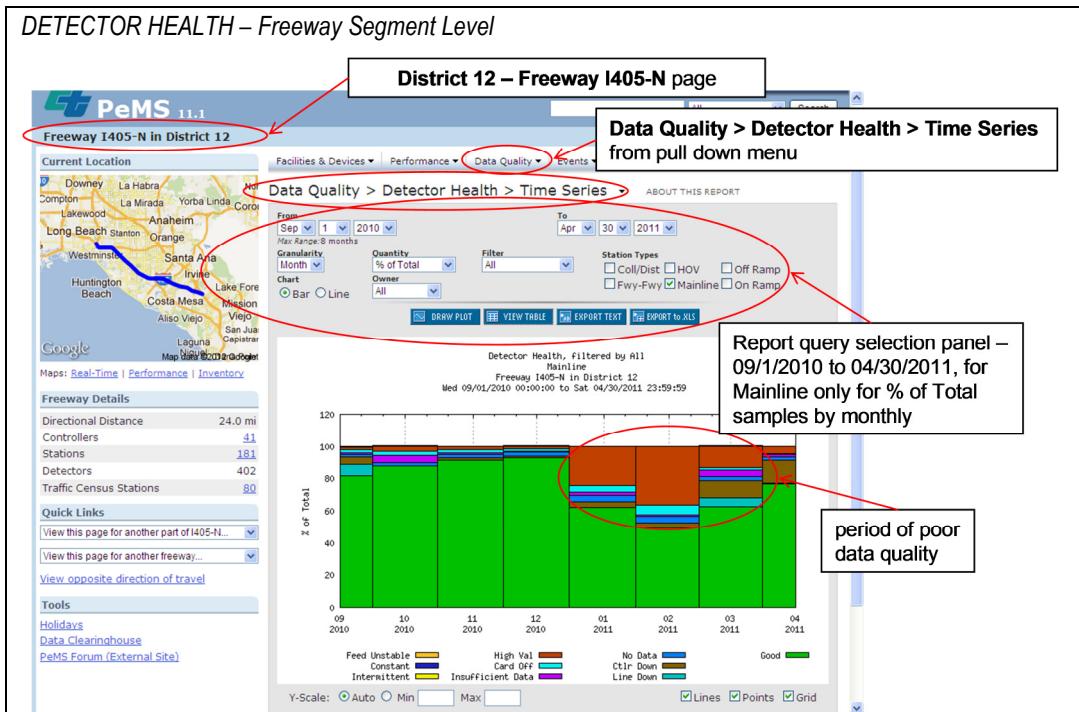
Freeway Segment Level Analysis

As just shown above for the station level analysis, users can view the samples received (**Data Quality > Detector Health > Samples**) for any freeway segment to determine the dates where there could be suspect data within the period of interest. The Samples report aggregates the samples from the individual stations within the user defined a freeway segment.

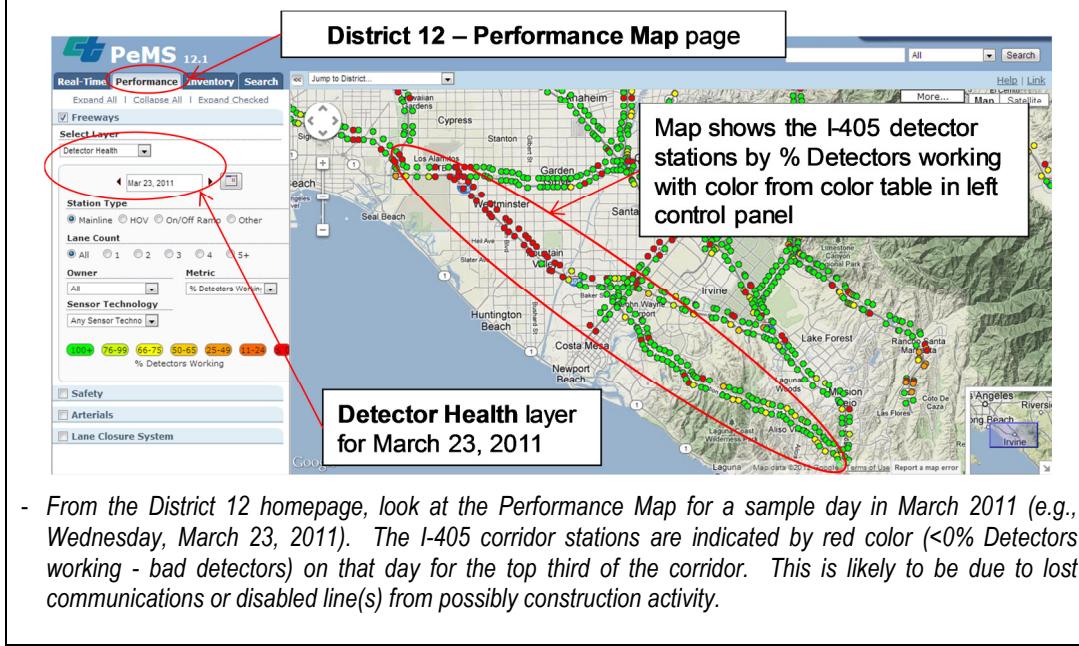
When analyzing a freeway segment, the emphasis is often about looking at the pattern of good and bad detectors down the freeway. For example, data quality is worse when a group of stations is bad in one section of the freeway segment as compared to having the broken stations interspersed down the freeway, even though the percentage of the bad detection is the same in both cases. This is because the imputation algorithms are more effective in estimating values in the latter case where there are more good detectors nearby from which to impute data for the bad stations. When the bad stations are all grouped together, there is not much good data from which to estimate values.

The **Data Quality > Detector Health > Time Series** report is useful for doing this type of freeway analysis in that it shows the detector health for each detector station within the chosen freeway segment. The report can be plotted by bar chart or line graph that shows the quality of the detectors for the freeway segment over time period, essentially a count of the number of detectors falling into each category of suspected error every day. Users can select the types of detector stations to include in the plot. Below is an illustrated example.

At the freeway segment level, users can also view detector health across all lanes for every station within a freeway segment on a given date using the report **Data Quality > Detector Health > Lanes**. The **Data Quality > Detector Health > Intensity** report provides a similar view of detector quality by station (not by lane) over a date range. Users can also view the **Performance Map** (see Chapter 2) and select the Detector Health layer to view detector health spatially.



- At the freeway segment level (District 12 – I405-N), look at **Data Quality > Detector Health > Time Series** from September 1, 2010 to April 30, 2011. January, February, and March 2011 had the poorest data quality in this time range (indicated by the non-green colors). During February 2011, about 50% of the freeway segment's detector stations had bad data quality.



- From the District 12 homepage, look at the Performance Map for a sample day in March 2011 (e.g., Wednesday, March 23, 2011). The I-405 corridor stations are indicated by red color (<0% Detectors working - bad detectors) on that day for the top third of the corridor. This is likely to be due to lost communications or disabled line(s) from possibly construction activity.

Geographical Aggregate Level

At the geographical aggregate level, users can assess the data quality of freeways within a larger geographical boundary. At this high level, detector health can be reported only in aggregate by region (e.g., county or district) or by freeway, not by individual station. This reporting level can provide an overall indication of a region's detection health and data quality.

DETECTOR HEALTH – Geographical Aggregate Level

District 6 Homepage

Data Quality > Detector Health > Summary
from pull down menu

Freeway Details

Directional Distance	4,072.7 mi
Controllers	133
Stations	260
Detectors	646
Traffic Census Stations	1,336

Featured Sections

- Mobility Performance Report
- Detector Health
- CHP Incidents
- Lane Closure System
- Corridors
- Photolog Viewer

Quick Links

- View this page for another district...
- View this page for county...

Data Quality > Detector Health > Summary

Date: Nov 30, 2011 | Group By: Freeway | Station Types: Coll/Dist, HOV, Off Ramp, Fwy-Fwy, Mainline | Show Values As: %

% Working

Good (89.47%)
Bad (10.53%)

Suspected Errors

- Line Down (0.00%)
- Ctr Down (27.94%)
- No Data (1.47%)
- Insufficient Data (20.59%)
- Card Off (32.35%)
- High Val (14.71%)
- Intermittent (2.94%)
- Constant (0.00%)
- Feed Unstable (0.00%)

Status by Freeway

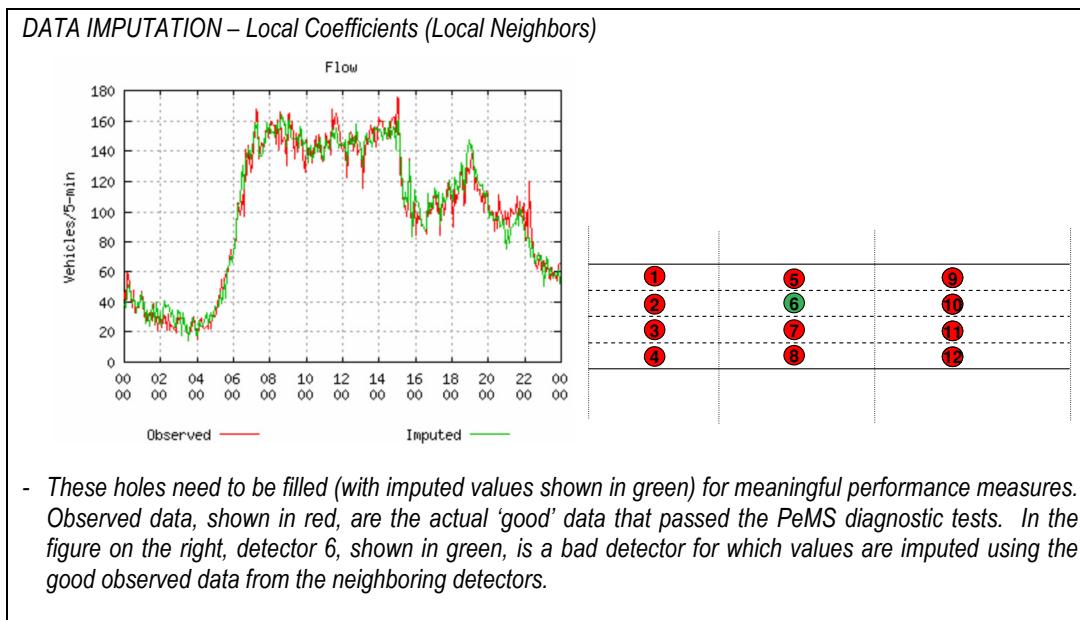
Freeway	# Det	% Good	% Bad	Line Down	Ctr Down	No Data	Insufficient Data	Card Off	High Val	Intermittent	Constant	Feed Unstabl
I5-N	2	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.
I5-S	2	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.
SR41-N	96	91.7	8.3	0.0	0.0	0.0	0.0	3.1	4.2	1.0	0.0	0.
SR41-S	99	86.9	13.1	0.0	5.1	1.0	0.0	1.0	6.1	0.0	0.0	0.
SR99-N	155	94.2	5.8	0.0	1.9	0.0	0.0	3.9	0.0	0.0	0.0	0.
SR99-S	162	91.4	8.6	0.0	1.9	0.0	2.5	4.3	0.0	0.0	0.0	0.
SR168S-E	14	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.
SR168S-W	48	91.7	8.3	0.0	0.0	0.0	0.0	8.3	0.0	0.0	0.0	0.
SR180-E	26	53.8	46.2	0.0	15.4	0.0	26.9	0.0	0.0	3.8	0.0	0.
SR180-W	42	81.0	18.0	0.0	9.5	0.0	7.1	2.4	0.0	0.0	0.0	0.
Totals	646	89.5	10.5	0.0	2.9	0.2	2.2	3.4	1.5	0.3	0.0	0.

- At the geographical aggregate level, in looking at **Data Quality > Detector Health > Summary** for November 30, 2011, users can see that the PeMS detector health report indicates that for District 6, nearly 90% of the data samples were of good quality. Among the freeway corridors with detection stations, SR180-E had the poorest detection health with over 45% bad detection (mostly controller down and insufficient data) while other corridors had relatively good detection health.

II. Data Fidelity

PeMS conducts diagnostics to determine which detectors are working by checking whether various criteria are met. For those detectors not reporting “good” data, PeMS estimates the missing data through a process called data imputation. The imputation process uses four main methods to fill holes in the data with estimated values. PeMS uses the methods listed below in the following order:

- *Linear regression from neighbors based on local coefficients* - Data holes are filled using information from the detectors in neighboring lanes at the same location and from detectors in locations immediately upstream and downstream.



- *Linear regression from neighbors based on global coefficients* - When PeMS determines that some detectors never report reasonable data, the system looks at general relationships in the detector data throughout the district and to fill in holes.
- *Temporal medians* - PeMS looks at data values at similar times and days of week over a long period of time. The medians of those data values are used to fill holes.
- *Cluster medians* - PeMS examines data from detectors with similar traffic patterns over a typical week to fill data holes.

Two key PeMS reports to be very useful in determining the quality of the data are:

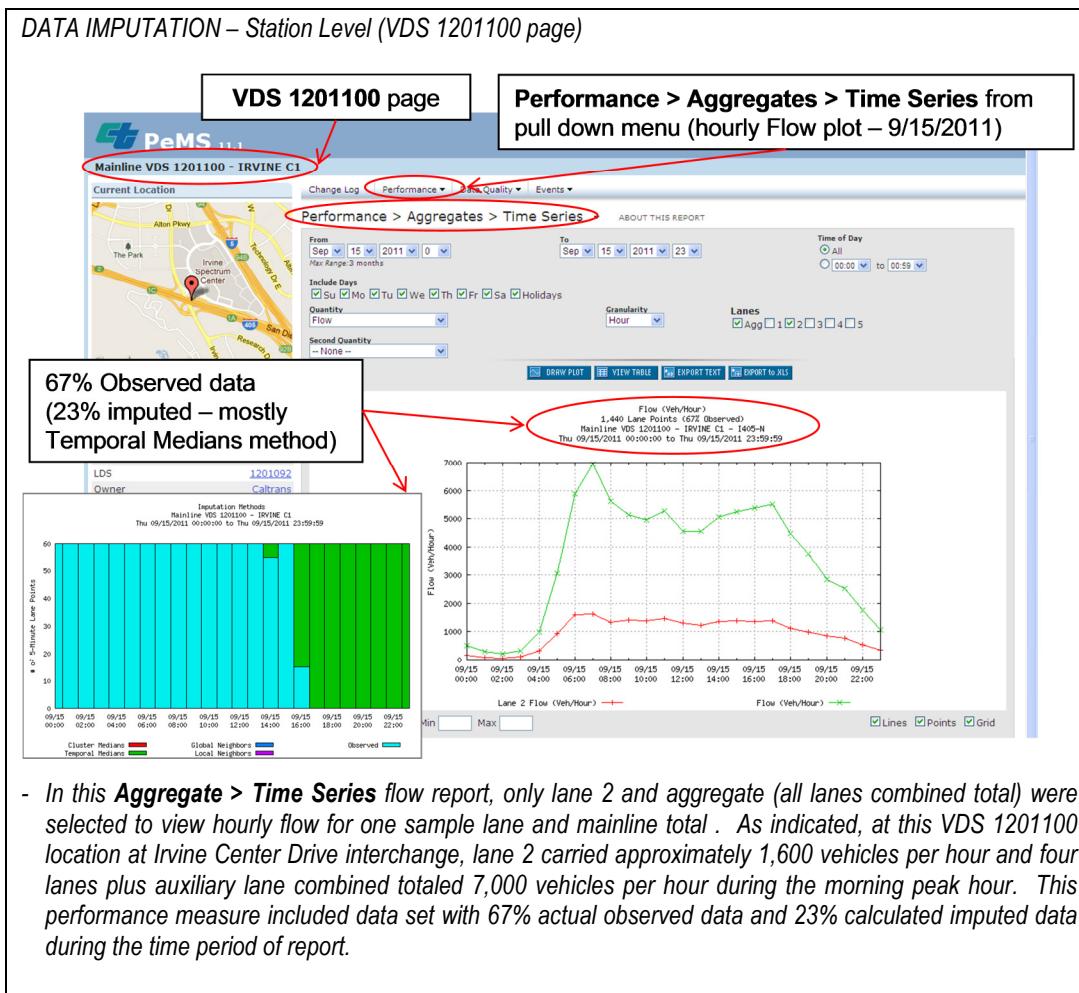
- Percent (%) Observed
- Imputation Methods.

The percent observed means how much data is observed (actual data received that met all diagnostic tests) as opposed to imputed. In PeMS, the smallest data samples (in terms of spatial and temporal aggregation) are individual 5-minute lane points. These points can be imputed or observed. Each report is made up of a number of these individual data samples. The percentage of these points that are observed is a proxy for the quality of the data in the report. Using the **Data Quality > Data Fidelity > % Observed** report, users can plot the percentage of data points observed over the geographical region over time.

Although PeMS uses four different imputation methods, the system picks the best method for each missing data packet and stores the imputed value from that method only (e.g., it does not use all for methods for each instance of imputation; it only uses one). As mentioned earlier, the imputation method that PeMS chooses to use is a function of the amount of information available at that particular location.

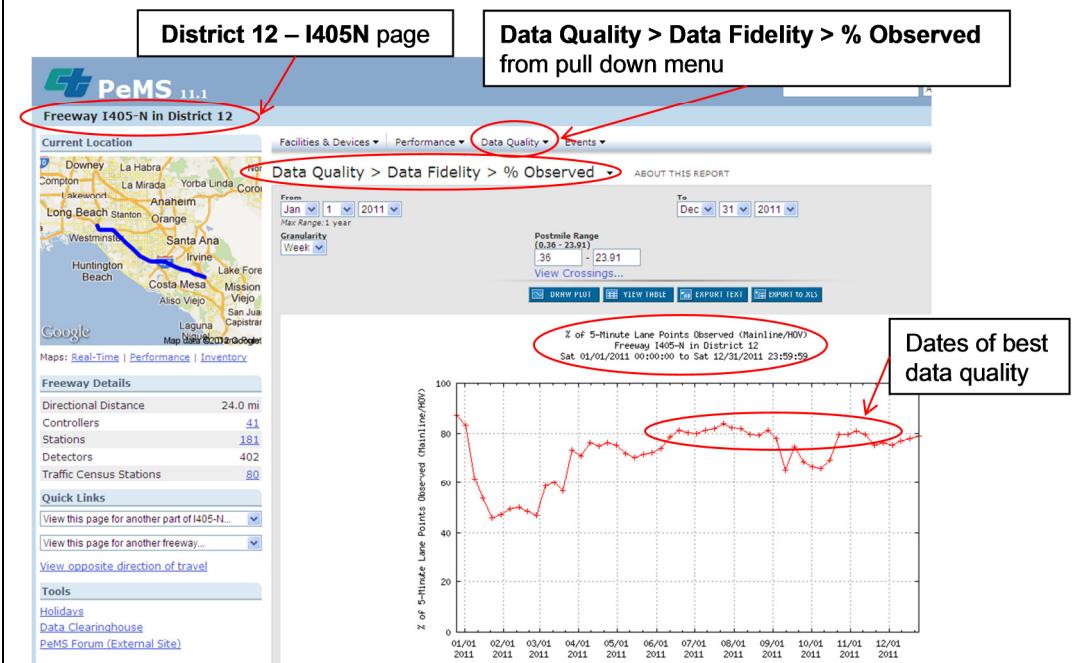
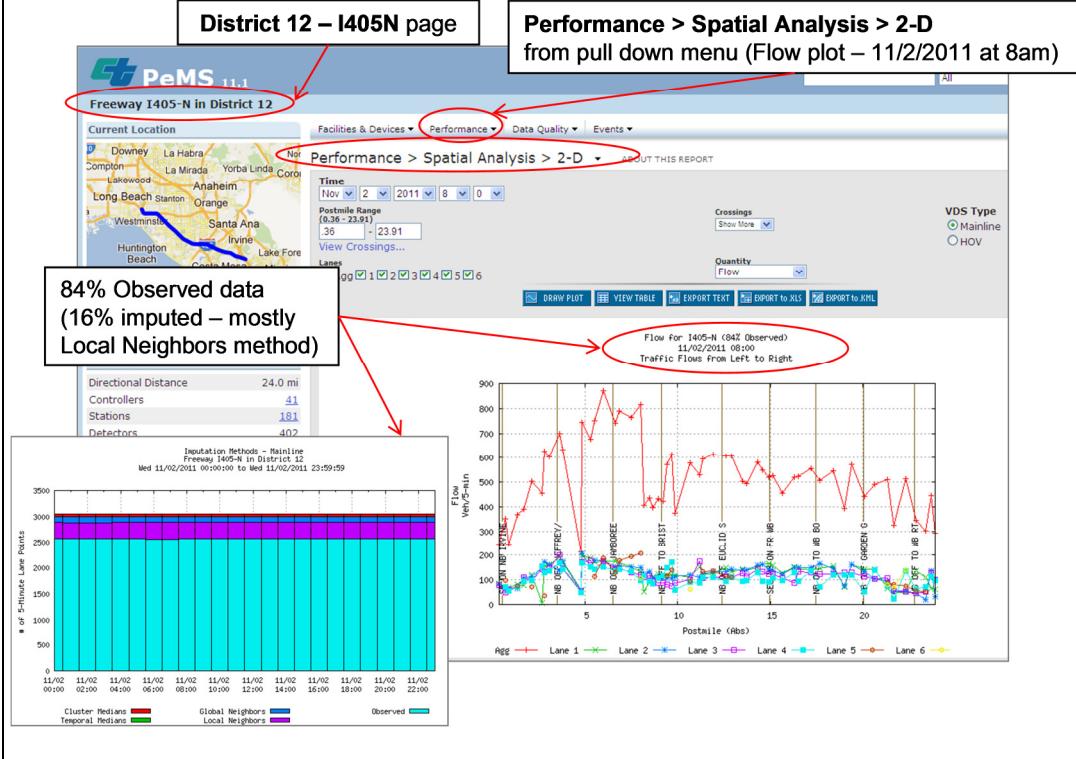
Station Level

At the station level, data fidelity reports for both % Observed and Imputation Methods are available for any detector station. Users can plot the % Observed report to see which dates had the highest data quality. If the user has flexibility in the date range the user can use for performance measurement and data analysis, the user can choose the dates with the highest data quality. If the user chooses to use a data range that includes imputed data, the user can view the Imputation Methods report to see which methods were used to impute the values. For any performance measure plot, PeMS reports the percentage of observed data used in that report.



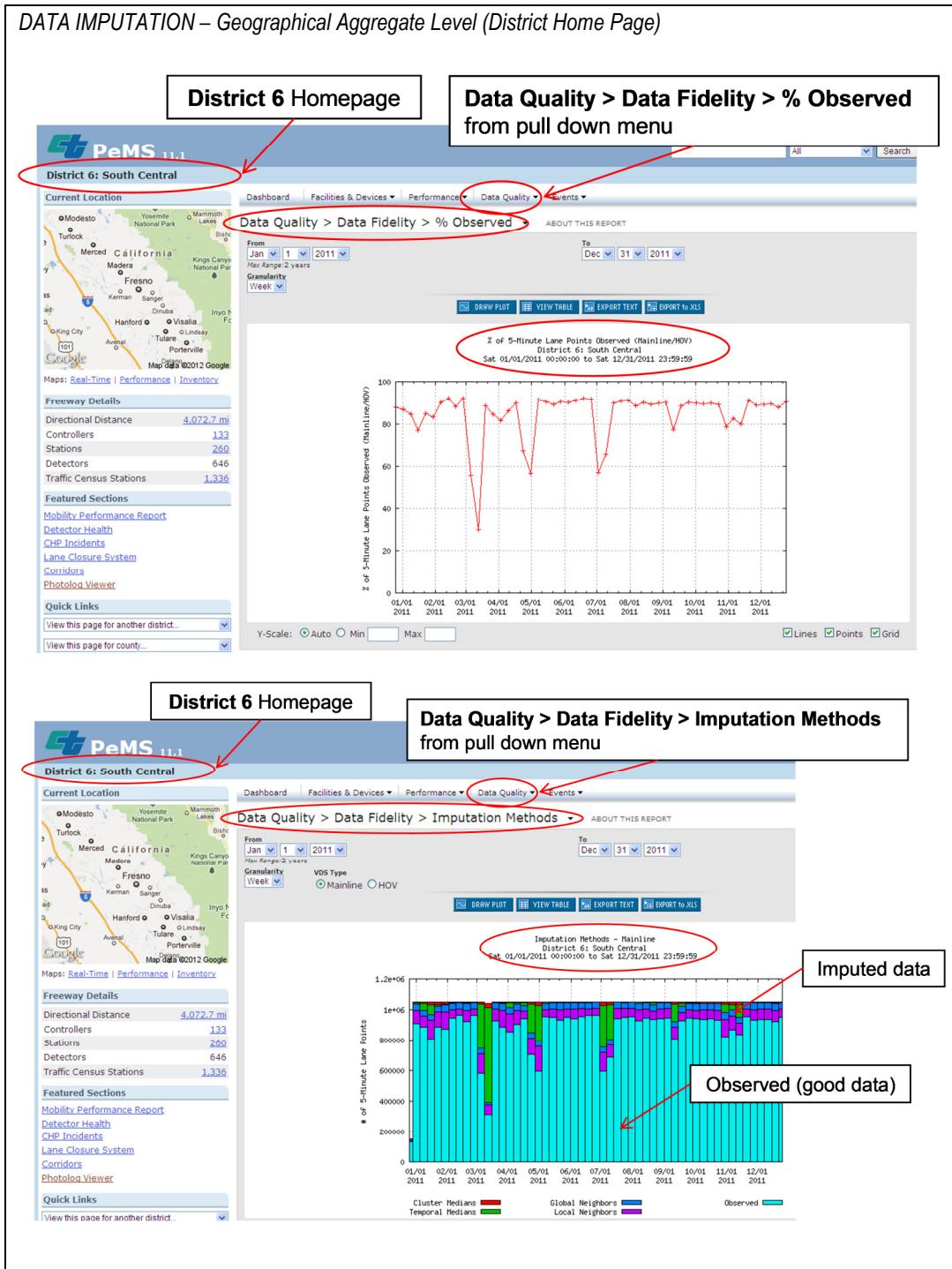
Freeway Segment Level

At the freeway segment level, data fidelity reports for both % Observed and Imputation Methods are available for any freeway segment. During a given time period, the report plots the percent of 5-minute lane points observed (Mainline/HOV only). For any performance measure plot, PeMS reports the percentage of observed data used in that report.

DATA IMPUTATION – Freeway Segment Level (District 12 – I405N page)**District 12 – I405N page**

Geographical Aggregate Level

At the statewide geographical aggregate level, data fidelity only provides % Observed reports. For a given time period, the report plots the percent of 5-minute lane points observed (Mainline/HOV only). At the district geographical aggregate level, both % Observed and Imputation Methods reports can be generated.



PeMS Data Quality Assessment Guide

The following pages provide illustrations of assessing data quality at the detector station, freeway segment, and geographical aggregate levels in PeMS.

PeMS Data Quality Assessment Guide

Instructions for accessing data quality reports are presented here. The main purpose of the illustrations in this section is to provide a few examples of how to get around in PeMS to check detector health. For instructions on how to use this guide, see Chapter 1 examples – PeMS Navigation Guide (page 1-I-1).

For illustrative purposes, District 12: Orange County, its I405-N freeway segment, and its VDS 1213963 – SAND CANYON 1 station were selected to provide some of the examples for this exercise.

To access spatial level or station level analysis reports, start at the Freeways inventory listing under the **Facilities & Devices** pull down menu. While other navigational tools, such as the Inventory Map or the Report Finder, can sometimes be faster options for accessing reports, the Freeways inventory is primarily used here for consistency and to build a standardized routine for new users. If users ever forget the short cuts that they have learned, they can always go back to this standard navigational approach.

The screenshot shows the PeMS 11.1 home page. A red circle highlights the PeMS logo in the top-left corner. Below it, a callout box contains step 1: "From the PeMS home page (click on PeMS icon upper left corner) Jump to the District 12: Orange County home page from the Quick Links pull down menu (click on Jump to default page for district... pull down arrow, select and click on D12: Orange County)".

A red arrow points from the "Quick Links" dropdown menu on the left side to the "District 12: Orange County" link in the "Jump to default page for district..." dropdown. Another red arrow points from the "District 12: Orange County" link to the "District 12: Orange County" link in the "District 12: Orange County" dropdown on the bottom page.

The "District 12: Orange County" link is highlighted with a red circle on both the top and bottom pages.

The screenshot shows the District 12: Orange County home page. A red circle highlights the "District 12: Orange County" link in the top-left corner. A callout box contains the text: "Users should see District 12: Orange County (District 12 home page)".

The page displays various data quality reports, including a "Travel Time Reliability" chart and a "Detector Health" chart. The "Detector Health" chart shows a statewide goal of 90% and yesterday's health at 64%.

In this example, we want to know the data quality at the geographical aggregate level (e.g., District 12: Orange County).

PeMS Detector Health Data Quality Assessment

From the District 12: Orange County home page

2. Move mouse pointer to **Detector Quality > Detector Health > Time Series** (click **Time Series**)

4. Select Dec 31 2011 under **To**

5. Deselect all but HOV and Mainline

6. Select Day under **Granularity**

7. Select Caltrans under **Owner**

8. Select Good under **Filter** (to plot good detectors)

9. Click **DRAW PLOT**

This is a plot of the good detectors as a percentage of total detector health for all District 12 freeways, in aggregate. As indicated, the entire 2011 had over 70% of detectors working, except for a very short period in October 2011 where it fell below 60%. This is a geographical aggregate level report. Now see something more specific to a freeway for spatial segment level assessment of data quality.

In this next example, we want to know the data quality of a freeway segment (e.g., I405-N).

PeMS Detector Health Data Quality Assessment

District 12: Orange County

Facilities & Devices

Time Series

Detector Health, Time Series

Detector Health, Filtered by Good HOV, Mainline

District 12: Orange County

Sat 01/01/2011 00:00:00 to Sat 12/31/2011 23:59:59

9. Move mouse pointer to Facilities & Devices > Freeways (click Freeways) – this will take the user to the Freeways inventory listing page

Freeway Inventory Listing

From this list, users can go to freeway segments for spatial level reports

District 12: Orange County

Facilities & Devices

Freeways

Freeway Details

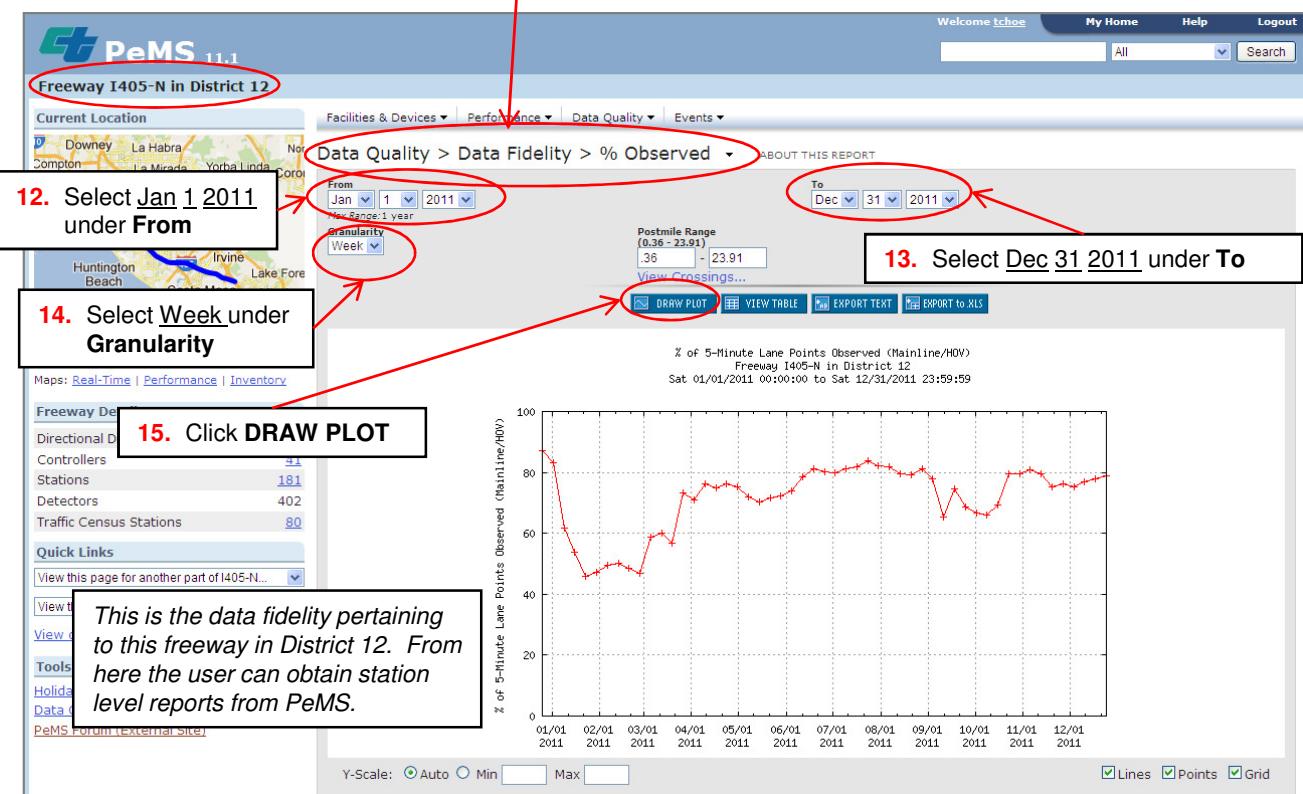
Fwy	Detection			Mainline Facilities			HOV Facilities			Ramps		
	# LDSs	# VDSs	# Detectors	Total Miles	# VDSs	Lane Miles	Miles	Lane Miles	# VDSs	Lane Miles	Fwy Off	Fwy On
I5-N	83	319	733	44.4	102	44.4	202.7	36.8	36.8	90	36.8	44.3
I5-S	70	311	747	44.4	99	44.4	208.4	36.8	36.8	86	36.8	43.4
I405-N	41	181	402	23.9	57	23.9	107.8	50.5	50.5	55	23.9	24.2
I405-S	45	180	410	23.9	55	23.9	112.4	0	0	57	0.0	24.3
I605-N	1	5	11	2.0	2	2.1	8.2	22.3	22.3	1	2.1	1
I605-S	2	7	13	2.0	2	2.1	8.2	1.6	1.6	2	1.6	8.2
SR1-N	0	0	0	33.7	0	0.0	0.0	0.0	0.0	0	0.0	0
SR1-S	0	0	0	33.7	0	0.0	0.0	0.0	0.0	0	0.0	0
SR22-E	24	111	220	13.3	39	13.3	45.5	11.0	11.0	35	11.0	13.3
SR22-W	25	106	215	13.3	41	13.3	47.7	11.0	11.0	32	11.0	13.3

In the District 12: Orange County Facilities & Devices > Freeways page, 10. Click on I405-N (under the Detection - Fwy column)

PeMS Detector Health Data Quality Assessment

From the I405-N in District 12 page

- 11.** Move mouse pointer to **Detector Quality > Data Fidelity > % Observed** (click **% Observed**)



This is a plot of the good detectors (% observed) for mainline and HOV stations. As indicated in this plot, July to September and November appear to have the best data quality for this I405-N freeway in 2011. This is a spatial level report. Now see something more specific to a station on this freeway for station level assessment of data quality.

Now, the data quality at a station level report (e.g., detector station on the I405-N flow plot) is presented.

PeMS Detector Health Data Quality Assessment

From the I405-N in District 12 page

12. Move mouse pointer to **Detector Quality > Detector Health > Lanes** (click **Lanes**)

13. Select Nov 2 2011 under **Date**

14. Deselect all but Mainline

15. Click **VIEW TABLE**

The user can see that VDS 1213963 (SAND CANYON 1) was bad (insufficient data) on this date.

16. Click on **1213963** link

Data Quality > Data Fidelity

Facilities & Devices | **Performance** | **Data Quality** | **Events**

Detector Health | **Data Fidelity** | **Inputs**

Lanes

From: Jan 1, 2011 | **To:** Dec 31, 2011 | **Granularity:** Week

Postmile Range: (0.36 - 23.8) | **Postmile Step:** .30 | **View Crossings...**

DRAW PLOT | **VIEW TABLE** | **EXPORT TEXT** | **EXPORT to XLS**

% of 5-Minute Lane Points Observed (Mainline/HOV)
Freeway I405-N in District 12
Sat 01/01/2011 00:00:00 to Sat 12/31/2011 23:59:59

Traffic Census Stations: 80 | Quick Links: View this page for another part of I405-N...

Points Observed: 60

From the I405-N in District 12 page

Facilities & Devices | Performance | Data Quality | Events

Detector Health | Data Fidelity | Inputs

Lanes

From: Nov 2, 2011 | To: Nov 2, 2011 | Owner: All

Show Crossings:

Station Types: Coll/Dist HOV Off Ramp
 Fwy-Fwy Mainline On Ramp

VIEW TABLE | **EXPORT TEXT** | **EXPORT to XLS**

Good | Line Down | Ctrl Down | No Data | Insufficient Data | Card Off | High Val | Intermittent | Constant | Feed Unstable

VDS	CA PM	Abs PM	MS ID	Name	Type	Lane 1	Lane 2	Lane 3	Lane 4	Lane 5	Lane 6
1211066	.6	.37	2436	N OF 5	Mainline						
1201100	.93	.7	1331	IRVINE C1	Mainline						
	.11	.88	1332	IRVINE C2	Mainline						
	.57	1.34	2474	S OF 133	Mainline						
	.93	1.7	2475	N OF 133	Mainline						
1209170	2.35	2.12	2041	LAGUNA CYN RD	Mainline						
1213963	2.39	2.66	5515	SAND CANYON 1	Mainline						
1201158	3.04	2.81	1551	SAND CANYON	Mainline						
1209059	3.11	3.08	2040	N OF SAND CYN	Mainline						
1201185	3.66	3.63	1335	JEFFREY	Mainline						
1201211	4.03	3.8	1336	JEFFREY 2	Mainline						
1201222	5.01	4.78	2603	YALE	Mainline						
1209076	5.05	4.82	2604	SPRING	Mainline						
1201254	5.55	5.32	1341	CULVER 1	Mainline						
1201283	5.74	5.51	1342	CULVER 2	Mainline						
1201298	6.21	5.98	2602	HARVARD	Mainline						
1201333	6.85	6.62	1343	JAMBOREE1	Mainline						
1201365	7.07	6.84	1344	JAMBOREE2	Mainline						
1201399	7.73	7.5	1345	MACARTHUR 1	Mainline						
1209204	8.26	8.03	2433	AIRPORT	Mainline						
1201430	8.4	8.17	2605	RED HILL	Mainline						
1214212	8.7	8.47	5558	ANTON	Mainline						
1209144	8.9	8.67	2415	N OF 55	Mainline						
1214238	9.2	8.97	05027	AVE. OF ART	Mainline						
1201453	9.46	9.23	1347	BRISTOL 1	Mainline						
1201481	9.65	9.42	1348	BRISTOL 2	Mainline						
1201490	9.8	9.62	5520	PEAK	Mainline						

PeMS Detector Health Data Quality Assessment

Mainline VDS 1213963 - SAND CANYON 1

Data Quality > Detector Health > Time Series

From: Oct 15 2011 To: Nov 15 2011

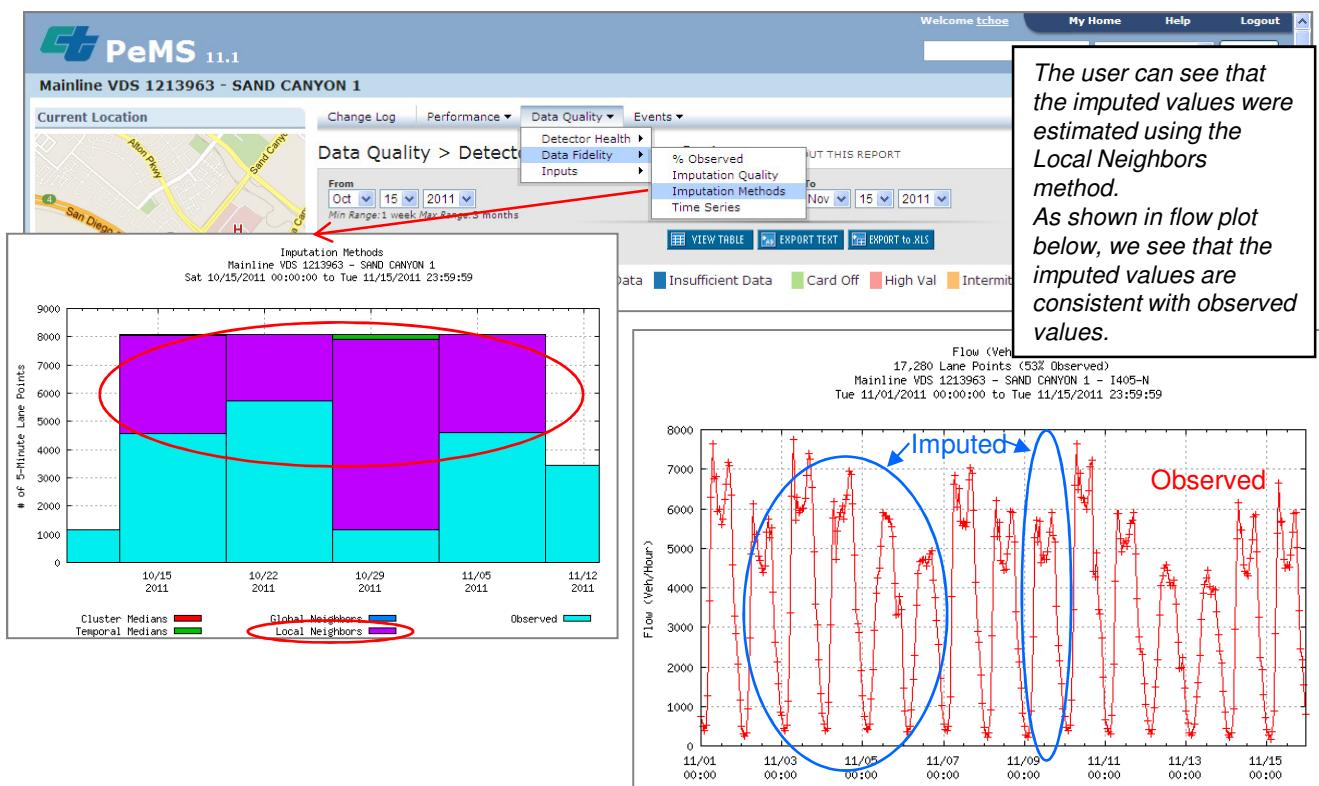
18. Select Nov 15 2011 under To

19. Click VIEW TABLE

17. Select Oct 15 2011 under From

The user can see that **VDS 1213963 (SAND CANYON 1)** was bad (insufficient data) on 11/2/2011 but had other dates with good data (shown in green).

Day	Lane 1	Lane 2	Lane 3	Lane 4
10/15/2011	Good	Good	Good	Good
10/16/2011	Good	Good	Good	Good
10/17/2011	Good	Good	Good	Good
10/18/2011	Good	Good	Good	Good
10/19/2011	Good	Good	Good	Good
10/20/2011	Good	Good	Good	Good
10/21/2011	Good	Good	Good	Good
10/22/2011	Good	Good	Good	Good
10/23/2011	Good	Good	Good	Good
10/24/2011	Good	Good	Good	Good
10/25/2011	Good	Good	Good	Good
10/26/2011	Good	Good	Good	Good
10/27/2011	Good	Good	Good	Good
10/28/2011	Good	Good	Good	Good
10/29/2011	Good	Good	Good	Good
10/30/2011	Good	Good	Good	Good
10/31/2011	Good	Good	Good	Good
11/01/2011	Good	Good	Good	Good
11/02/2011	Insufficient Data	Insufficient Data	Insufficient Data	Insufficient Data
11/03/2011	Good	Good	Good	Good
11/04/2011	Good	Good	Good	Good
11/05/2011	Good	Good	Good	Good
11/06/2011	Good	Good	Good	Good
11/07/2011	Good	Good	Good	Good
11/08/2011	Good	Good	Good	Good
11/09/2011	Good	Good	Good	Good
11/10/2011	Good	Good	Good	Good
11/11/2011	Good	Good	Good	Good
11/12/2011	Good	Good	Good	Good
11/13/2011	Good	Good	Good	Good
11/14/2011	Good	Good	Good	Good
11/15/2011	Good	Good	Good	Good



CHAPTER 3 EXERCISES

Data Quality Assessment

1. What is the mainline VDS ID number at District 12 northbound SR-57 (SR57-N) at Wagner Avenue in Anaheim?
2. Look at the Detector Health (Samples or %Observed) for the two week period between 8/6/2012 and 8/19/2012 for Wagner Avenue VDS. Any bad detector quality days?
3. If bad detector days, what is the imputation method used by PeMS to estimate for the data gap?
4. Run the Performance > Aggregate > Time Series report of FLOW for that time period of bad detector days. What is the percent data observed for that aggregate data? What is the percent imputed data?

Answers are provided in the Appendix.

Chapter 4

Basic Performance Application

CHAPTER 4

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In this chapter, PeMS basic performance measurement applications are introduced. This chapter can be used in conjunction with Chapter 2 (PeMS Calculations and Analysis Results). Chapter 2, Section II explains how traffic data can be retrieved at three different geographic levels – at the individual point level (in other words, by detector station), at the freeway segment level, and at the geographical aggregate level (by city, county, district, or statewide). Accordingly, performance measurement reports can be generated at these same three geographic levels.

For the purpose of analyzing the transportation system, a performance measure is a quantitative or qualitative characteristic describing the performance of a transportation facility. PeMS is a tool for assessing the performance of the State's freeway network. The system currently operates more extensively along urban area freeways since detection devices are more densely deployed on those routes to monitor congestion. PeMS also features tools for assessing the performance of arterials and transit facilities. There are many different performance measures used by transportation agencies, and PeMS calculates a number of measures used by Caltrans. These measures include:

- Flow (Volume)
 - 5-min, Hourly, Daily Aggregates
 - Average Daily Traffic (ADT)
 - Annual ADT (AADT)
 - Monthly ADT (MADT)
- Speed
- Occupancy (% time over detector)
- Delay (expressed in vehicle hours)
- Lost Productivity (expressed in lane mile hours)
- Vehicle Miles Traveled
- Vehicle Hours Traveled
- Travel Time Index (the ratio of the actual average travel time to free-flow travel time)
- Level of Service

In this manual, the most common performance measure reports are introduced for analysis at the individual point (vehicle detector station) level and for the spatial, freeway segment level. It is not all-inclusive of possible reports that can be generated by PeMS.

I. Freeway Station Level Analysis

Traffic Flow (Volume)

In PeMS, traffic flow (volume) is a quantity representing the number of vehicles that passed over each detector on the roadway in a given time period. The units are usually reported in terms of vehicles per time period (i.e. 5-min flow, hourly flow, etc.). Freeways typically have a capacity of approximately 2,000 hourly flow (vehicles per hour) per lane (at one individual detector).

In PeMS reports, flow refers to the number of vehicles per time period of “granularity.” Granularity is the time interval (i.e. 5-min, hourly, daily, monthly) at which data is aggregated by PeMS. The flow is available only at the detector station level since flow or volume is an individual point measure (volume over space or freeway segment is a density measure).

Users can query flow data at any detector station shown in PeMS (see Chapter 2 on finding detector stations). At a vehicle detector station (VDS) page in PeMS, flow data can be queried by going to the **Performance** pull-down

menu and selecting **Aggregates**. There are four types of *Aggregates* reports: *Time Series*, *Time of Day*, *Day of Week*, and *Quantity Relationships*.

What are Aggregates?

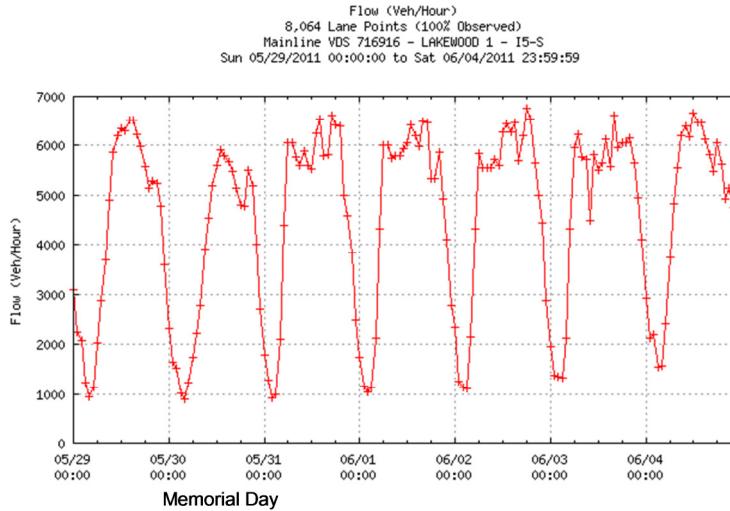
In PeMS, aggregated data refers to data consolidated into larger time or space intervals for a more comprehensive perspective. For example, the PeMS detector starts off as one sample every 30 seconds for each lane of the freeway. PeMS then aggregates that 30-second data to 5-minute data in order to make plots. These 5-minute data can then be summed or aggregated into larger intervals such as hourly, daily, etc. For a detailed explanation of the calculations, users can refer to the *System Calculations* page in the *Help* section in PeMS.

Performance > Aggregates > Time Series

Time Series reports allow the user to view flow for a particular detector station over time. For example, one could look at flow data collected over the last week, or over that same week last year. In these reports, users are able to display any combination of individual lane or aggregate (sum of all lanes) values on the same report. Note that PeMS only stores and shows the individual lane values at the 5-minute and hourly level.

Why would I use this report?

With this report, users can view flow patterns across the selected time period at the selected granularity. Users can view current traffic flow and see if flow has increased or decreased from previous days or weeks. For example, is a holiday week's (e.g., Memorial Day week) hourly flow less or more than those of other typical weeks?



Performance > Aggregates > Time of Day

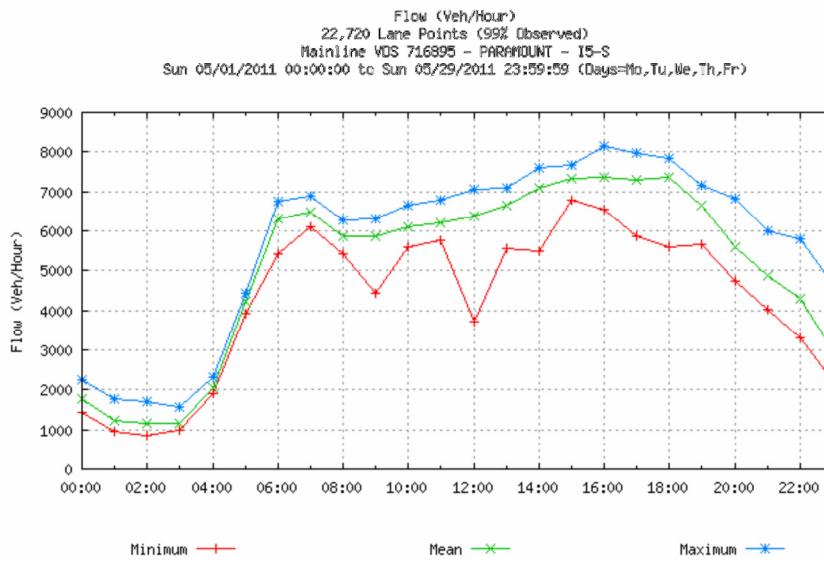
Time of Day reports show the averages of flow over each hour of the day, throughout the entire 24-hour day period, for the days within the selected date range. It offers the following choices for statistics to report:

- Mean, minimum and maximum
- Mean, mean + 1 standard deviation, mean - 1 standard deviation
- Median, and two user specified percentiles (default percentiles are the first and fourth quartiles)
- Discrete Days (this option does not show statistics; instead it shows all of the data points that go into the graph; it shows an hourly point for each day in the day range). This option is only available for date range of 10 or fewer days.

In this report, each hourly value is calculated from the set of points at that particular time of day over the selected date range. This report is commonly used to look at typical weekday traffic patterns. Users can easily restrict the report to weekdays by not selecting the weekend or holiday check boxes.

Why would I use this report?

Users can use this report to see what traffic looks like throughout the course of the day on a typical weekday. This report will show users what time of day has the highest flows (e.g., on weekdays, it could be during peak hours; on weekends, it could be during midday).



Performance > Aggregates > Day of Week

Day of Week reports allow the user to see the difference between the days of the week for the selected quantities. The sets of statistics available here are the same as those in the *Time of Day* reports.

Why would I use this report?

With this report, users can see which day of the week has the highest average (mean) flow and which has the lowest.

Day	Minimum	Mean	Maximum	Data Quality		
				# Lane Points	% Observed	
Sun	103,223.00	105,293.60	106,918.00	5,760	96.0	
Mon	116,384.00	118,173.25	120,027.00	4,608	100.0	
Tue	117,295.00	119,763.75	122,115.00	4,608	100.0	
Wed	120,254.00	121,389.00	121,963.00	4,608	100.0	
Thu	122,706.00	124,445.50	126,196.00	4,608	100.0	
Fri	127,251.00	127,744.00	128,075.00	4,608	94.0	
Sat	121,161.00	121,919.75	122,673.00	4,608	94.0	
Total				33,408	97.5	

Performance > Aggregates > Quantity Relationships

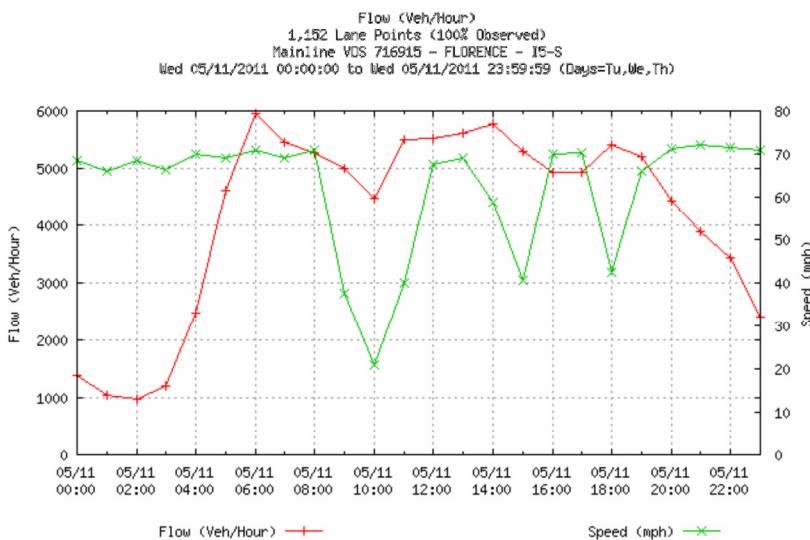
Quantity Relationships reports allow the user to choose any two quantities (e.g., flow and speed) and plot them against each other. The standard traffic theory plots are *speed versus flow* and *occupancy versus flow*. Users can display either of these by specifying the correct values for the x and y axis.

Why would I use this report?

With this report, users can plot and view 5-minute flow data points against speed data points. This graph is useful in checking to see at what speed highest flows are recorded.

Using the Performance > Aggregates > Time Series report

Users can also use the Performance > Aggregates > Time Series report to view two quantities on the same plot. With this report, users can plot and view hourly flow against speed on the same graph. This graph is useful in checking to see if flow declines when speeds fall below 35 miles per hour, an indication of productivity loss. In the Time Series page, select Quantity (e.g., flow) and a Second Quantity (e.g., speed) to view them on the same plot.



Plots and Tables

When running a report, if users select the “DRAW PLOT” option, a graphical representation of the data will be displayed (for an example, see the flow vs. speed plot above). In the title of each plot, PeMS shows the following four lines of information:

- Title and units - This is the title of the plot. It usually contains the units being displayed as well.
- Data quality information - This shows the number of 5-minute lane data points which went into the plot. In addition, it shows the percentage of those points which are completely *observed*. A point is either observed or imputed.
- Geographic segment - This is the type of geographic segment (i.e., County, or VDS) and the name of the segment (e.g., Los Angeles County or VDS 1201100).
- Time range - The time range for the data included in this plot as well as specific days selected (e.g., Tu, We, Thu).

If users select the “VIEW TABLE” option when running a report, users will see a table displaying the quantities (i.e., flow) that they chose at each time interval (e.g., every 5 minutes if 5-minute granularity is selected). It also shows the data quality information, the number of 5-minute lane data points, and the percentage of those points that are completely observed, for each time interval. Users can also select the “EXPORT TEXT” option to download this table into a text file or select the “EXPORT TO .XLS” option to download this table into a spreadsheet file. For an example of a “VIEW TABLE” report, see the Performance > Aggregates > Day of Week example given earlier in this section.

ADT and AADT

In PeMS, daily traffic volume (flow) is available only at the station level and can be reported for selected days in the *Performance > Aggregates > Time Series* reports. This is essentially a sum of aggregate flows for each day of the selected period of interest. The **Average Daily Traffic (ADT)** is the average of the daily volumes (flow) for each day of the selected period of interest.

A PeMS report commonly used for obtaining ADT for short periods is the *Performance > Aggregates > Day of Week* report. This report plots the ADT by day of week for the selected period. For example, for a selected period, Wednesday ADT represents the average of all Wednesday volumes during that selected period.

Annual Average Daily Traffic (AADT) is simply the total vehicle volume (flow) per day, averaged over a year-long period. This quantity is described in great detail in the FHWA Traffic Monitoring Guide, Section 3, Traffic Volume Monitoring. Conventional methods for calculating AADT values require that the input data meet certain completeness standards. For example, AASHTO's 1992 "Guidelines for Traffic Data Programs" requires that a full day's worth of flow data be available for every day of the week and for every month of the year, with no imputed data allowed. However, much real-world sensor data does not meet such rigorous standards. Several research groups have developed variant procedures designed to accommodate typical patterns of missing data and minimize their distorting effect on the averages. PeMS computes AADT values using eight of these methods for every detector station in the system and for every 12-month period that starts at the first of a calendar month. The inputs to these methods are the total station flow values (across all lanes) aggregated to the hourly or daily level. In every case, no imputed data is allowed; only those hours or days for which all data points are real, observed values are included in the computations.

At the detector station level, users can view a plot or table of AADT by month. A line is drawn for each AADT method that had a sufficient amount of observed data. In the table, values will be blank if there were not sufficient good data points to compute the AADT according to the computation method's rules. The red bars indicate the percentage of days over the 12-month period that was used in the calculation. Users can also view the results in tabular form by selecting the "VIEW TABLE" option or by downloading a text or spreadsheet file by selecting the "EXPORT TEXT" or "EXPORT TO .XML" option.

The eight methods used to calculate AADT in PeMS, for each station and each 12-month period, are as follow:

AADT_1: Arithmetic Mean

This is simply the average of all daily traffic flows over the entire year. This is the most common value to use for most applications.

AADT_2: ASTM Standard 1442

American Society for Testing and Materials (ASTM) is an international standards organization that develops and publishes voluntary consensus technical standards for a wide range of materials, products, systems, and services. The first step in this method is to calculate Monthly Average Days of the Week (MADW) values, which are the average daily flows for each day of the week and each month of the year (a total of 84 values). From these, 12 Monthly Average Daily Traffic (MADT) values are calculated as the average of the non-missing MADW values for each month. Finally, AADT_2 is calculated as the average of all MADT values. This algorithm allows one or more of the 7 weekday values to be missing for the MADT computation, but none of the 12 MADT values may be missing for the final average computation.

AADT_3: Conventional AASHTO Procedures

American Association of State Highway and Transportation Officials (AASHTO) is a standards setting body which publishes specifications, test protocols and guidelines which are used in highway design and construction throughout the United States. The algorithm for this method also begins with the MADW values, computed as described above for AADT_2. From these, an Annual Average Days of the Week (AADW) value is

computed for each day of the week as the average across all 12 months. Finally, AADT_3 is computed as the average of these seven AADW values.

AADT_4: Provisional AASHTO Procedures

This algorithm first calculates, across all 12 months, the monthly average flow for each hour of the week (MAHW), which results in $24 \times 7 = 168$ values per month. Then, for each month and day of the week, the 24 MAHW values are summed to produce a MADW value. Then, just as in AADT_3, seven AADW values are produced as the averages of MADW across 12 months, which are then averaged to yield AADT_4.

AADT_5: Sum of 24 Annual Average Hourly Traffic Volumes

For each hour of the day, hourly traffic flow is averaged across all days of the year, resulting in 24 annual average hourly values. AADT_5 is computed as the sum of the 24 hourly values.

AADT_6: Modified ASTM Standard

This algorithm is a modified version of AADT_2, in which one of the 12 MADT values may be missing for the final AADT calculation.

AADT_7: Modified Conventional AASHTO

This algorithm is a modified version of AADT_3, in which one of the 12 MADW values may be missing in the AADW subcomputation, and/or one of the seven AADW values may be missing in the final AADT_7 computation.

AADT_8: Modified Provisional AASHTO

This algorithm is a modified version of AADT_4, in which one of the 12 MADW values may be missing in the AADW subcomputation, and/or one of the seven AADW values may be missing in the final AADT_8 computation.

Along with the eight AADT values, PeMS computes a k-factor for each station and for each month. This is defined to be the 30th highest hourly traffic flow observed at that station across all hours of the preceding year.

Speed

In PeMS, speed is the rate of motion at which a detector records drivers operating their vehicles. For individual detectors (meaning an individual lane) the speed is either measured directly (as is possible with radar detectors) or is calculated using a g-factor accompanying the flow and occupancy (as with single-loop detectors). For the aggregate speed that spans all of the loops, the speed is the flow-weighted mean across the lanes.

The g-factor is a conversion factor used to convert the measured quantities of flow and occupancy into speed for detectors that do not measure speed directly. The g-factor is a combination of two quantities: 1) the average length of the vehicles traveling over the detector and 2) the tuning of the detector. Each detector in the system has its own tuning characteristics. PeMS calculates a g-factor for every single detector over every 5-minute period for an entire week. By doing this, PeMS captures the weekly characteristics of the traffic mix as well as the individual characteristics of each detector.

For more detailed information on speeds and g-factors, go to System Calculations in the Help link.

PeMS speed plots and tables are similar to those of flow; average speeds can be plotted by a granularity of 5 minutes, an hour, a day, or a month. The speed values plotted are the average over the unit of granularity. Like flow, speed is available only at the station level, as it is an individual point measure.

Users can query speed data at any detector station shown in PeMS. At a vehicle detector station (VDS) page in PeMS, speed data can be queried by going to the **Performance** pull-down menu and selecting **Aggregates**. The

same four *Aggregates* reports used to view flow can be used to view speed: *Time Series*, *Time of Day*, *Day of Week*, and *Quantity Relationships*.

See the Flow subsection (pages 1 to 4) in this Chapter for detailed descriptions of the above reports to query speed data.

Occupancy (percent time over detector) and Density

In PeMS, occupancy is a quantity that is measured by a detector. It is the percentage of time that a detector is “on” for a given time period (in other words, the percentage of time in which vehicles are passing over the detector). Occupancy is a percentage that ranges from 0 to 100%. The occupancy data is available only at the station level, as it is an individual point measure. Occupancy plots and tables can be pulled in much the same way they are for flow and speed. Users can query occupancy data at any detector station shown in PeMS. At a vehicle detector station (VDS) page in PeMS, occupancy data can be queried by going to **Performance** pull-down menu and selecting **Aggregates** and one of the four report options: *Time Series*, *Time of Day*, *Day of Week*, and *Quantity Relationships*.

See Flow (pages 1 to 4) in this Chapter for detailed descriptions of the above reports to query occupancy data.

Is occupancy the same as density?

Occupancy is commonly used as a surrogate for the density of traffic over a roadway segment, but it is not the same. Whereas occupancy is directly measured, density is a quantity that is calculated, not measured. Whereas occupancy is a detector station level quantity, density is a spatial quantity that represents the number of vehicles on a roadway segment averaged over a spatial distance, usually expressed as vehicles per mile or vehicles per mile per lane. PeMS calculates density by dividing flow by speed (Density = Flow/Speed) at each detector station, and it is used to determine the operating Level of Service (LOS). PeMS does not present density values (plots or tables) but it does calculate LOS, which is discussed in the next section of this Chapter.

Other Performance Measures

At the detector station level, users can query other performance measure data including delay, vehicle miles traveled, vehicle hours traveled, travel time index, and lost productivity by going to *Performance* pull-down menu and selecting *Aggregates*, and using the four types of reports: *Time Series*, *Time of Day*, *Day of Week*, and *Quantity Relationships*. These measures, however, are more meaningful at the spatial (freeway segment) level as they are essentially spatial measures. For example, vehicle hours traveled is a quantity representing the amount of time a vehicle has spent on the roadway and vehicle miles traveled is a quantity representing the distance a vehicle has traversed over time. As such, these measures are discussed in the next section, Freeway Spatial Level Analysis.

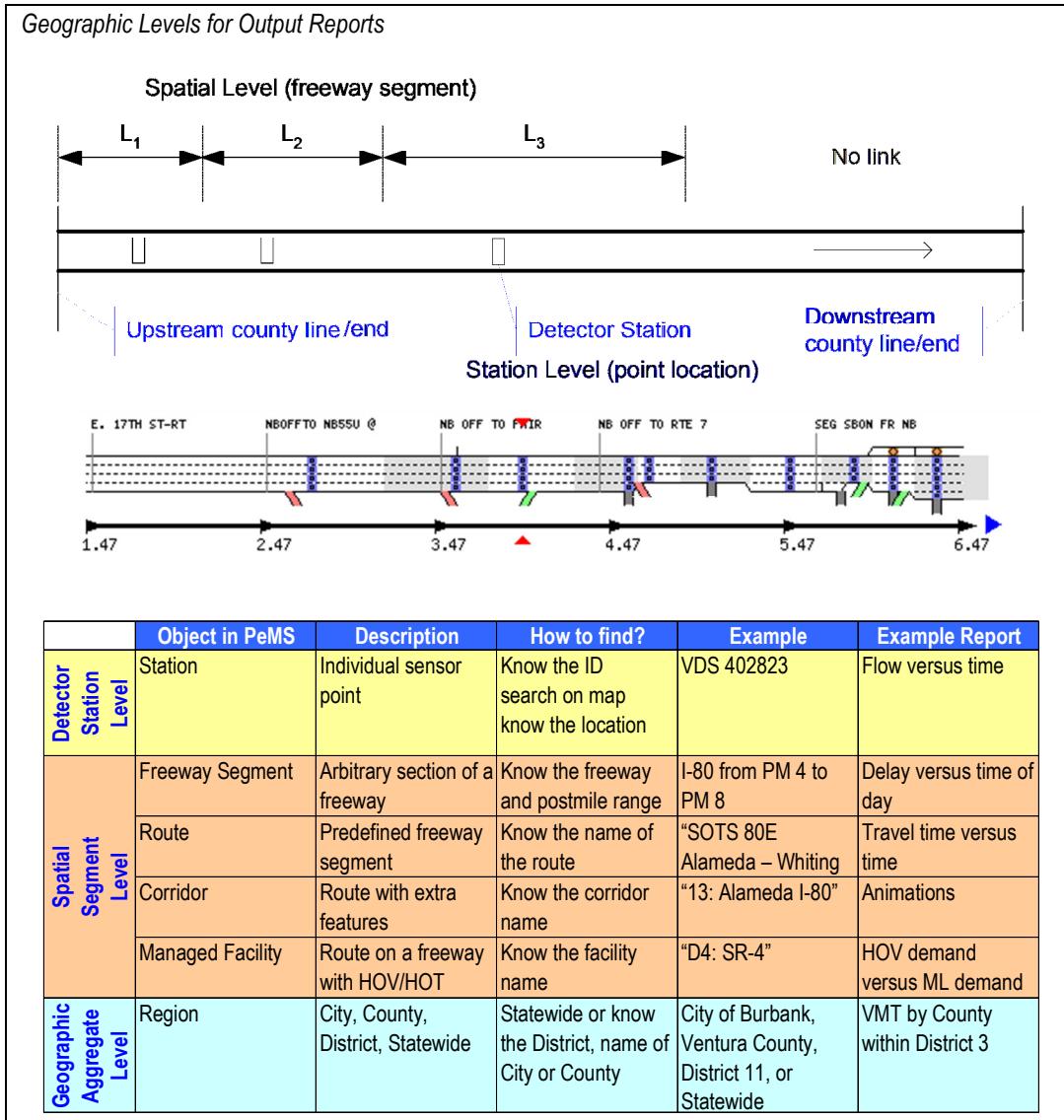
PeMS Application Guide

At the end of this Chapter is the PeMS Application Guide that provides illustrations of using PeMS to obtain flow, speed, and occupancy data reports. It is intended to be a step-by-step guide for obtaining similar quantity plots and tables. It is not all-inclusive and does not provide instructions for all possible types of reports that can be generated by PeMS.

Users are encouraged to use the Help features in PeMS and participate in the PeMS Forum to attain or share further information on using PeMS to its fullest capacity.

II. Freeway Spatial Level Analysis

As described in Section I, PeMS output reports are generated for three geographic levels: the individual detector station level (i.e., a point along a freeway corridor), the spatial segment level (i.e., a freeway segment), and the geographical aggregate level (i.e., multiple freeways within a larger geographical area, such as a city, county, Caltrans District, or statewide).



At the spatial segment level, performance measures are calculated across freeway segment lengths. The user can use either fixed/pre-determined lengths (e.g., Route, Corridor or Managed Lane) or user-defined lengths (by postmile) in the query. In PeMS, a unit-segment is the length from the midpoint between two detectors to the midpoint between the next two detectors (depicted as L₂ in the figure above). Freeway segments are comprised of several adjacent unit-segments. Within a user-specified range of postmiles, PeMS selects the nearest unit-segments at the postmile ends. For the end of a freeway, PeMS applies the distance from the last detector to the end of the freeway limit, up to a maximum of 2.5 miles, as the first or last unit-segment length (depicted as L₁ and L₃ in the figure above).

The user can find spatial segments in one of three ways: 1) from the directional freeway name, 2) from a list of pre-defined freeways/routes/corridors/managed lanes, or 3) from a map.

At the spatial segment level, the user can generate all the performance measures available for freeway stations plus the following additional performance measures:

- Bottlenecks
- Congestion
- Incidents/collisions
- Travel time
- Level of service
- Spatial AADT
- Animation
- Lane closure system elements
- Detector health
- Roadway configuration.

Aggregate Reports

As with the station level analysis, aggregate reports are available for spatial segment analysis. These aggregate reports can provide several performance measures including: delay, lost productivity, vehicle miles traveled, vehicle hours traveled, and travel time index. These performance measures can be used to capture several aspects of highway effectiveness on selected segments.

Delay and Lost Productivity

In PeMS, delay is the amount of extra time spent by all the vehicles beyond the time it takes to traverse a freeway segment at a threshold speed. In other words, it is the amount of additional time that vehicles spend on the roadway due to congestion. PeMS can compute the amount of delay using different threshold speeds (i.e., 35, 40, 45, 50, 55, 60, and 65 miles per hour).

PeMS does not sum the per-lane delay to compute the aggregate delay for a VDS location. Rather, the system uses the aggregate speed (which is the flow-weighted speed across the lanes) and the aggregate flow as the inputs to calculate delay for a VDS location over a 5-minute period. This delay is used in all subsequent delay calculations in PeMS. For example, the hourly delay for a station equals the sum of twelve 5-minute delay calculations. Due to these complexities, PeMS neither computes the hourly delay per lane nor does it show the hourly delay per lane on the Time Series plots. This is to avoid confusion, because the sum of the hourly delay in each lane would not equal the hourly delay for the VDS.

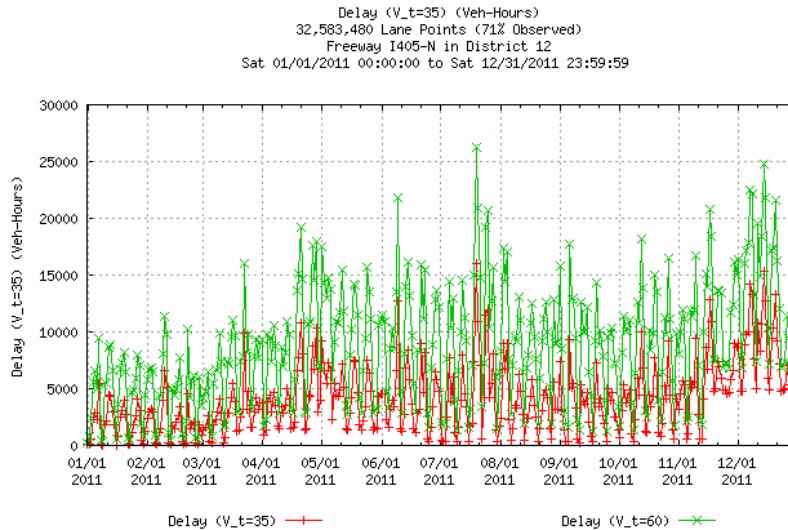
Typically, the flow drops during highly congested conditions. PeMS reports lost productivity as the equivalent lane-mile-hours of highway capacity missing due to a freeway operating under congested conditions. PeMS determines that a freeway is congested, when the speed is below a user-defined threshold. For those time periods and locations that a freeway is congested, PeMS calculates the ratio between the measured flow and the capacity. PeMS then multiplies one minus this ratio by the length of the segment to determine the number of equivalent lane-miles-hours of freeway.

Users can query delay or lost productivity reports for any freeway (segment) available in PeMS. Chapter 2 provides more information on finding freeway segments. One selects the delay or lost productivity report using the **Performance** pull-down menu and selecting **Aggregates** on the PeMS freeway segment page.

There are three types of Aggregates reports: *Time Series*, *Time of Day*, and *Day of Week*. *Time Series* reports allow the user to view delay or lost productivity for a freeway segment over time (maximum range is 1 year if the granularity is by day, week, or month; maximum range is 3 weeks if by hour). *Time of Day* reports show the

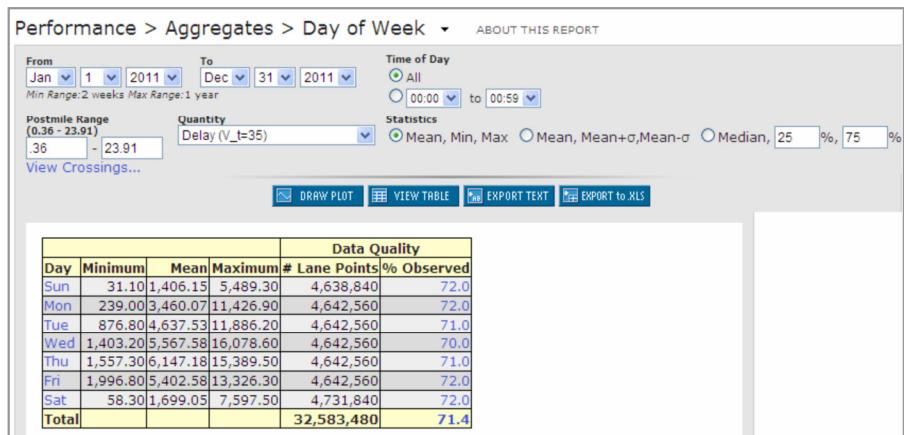
averages of delay or lost productivity over each hour of the day throughout the entire 24-hour day period for the days within the selected date range (maximum range is 3 weeks). *Day of Week* reports allow the user to see the difference between the days of the week for the selected quantities (maximum range is 1 year).

Using the Performance > Aggregates > Time Series report



This report shows the daily delay for all of 2011. Using the report, users can see when delay is highest during the year. The plot above shows the difference between the delays with threshold level of 35 miles per hour compared to the delays with threshold level of 60 miles per hour. Delay is highest during summer months and December for this particular route. Also, note that the data quality (data fidelity) is 71% observed. This means that 29% of the data is imputed.

Using the Performance > Aggregates > Day of Week report



Users can also apply this report to view daily delay for the whole year by day of the week to see which day has the highest average (mean) delay and which has the lowest. In the table above, the difference between the various days is shown with Thursday having the highest mean delay in 2011. Also, note that the data quality (data fidelity) varies from 71% to 72% observed.

Vehicle Miles Traveled (VMT), Vehicle Hours Traveled (VHT), and Q (VMT/VHT)

VMT is the total miles driven by all of the vehicles over a freeway segment during a specified time period. When plotted over a spatial segment, this quantity is simply the sum of VMT from the individual detectors. VHT is the total amount of time spent by all of the vehicles over a freeway segment during a specified time period. When plotted over a spatial segment, this quantity is simply the sum of VHT from the individual detectors. Q is the sum of VMT divided by the sum of VHT. For a freeway segment over time it is a measure of the efficiency of the transportation system. It is also the space mean speed (or the harmonic mean of speeds on the freeway).

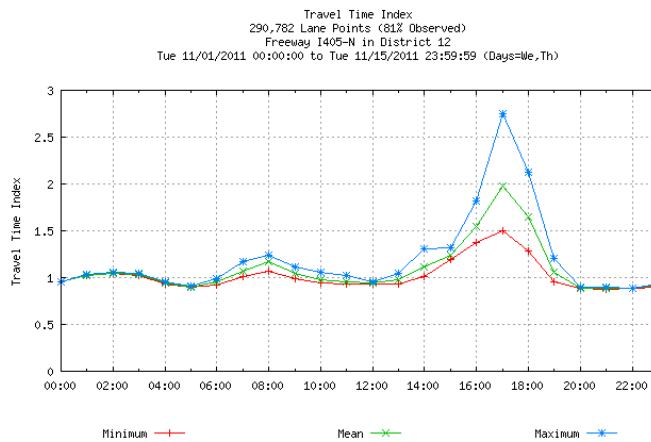
Users can query VMT, VHT, or Q reports for any freeway (or segment) available in PeMS (see Chapter 2 on finding freeway segments). At a freeway segment page in PeMS, users can select the VMT, VHT, or Q reports by using the Performance pull-down menu and selecting Aggregates. There are three types of Aggregates reports: Time Series, Time of Day, and Day of Week. *Time Series* reports allow users to view VMT, VHT, or Q for a freeway segment over time (maximum range is 1 year if the granularity is by day, week, or month; maximum range is 3 weeks if by hour). *Time of Day* reports show the averages of VMT, VHT, or Q over each hour of the day for days within the selected date range (maximum range is 3 weeks). *Day of Week* reports allow users to see the difference between the days of the week for the selected quantities (maximum range is 1 year).

Travel Time Index

Travel Time Index is the ratio of the average travel time for all vehicles across a freeway segment to the free-flow travel time. The free-flow travel time is the amount of time to traverse the freeway segment distance traveling at 60 miles per hour. With this measure, users can assess how close the travel time is to the free-flow travel time.

Users can query travel time index reports for any freeway (or segment) available in PeMS (see Chapter 2 on finding freeway segments). At a freeway segment page in PeMS, travel time index reports can be queried using the **Performance** pull-down menu and selecting **Aggregates**. Users can access the three types of **Aggregates** reports: *Time Series*, *Time of Day*, and *Day of Week*. *Time Series* reports allow the user to view travel time index for a freeway segment over time. The most commonly used granularity is by hour (maximum range is 1 year if the granularity is by day, week, or month; maximum range is 3 weeks if by hour). *Time of Day* reports, also commonly used, show the averages of travel time index over each hour of the day for the days within the selected date range (maximum range is 3 weeks). *Day of Week* reports allow users to see the difference among days of the week for the selected quantities (maximum range is 1 year).

Using the Performance > Aggregates > Time of Day report



As shown in the above plot, the mean travel time for this particular route can be 2 times that of the free flow travel time (travel time index of 2) at 5 p.m. in the evening on average of Wednesdays and Thursdays.

Spatial Analysis Reports

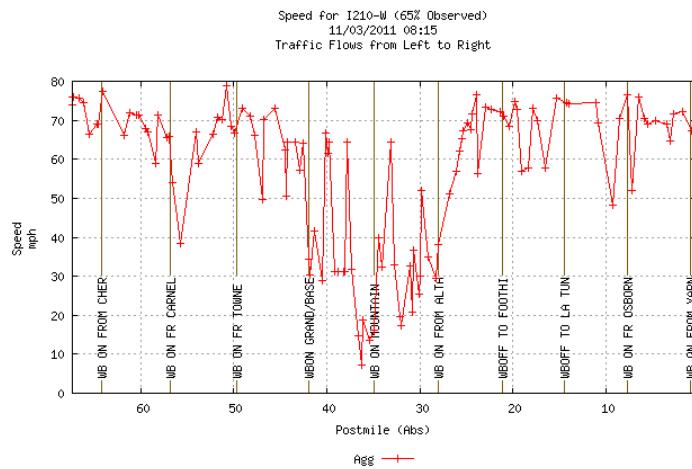
In addition to the Aggregate reports, PeMS provides the Spatial Analysis reports, available in the spatial segment level only, including the following:

- 2-D (corridor performance measure profile at selected time)
- Time Series Contours (performance measure by corridor and by time period for one selected day)
- Time of Day Contours (contours of average of multiple days)
- Hourly Summary (average hourly values for every detector within freeway segment for selected days)
- Long Contours (contours of arithmetic average over extended periods of time, by month or quarter).

2-D (Corridor Performance Measure Profile) of Flow, Speed, Occupancy, Delay

This report allows users to see the various performance measure quantities down the freeway corridor segment at a given time (i.e., one 5-minute time point). This report is useful when attempting to view performance characteristics along a freeway. Examples include identifying where slowdowns occur, where traffic throughput falls (productivity losses), and where traffic is most dense. Users can identify sections of the freeway and step through different time slices to see how the traffic progresses. This feature can be used to determine when congestion or bottlenecks form or when they end. The following quantities are available in this report: flow, speed, occupancy, and delay.

Using the Performance > Spatial Analysis > 2-D report (for selected freeway segment)

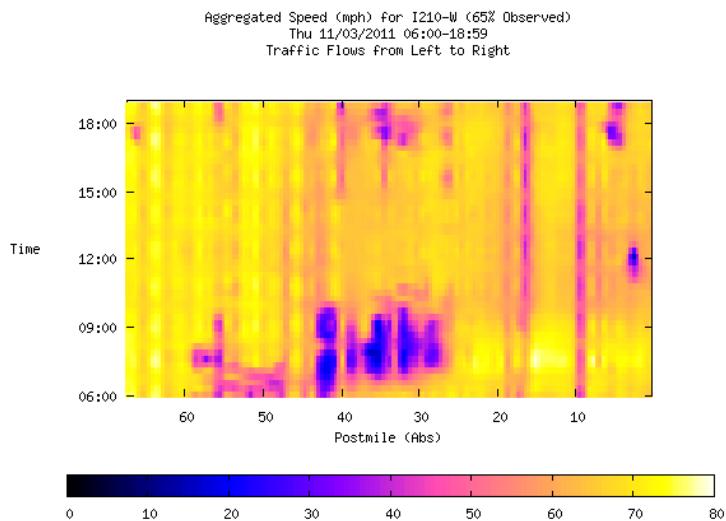


The above is a plot of the westbound speeds along the I-210 freeway corridor at 8:15 a.m. on 11/3/2011 (Thursday). As indicated, speeds begin to fall at post mile 42, near Grand/Baseline and increase at post mile 25 near Altadena. Congestion is evident from post mile 42 to 25 at 8:15 a.m. on this day.

Time Series Contours of Flow, Speed, Occupancy, Delay

This report allows users to view performance measure quantity by freeway corridor and time period for one selected day. The Time Series contour plots are used to visualize various performance quantities over a freeway segment for all or part of a day. The contours are all of the 5-minute, 2-D profiles (within the selected time range) put together. Contours plots are like MRI images or CT-scan images that can help users identify congestion areas, dense areas, and heavy traffic flow areas. PeMS users often rely on the Time Series Contour speed plots to identify bottleneck locations, particularly hidden bottlenecks. The feature allows users to view differences in speeds over a time period, identify the peak period of recurrent congestion, and measure the length of queues. Users can also use Time Series Contour speed plots to identify and measure incident-related congestion. The following quantities are available in this report: flow, speed, occupancy, and delay.

Using the Performance > Spatial Analysis > Time Series Contour report (for selected freeway segment)



The above plot shows speeds along westbound I-210 between 6 a.m. and 7 p.m. on 11/3/2011 (Thursday). The different colors represent speeds. As shown in the plot speeds begin to fall at post mile 42, near Grand/Baseline, and increase at post mile 25, near Altadena. The morning congestion is evident from post mile 42 to 25 from about 6 a.m. to 10:00 a.m. on this day.

Time of Day Contours and Long Contours Flow, Speed, Occupancy, Delay

These reports are essentially the same as the Time Series Contours, except that they allow users to view averages for multiple days or extended periods of time (i.e., month or quarter). Performance measures, such as speed, flow, occupancy, and delay can vary significantly from one day to the next. The contour reports average these values over multiple days. These average values can be considered to be “normalized” or to represent an average (or typical) day. A bottleneck identified using a contour speed plot is likely to reoccur most days rather than be a one-day anomaly. Likewise, a peak period or queue length estimated from the average of multiple days can represent typical conditions.

Hourly Summary (Table) of Flow, VMT, VHT, Delay, Lost Productivity

The Hourly Summary table shows the hourly (aggregate) values for every hour and detector within a selected freeway segment on user-selected days. Users commonly use this table to collect data for other analyses. The quantities are available by minimum, mean, maximum, percentile, or sum. For flow or occupancy measures, values are also available from the ramp detectors. To get values for a single day, rather than average or sum over multiple days, users can select the same “from” and “to” dates in the date range.

Table columns include:

- CA PM – Caltrans post mile (or post mile reported by local agency)
- VDS – vehicle detector station identification number
- Name – name assigned to the VDS ID
- Type – type of detector (e.g., mainline, ramp, etc.)
- Observed % – percentage of values that are observed. Percentage reflects data quality. PeMS does not impute data for ramps, so this column will always be marked “N/A” for ramp VDS
- Hours (range from 00 to 23) – hours of the day, from midnight to midnight

Using the Performance > Spatial Analysis > Hourly Summary report (for selected freeway segment)

The top picture is the output table shown in PeMS. Below that is the output table exported to a spreadsheet. The example shows aggregate hourly flows for every detector along westbound I-210 on 11/3/2011 (Thursday) from midnight to midnight.

Level of Service (LOS) Reports

Level of Service (LOS) reports allow users to see the quality of service along the freeway system. The freeway LOS is a way to classify the service that vehicles are experiencing using a grading system ranging from A to F. Typically, LOS is identified using either the density of vehicles on the freeway or the volume-to-capacity (v/c) ratio. PeMS estimates the LOS using density only.

The relationship between LOS and the density of vehicles on a freeway is defined in the Highway Capacity Manual (HCM2010). The table below summarizes this relationship and provides a description of the traffic condition (quality of service) at each level from LOS A to LOS F. LOS A (density less than 11 vehicles/mile/lane) occurs when traffic is light and unimpeded. LOS F (density equal to or greater than 45 vehicles/mile/lane) occurs when the roadway is completely congested.

LOS	Density (veh/mi/ln)	Volume/Capacity (FFS=65mph)	Traffic Flow Description
A	$0 \leq x = 11$	$x \leq 0.3$	Virtually free flow; completely unimpeded.
B	$11 \leq x < 18$	$0.3 < x \leq 0.5$	Stable flow with slight delays; reasonably unimpeded.
C	$18 \leq x < 26$	$0.5 < x \leq 0.71$	Stable flow with delays; less freedom to maneuver.
D	$26 \leq x < 35$	$0.71 < x \leq 0.89$	High density, but stable flow.
E	$35 \leq x < 45$	$0.89 < x \leq 1.0$	Operating conditions at or near capacity; unstable flow.
F	$45 \leq x$	$1.0 \leq x$	Forced flow, breakdown conditions.

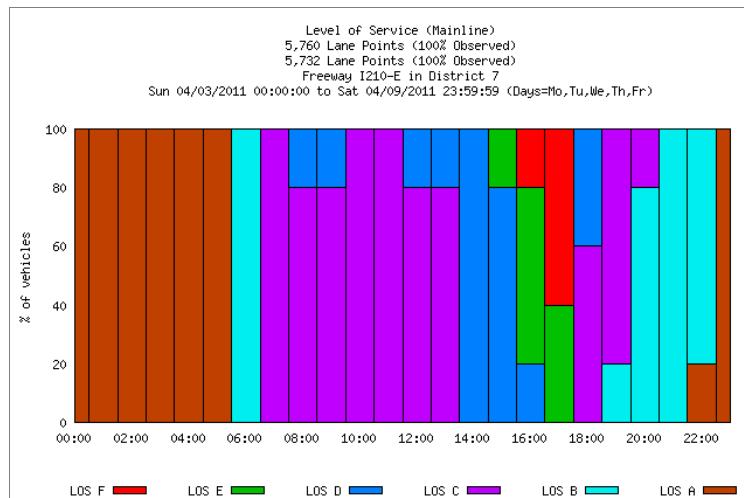
PeMS computes the density at each detector for each hour from the flow and speed (where Density = Flow/Speed). PeMS calculates the number of vehicles experiencing this particular density by multiplying the density of the segment by the length of the segment. This results in the number of vehicles experiencing each LOS. PeMS uses the estimated density and the number of vehicles to compute the distributions. This means that when the percentage for LOS A is 40 percent the interpretation is that 40 percent of the vehicles on the freeway system are operating in LOS A at that time.

The PeMS algorithm assumes a constant flow and speed over the entire segment during the hour. This means that the LOS results are less accurate for longer freeway segments. While the assumption is consistent with the HCM 2000 basic freeway segment analysis, PeMS does not incorporate the corrections needed for heavy truck volumes. The HCM 2000 analysis requires truck volumes to be converted to passenger car equivalents when computing LOS. Since truck flow data is not available in PeMS, this step must be omitted in the calculation of LOS. This means that the LOS computed in PeMS may be understated on freeway segments where truck traffic is heavy.

Users can query LOS reports for any freeway (or segment) available in PeMS (see Chapter 2 on finding freeway segments). At a freeway segment page in PeMS, LOS reports can be queried using the **Performance** pull-down menu and selecting **Level of Service**. Users can access the four types of Level of Service reports: Time Series, Time of Day, Day of Week, and Cumulative Distribution.

Time Series reports allow users to view changes in the distribution of LOS over a selected range of times. When all LOS categories are plotted, the graph is shown as a stacked bar chart. When individual LOS categories are plotted, the graph is shown as a line chart. Users can also plot LOS greater or less than a certain service level on a line graph. For these plots, PeMS estimates LOS only at the hourly level. *Time of Day* reports allows users to see trends for average LOS by time of day. These plots require PeMS to process a lot of data, so they take longer than other reports to generate. *Day of Week* reports allows users to see trends for average LOS over days of the week. *Cumulative Distribution* reports show the cumulative distribution of density from all detectors in a freeway segment over a time range. The distribution shows the hourly number of vehicles operating at that density. If the 80th percentile of density is at 30 vehicles/mile/lane, 80 percent of the vehicles in the system at the time are operating at a density of 30 vehicles/mile/lane or less.

Using the Performance > Level of Service > Time of Day report (for selected freeway segment)



The above Time of Day plot shows the LOS of eastbound I-210 between the Baldwin on-ramp and the Santa Anita off-ramp (basic freeway segment) averaged over weekdays during the week of April 3, 2011 to April 9, 2011. As shown in the plot, the peak hours are in the afternoon when LOS is degraded to LOS D starting at 2 p.m., worsens to LOS F at 5 p.m., and improves to LOS C by 7 p.m. HCM 2000 analysis of this segment for the 5 p.m. peak hour also results in LOS F.

Top Bottlenecks Reports

PeMS runs a bottleneck identification algorithm every day. The original algorithm was presented in, "Systematic Identification of Freeway Bottlenecks," by Chen, C., Skabardonis, A., Varaiya, P. (2003). Transportation Research Board, 2004. This algorithm attempts to identify bottlenecks on the freeway system at every detector.

By definition, a bottleneck is where the traffic demand exceeds the available capacity of the roadway facility. Characteristics include reductions in speeds, congestion, queuing, and delay. PeMS can identify a bottleneck at a particular detector where there is a persistent drop in speed from the detector immediately upstream. Specifically, PeMS uses the following conditions define a bottleneck:

- There is a drop in speed of at least 20 mph.
- The speed at the current detector is less than 40 mph.
- The detectors are less than 3 miles apart.
- The decline in speed lasts for at least 5 of any 7 contiguous 5-minute data points.

If all of these conditions are met, PeMS identifies a bottleneck at the location and assumes the bottleneck occurred in all seven (7) 5-minute time points. From an engineering standpoint, the bottleneck may be occurring somewhere between the two detectors, but unless detectors are installed more abundantly in closer intervals across the entire highway system, PeMS may not precisely pinpoint the exact location of the bottleneck. Still, this feature provides users with an approximate location between detectors where the bottleneck is likely to be so that they may hone in any further analysis effort to that area. Hence, the system reports that the bottleneck occurs at the detector where the speed dropped. PeMS performs this analysis for each of three time periods ("shift" in PeMS): AM shift (5 a.m. - 10 a.m.), noon shift (10 a.m. – 3 p.m.), and PM shift (3 p.m. – 8 p.m.). For each bottleneck locations, PeMS computes the following:

- Bottleneck (Spatial) Extent (in miles): For each day, PeMS measures the distance a bottleneck stretches upstream every 5 minutes. The median distance over the duration of the bottleneck is

- considered to be the spatial extent of the bottleneck for the day. The distances are averaged over the days a bottleneck was active.
- Bottleneck Delay: PeMS reports the average delay (due to speeds below 60 mph) due to a bottleneck over the days the bottleneck was active.
 - Bottleneck Duration: PeMS reports how long a bottleneck last during a shift on a particular day.

The Top Bottlenecks reports list the top bottlenecks identified over a given time period for a specific freeway segment. The report identifies detector stations where bottlenecks have occurred on the selected days.

Users can query Top Bottlenecks reports for any freeway (or segment) available in PeMS (see Chapter 2 on finding freeway segments). At a freeway segment page in PeMS, Top Bottlenecks reports can be queried by using the Performance pull-down menu and selecting Bottlenecks. A Top Bottlenecks report provides a table listing detector stations where bottlenecks were identified during the selected days. The report also summarizes the number of days bottlenecks occurred (number of days “active”), the average extent of the bottlenecks (in miles), the total bottleneck delay (in vehicle-hours), and the total duration (in minutes) of the bottlenecks. Users can sort the list by any of the summary columns.

Using the Performance > Bottlenecks > Top Bottlenecks report (for selected freeway segment)

Bottleneck Characteristics

VDS	Name	Shift	Fwy	Abs PM	CA PM	# Days Active	Avg Extent (Miles)	Total Delay (veh-hrs)	Total Duration (mins)
717684	AZUSA 2	PM	I210 -E	40.00	R39.71	5	0.8	2,498	725
761128	HUNTINGTON 1	PM	I210 -E	33.15	R32.86	5	3.6	1,628	250
761126	HUNTINGTON 1	PM	I210 -E	33.15	R32.86	5	2.8	897	790
772874	W/O IRWINDALE	PM	I210 -E	37.79	R37.5	5	2.1	868	830
771603	SAN DIMAS AVE	PM	I210 -E	45.95	R45.66	4	1.9	750	275
767969	TOWNE AV	PM	I210 -E	49.97	R49.68	5	0.6	712	1,500

This Top Bottlenecks report table identifies bottlenecks on eastbound I-210 between post mile 25 (Fair Oaks IC) and post mile 52.18 (County Line) on weekdays during the week of April 3, 2011 to April 9, 2011. As shown in the table, the biggest bottleneck identified by PeMS is at the Azusa detector station with the highest total delay at 2,498 vehicle-hours in the five days.

Congestion Pie Reports

The Congestion Pie reports, accessible via Performance pull down menu from PeMS home page or a district home page, allow users to view the proportion of congestion (by delay) on the freeway system in a pie chart. The detailed description of the PeMS congestion pie algorithm is provided in the Calculations page of the Help link. A congestion pie report is aggregative, starting with the total amount of congestion on the freeways as measured by the detectors and then assignment of the amounts of delay to various causes identified by PeMS. In PeMS, there are four types of delay considered for the Congestion Pie reports:

- Delay assigned to collisions.
- Delay assigned to bottlenecks from the PeMS bottleneck identification algorithm. The bottleneck delay is also broken down into two components: potential delay that can be saved by running an ideal ramp

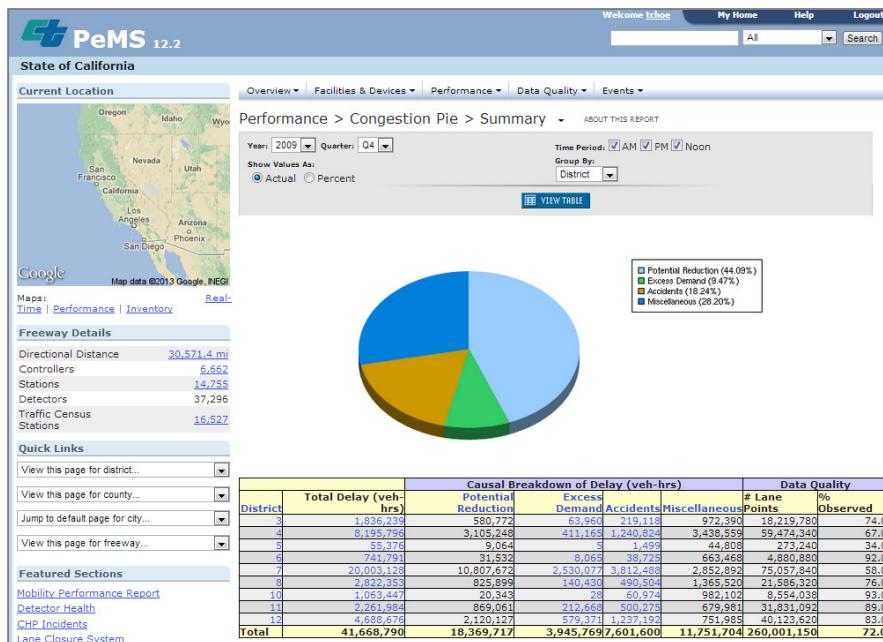
metering algorithm at the major bottlenecks on the freeway and delay caused by excess demand that no ramp metering algorithm could reduce.

- Delay assigned to miscellaneous - all other remaining delay not assigned to collisions or bottlenecks.
- Total daily delay on the freeway, sum of the three above.

The smallest time period granularity available is a quarter of a year and only the 60 miles per hour threshold speed is used for the delay calculations amounts (delay from speeds below this threshold speed). It should be noted that PeMS collects delay data for only the portions of each freeway that are instrumented with vehicle detectors, whereas the TASAS incident database covers the entire freeway. Therefore, the PeMS Congestion Pie Report only presents delay measured by PeMS and does not include delay from portions of the freeway that do not have any vehicle detection.

The summary report shows the results of the congestion pie calculation for a single quarter. Users need to select a quarter, and either the AM (5am-10am), noon (10am-3pm), or PM (3pm-8pm) shift. The congestion pie is then drawn for the entire geographical region as a pie chart. Below the pie chart, a table lists the breakdown of the congestion pie for each individual geographical segment (by freeway, by county, or by district). The time series report shows the congestion pie over time. It allows users to see how the assignment of congestion is changing from quarter to quarter.

Using the Performance > Congestion Pie > Summary report (for selected geographic segment)



This Congestion Pie summary report presents a pie chart of the delay amounts by category of delay causes by percentage of the total of fourth quarter in 2009. The table below the chart presents the breakdown of the delay totals by District (geographic segment). Geographic segment breakdown can also be by Freeways or by County. The Congestion Pie report is also available for each District.

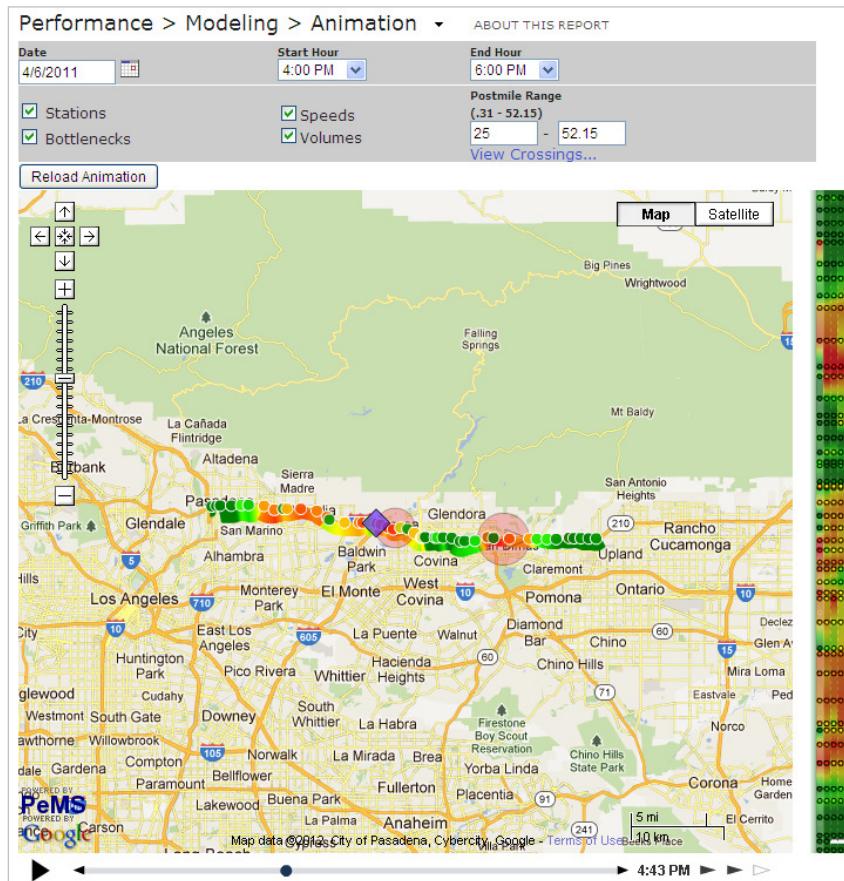
Performance Modeling ([Animation](#)) Reports

PeMS provides performance animation modeling reports for any selected freeway segment. These reports allow users to view speeds, volumes, and bottlenecks over time in an animation video sequence. The performance animation is presented on top of a Google map showing the selected freeway segment. The map includes the following features:

- Speeds are shown by color and detector station along the corridor segment.
- Volumes are denoted by the thickness of the segment speed colors.
- Incidents, if any, are shown as purple diamonds.
- Detector stations are shown as small circles and colored according to speed.
- Bottlenecks are shown as pink large circles with inner triangles. The points of the triangles show the relative starting points of the bottlenecks. The sizes of the circles indicate the extents of the bottlenecks.

Users can move the mouse pointer (cursor) over any part of freeway corridors to find the relative positions on the lane configuration diagrams next to the maps. Likewise, users can position the pointer on the configuration diagrams and find the relative positions on the maps. Moving a mouse over a detector station, incident purple diamond icon, or pink bottleneck circle will also bring up a pop-up window that provides specific details for the specific icon. Whenever a user alters any of the parameters such as date, time, segment range, or highlighted elements, the user must click on Reload Animation button to regenerate the animation.

Using the Performance > Modeling > Animation report (for selected freeway segment)



The picture shows a still shot from an animation video of eastbound I-210 between post mile 25 (Fair Oaks IC) and post mile 52.18 (County Line) of April 5, 2011 from 4 p.m. to 6 p.m. The speeds are represented by colors with red indicating congested speeds and green indicating higher, free-flow speeds. The volumes are represented by the thickness and bottlenecks are represented by the pink circles where the diameters of the circles are the bottleneck influence areas. Incidents are also represented by the purple diamonds. Clicking on the diamond provides details of the specific incident. Users can pan and zoom using the map navigation tool. Users can also play the animation video, quickly play the video, or simply advanced the video forwards or backwards using the video play tools on the bottom of the graphic.

The animation is a useful way to show the relative speeds, congested segments, bottleneck locations, bottleneck starting times and ending times, incident impacts. The animation provides a graphical, aerial view that makes the data easy to visualize. Users can select a map or satellite overlay of the animation. With the map/satellite graphic and lane configuration diagram, users can often identify likely causes of the bottlenecks, such as ramp merges or lane drops. At this time, the PeMS does not directly support recording the videos (e.g., for use in PowerPoint presentations). However, there are many third party programs that users can use to record animation videos.

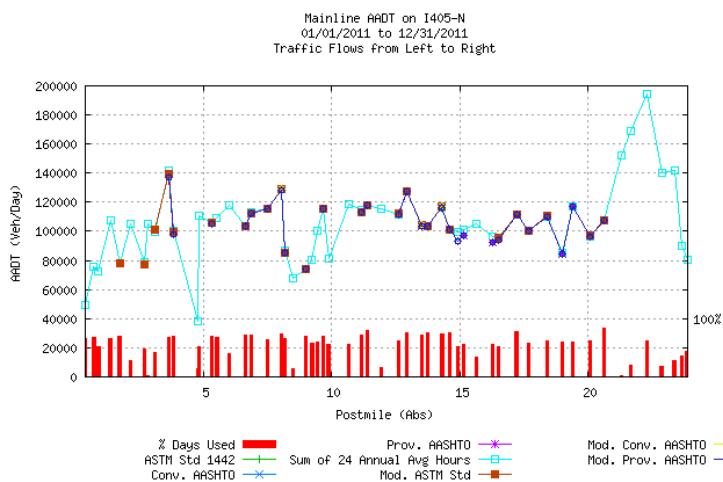
Spatial Annual Average Daily Traffic (AADT) Reports

Section I presented AADT at the detector level, where users can query AADT reports at the detector station page in PeMS using the Performance pull-down menu and selecting Planning Analysis. With the PeMS Spatial AADT reports, users can also view AADT across freeway segments. Conceptually, AADT is simply the total vehicle flow per day, averaged over a year. As at the detector station level, PeMS computes AADT values using 8 alternative methods for every detector station and for every 12-month period starting on the first of a calendar month.

Users can access the Spatial AADT reports for any freeway (segment) available in PeMS (see Chapter 2 on finding freeway segments). At a freeway segment page in PeMS, Spatial AADT reports can be queried by using the Performance pull-down menu, selecting Planning Analysis, and selecting Spatial AADT.

In the report plot, a line is drawn for each AADT method with a sufficient amount of observed data. The red vertical bars indicate the percentage of days over the 12-month period used in the calculation. This report is useful in viewing the AADT across the corridor to see the changes through the traffic stream from one part of the segment to the next.

Using the Performance > Planning Analysis > Spatial AADT report (for selected freeway segment)



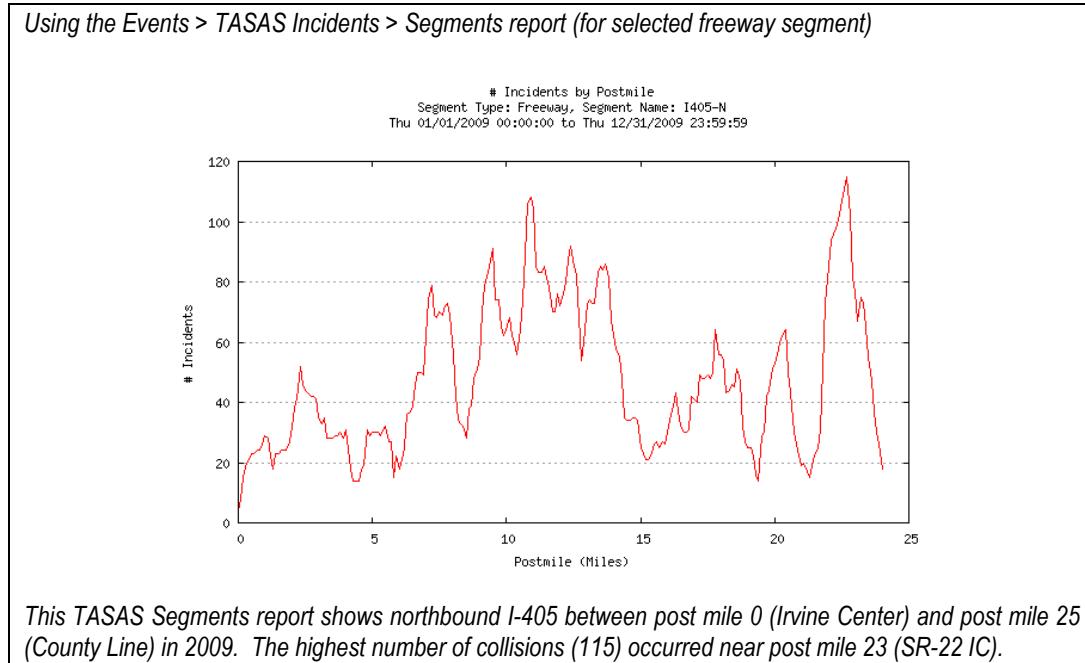
This Spatial AADT report shows northbound I-405 between post mile 0 (Irvine Center) and post mile 25 (County Line) in 2011. The AADT ranges from 100,000 to 120,000 along the corridor segment except from post mile 20 to 25, where AADT soars to a peak of 200,000 near post mile 23. In this location, the roadway has many more lanes.

Incident (CHP and TASAS) Reports

PeMS provides California Highway Patrol (CHP) computer-aided dispatch (CAD) incident reports as well as Traffic Accident and Surveillance Analysis System (TASAS) data reports. The CHP incident reports in PeMS include all incident data found in the CHP CAD. The TASAS records include all accidents that occur on State Highways. The TASAS records are manually verified by Caltrans staff, so the reporting to PeMS lags by approximately one to two years. PeMS obtains TASAS records that include the starting time, freeway, direction, post mile, severity and

location of each incident. The records do not have information on the duration of incidents. PeMS allows users to examine incidents on a freeway segment using a number of different types of reports:

- Time Series – view incidents over a time range
- Time of Week, Radial (CHP incidents only) – view incidents in a radial chart by time of day and day of week
- Time of Day – view incidents over time of day by hourly average
- Day of Week – view the total number of incidents for each day of week
- Duration (CHP incidents only) – view distribution of the durations of incidents
- Characteristics (TASAS only) – view percentage breakdown by selected characteristics for a time range
- Detail – view listing of individual incidents over a selected time range
- Contours – view concentrations of incidents along a corridor segment over time period
- Comparison (CHP incidents only) – view comparison of incident types with average duration
- Relationships – view the relationship between performance measures and the number of incidents
- Spatial Distribution (CHP incidents only) – view the number of incidents along corridor segment
- Segments (TASAS only) – view the number of incidents along corridor segment



These reports are useful in identifying incident concentrations, correlating with performance measures such as congestion delay, and analyzing incident characteristics at a particular location.

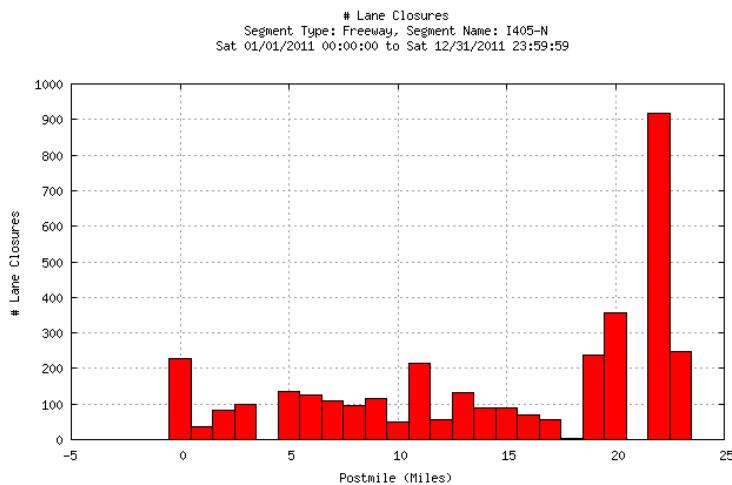
Lane Closure System Reports

PeMS extracts lane closure data from the Caltrans Lane Closure System (LCS) in real-time and allows users to view various reports related to LCS. LCS is a tracking system used by Caltrans District Traffic Managers and contractors to request, review, and approve lane closures on the freeway system. The lifecycle of a lane closure request consists of two phases: the request phase and the work phase. The LCS system stores data about each phase. There are a number of elements common to all reports that PeMS can generate from the LCS data. With each lane closure there are two dates: the date that the closure was requested (i.e., the request date), and the date when the work will be started on the freeway (i.e., the start date). The start date is the most common date to use for PeMS reports. Depending on the report, users can filter the results to a subset of the lane closures. All of the reports (except for the Listing tab) have the ability to present results in a plot, a table, as text, or to export values to a spreadsheet. The various reports available include the following:

- Summary – view lane closures by quantity (facility type, closure type, work type, etc.)

- Cross Tab – view lane closures by lane closure type, by quantity, or by various requesting groups
- Listing – view listing of closures that match filtering conditions of the selected time range
- Time Series – view the number of lane closures over time by quantity
- Day of Week – view the number of lane closures over the days of the week
- Segments – view spatial distribution of closures that took place (starting locations only) along the freeway segment
- Histogram – view a histogram of either the temporal duration or the spatial extent of lane closures

Using the Events > Lane Closure System > Segments report (for selected freeway segment)



This LCS Segments report shows northbound I-405 between post mile 0 (Irvine Center) and post mile 25 (County Line) in 2011. The highest number of lane closures (starting locations) occurred near post mile 22 (Seal Beach), at about 900 closures in 2011. These closures are due to a major construction project that started in 2011.

PeMS Application Guide

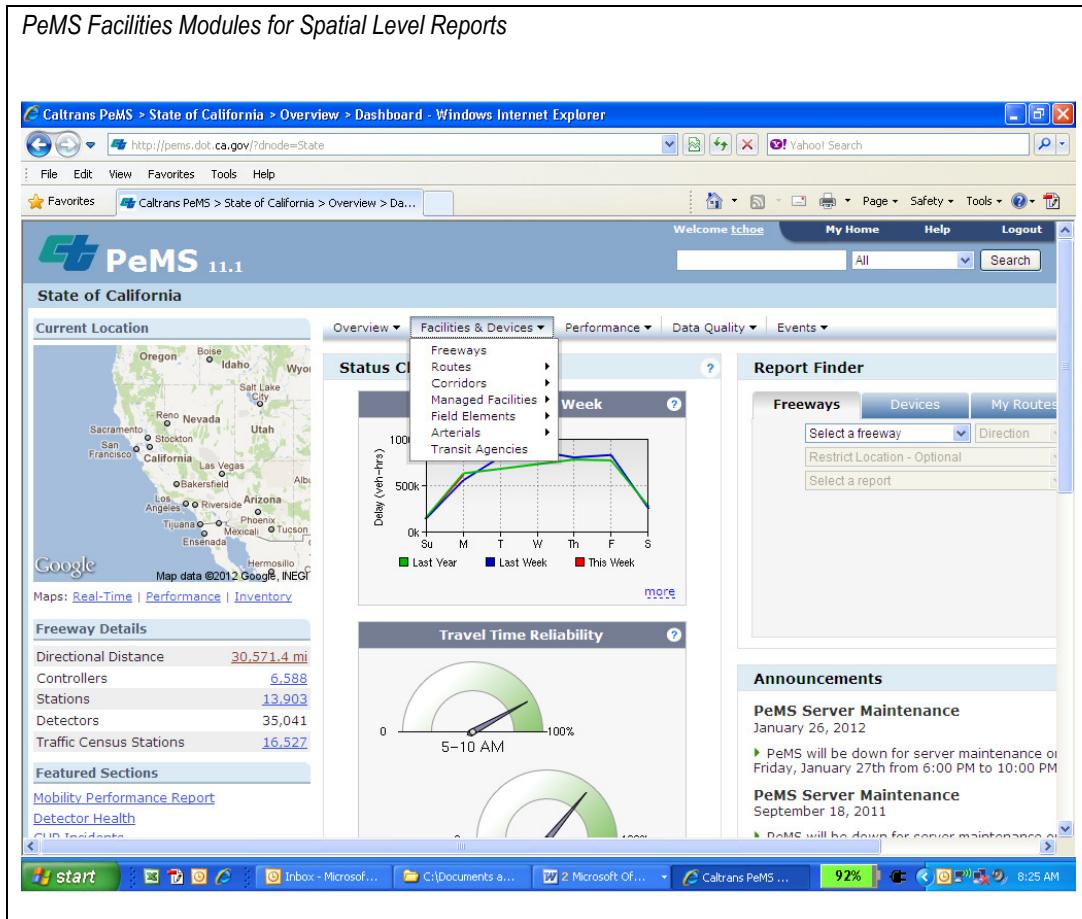
At the end of this Chapter is the PeMS Application Guide that provides illustrations of using PeMS for spatial level analysis. It is intended to be a step-by-step guide for obtaining spatial level analysis reports with quantity plots and tables. It is not all-inclusive and does not provide instructions for all possible types of reports that can be generated by PeMS.

Users are encouraged to use the Help features in PeMS and participate in the PeMS Forum to attain or share further information on using PeMS to its fullest capacity.

III. Freeway Spatial Level Analysis – Modules

There are five specific and separate facilities modules, apart from freeways, available in PeMS for spatial level analysis. They are found in the Facilities & Devices pull down menu either from the PeMS home page or from the District home page. They include:

- Routes
- Corridors
- Managed Facilities
- Arterials
- Transit



Routes (Travel Time Reports)

PeMS allows users to investigate the performance of Routes through the freeway system. A Route is a pre-defined freeway or arterial corridor with a specific starting point and a specific ending point. All of the performance measure reports found in the freeway spatial level analysis are also available in the Routes. Unlike the freeway segments selected from the freeway facilities inventory list, users cannot redefine the segment lengths of Routes. All Routes have fixed segment lengths. Unique to Routes, however, PeMS allows users to view the travel time statistics of the route over time.

PeMS Routes Module for Spatial Level Reports

The screenshot shows the PeMS 11.1 Routes module. On the left, there is a map of Southern California with various cities labeled. Below the map, there are sections for "Freeway Details" showing directional distance (2,318.2 mi), controllers (1,435), and stations (4,573). The main area is titled "Facilities & Devices > Routes" and contains a table titled "List of Routes". The table has columns for Dist, Name, Start, End, Roadway, Length (Miles), HOV (Miles), and # Stations. The data is as follows:

Dist	Name	Start	End	Roadway	Length (Miles)	HOV (Miles)	# Stations
D7	10w 17th - Bundy	10-W/17th St	10-W/Bundy Dr	Freeway	10.5		29
D7	210W-FruitToLake	210-W/Fruit St	210-W/Lake/Map St	Freeway	21.3		87
D7	210W-Vernon-Maple	210-W/Vernon/H St	210-W/Maple St	Freeway	13.5		55
D7	405 Santa Monica Blvd (near) to 710 South	405-S/Beloit/Stat Hwy 2	405-S/Wardlow Rd	Freeway	22.3	18.0	104

The screenshot shows the PeMS 11.1 Performance module. The top navigation bar includes "Performance > Travel Time". A dropdown menu under "Performance" is open, showing options like "Travel Time", "Aggregates", "Level of Service", and "Comparison". The main area displays a line graph titled "Travel Time - Time of Day (69% Observed)". The graph plots Travel Time (min) against Time of Day (00:00 to 23:00). The graph shows two data series: Mean (green line with 'x' markers) and Maximum (blue line with '*' markers). The travel time peaks at approximately 58 minutes around 07:00 and 18:00, and is generally lower during the night and early morning.

PeMS computes the travel time on a Route by "walking the velocity field". This means that for each link segment (see page 8) in the Route, PeMS calculates the time it takes to traverse that segment and then get the speed for the next segment at the time arriving at that segment. This is in contrast to methods which just sum the travel time of every segment in the route at the starting time.

PeMS computes the travel time for all of the Routes in the system in real-time and stores them in the database. PeMS starts computing travel time for Routes once they are defined, including Routes created by the user (users can create up to two custom routes, called "My Routes"). The Route configuration page gives the details of when

a route was defined or created, and if any historical travel times have been computed. Currently backfilling process for route travel time is not available in the system. It requires manual programming by the administrator.

It is important to note that these travel times are computed from the fixed detector data, where speeds are computed rather than measured. Also note that PeMS computed travel times do not take into account of any lane closings or blockages. As PeMS imputes for missing data for travel time, users should verify the quality of the detectors before using a travel time report. Also, the HOV lane in the lane selection on these pages only refers to lanes that are 24-hour HOV facilities. It does not refer, nor incorporate, facilities that are general purpose lanes during a portion of the day (part-time HOV facilities). If there is not an HOV-defined VDS along this Route, then PeMS will always select as lane 1.

For travel time performance measure, there are several different reports to select from including *Time Series*, *Comparison*, *Time of Day*, *Departure Time Series*, *Time of Day Time Series*, and *Prediction*.

Time Series – This report allows users to plot the travel time for a Route over the selected time period. Users can view the travel time for each lane of travel.

Comparison – This report allows users to compare the travel time for a Route for a particular day versus the average travel time for this Route over many days; users can select the days over which to average as well as the day to compare to.

Time-of-Day – This report shows detailed statistics about travel time of a Route over many days. Users can also view % Variability (standard deviation of the travel time divided by the mean travel time) and Buffer Time Index (extra amount of time that a user has to provision in order to make this trip 95% of the time).

Departure Time Series – This report allows users to pick a fixed departure time for a Route and then to see how the travel time for the Route changes over time.

Time-of-Day Time Series – This report shows users the 3-D plot of travel time versus time of day for many days in a row.

Prediction – This report provides a prediction of the travel time for the current Route from the time of the report selection until the rest of the day. The prediction is based on a nearest neighbors approach. This means that PeMS looks at the collection of historical travel times for this particular Route and choose the days with the 3 closest travel time profiles, using a simple weighted vector over the last few samples to measure distance between travel time profiles. PeMS then forms its prediction by taking the median of these three closest travel time profiles. A typical report will show the computed travel time up to the time of the report and then prediction for the remainder of the day.

Corridors

PeMS also allows users to investigate the performance of Corridors through the freeway system. A Corridor is a pre-defined freeway corridor with a specific starting point and a specific ending point that corresponds to specific Corridor System Management Plan (CSMP) facility as designated by Caltrans. Unlike the freeway segments selected from the freeway facilities inventory list, users cannot redefine the segment lengths of Corridors. All Corridors have fixed segment lengths. The Corridor Module offers unique reports that are not available in the other modules or from the freeway facilities inventory list such as Congestion reports. Also the Corridor animation allows users to view both directions of the freeway Corridor at the same time. Corridor features include:

- Map
- Animation
- Congestion
- Travel Times

- Detector Health
- Downloaded (archive data files)

PeMS Corridor Module for Spatial Level Reports

The screenshot shows the PeMS 11.1 Corridor Module. At the top, there's a navigation bar with links for Welcome, My Home, Help, and Logout. Below that is a search bar. The main area is titled "Corridor 01A: Los Angeles I-5". On the left, there's a sidebar with a map of Los Angeles showing the corridor route, and sections for Active Corridor (01A: Los Angeles I-5), Show (Routes, Stations checked), Tools (Holidays, Data Clearinghouse, PeMS Forum), and Credits (Powered by PeMS, Google). The central part of the screen displays a map of the corridor from I-5 through various neighborhoods like Bellflower, Downey, Norwalk, and Whittier. Red dots mark specific locations along the corridor. To the right of the map is a vertical bar with a grid of numbers representing detector health or travel times. At the bottom, there's a footer with links for Real-Time, Performance, and Inventory.

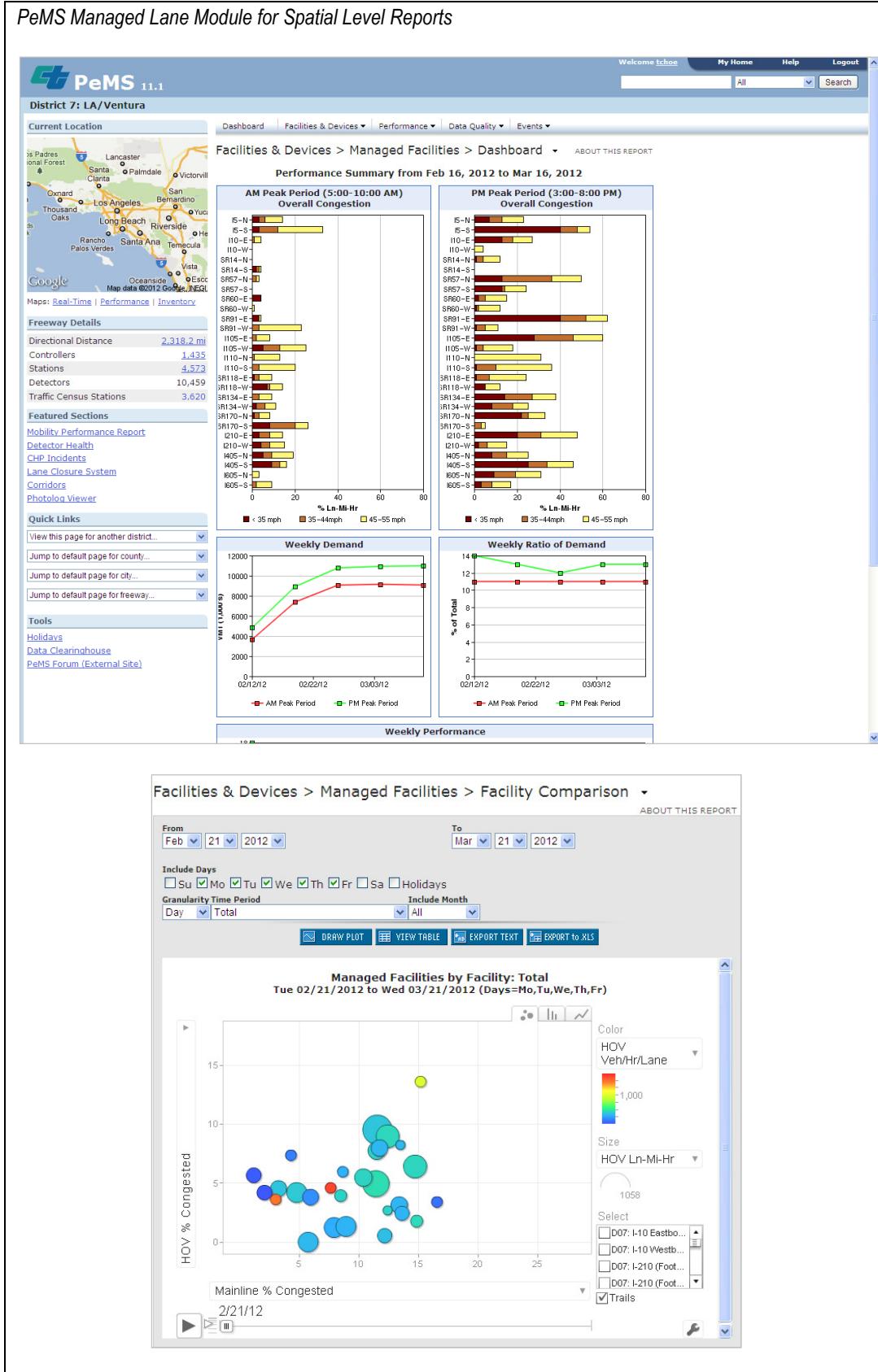
Available features in the Corridor Module are highlighted by the red oval above.

Managed Facilities

PeMS allows users to investigate the performance of HOV lanes and other Managed Facilities through the freeway system. A Managed Facility in PeMS is a collection of ordered links. A link represents a section of roadway between two points and must include at least one managed lane. Managed lanes include:

- HOV Lanes
- Bus Only Lanes
- Toll Lanes and bypasses

Each Managed Facility contains at least one set of ordered links for the primary direction of travel. The facility may also contain a set of ordered links for the secondary direction of travel. Most facilities will contain both sets of links, but exceptions are possible. Each link has a name and optional abbreviation. The link describes a section of roadway defined by two endpoints. Every link contains description of at least one managed lane.



Arterials

Users can access available arterial data reports by going to Facilities & Devices pull down menu and selecting Arterial link from either the PeMS home page or a District home page. Arterials are defined in PeMS as any segment of road that is not a freeway. PeMS has modeled the arterial networks with three objects:

- Intersections – a place where two more streets come together. The intersections typically have traffic control devices (signals, stop signs, etc associated with them).
- Links – a portion of the arterial road between two intersections. A link is only in one direction. Hence a standard street will always have two links, one for each direction, independent of whether it's physically separated with a barrier or not (this is in contrast to the typical understanding of a link in the GIS where it's only separated into two links if it's a physically separate road, like a large freeway).
- Link Lines – a virtual line on a link that we use to place detectors or change the attributes (e.g. capacity, speed limit, etc) of the link.

These three objects are defined over portions of the arterial network for which detectors are deployed. In other words, the model of the arterial network that is represented in PeMS only contains intersections, links and link lines where there are sensors deployed (or links that are adjacent to links that have sensors deployed).

PeMS Arterial Module for Spatial Level Reports (Facilities & Devices > Arterials > Intersections)

The screenshot shows the PeMS 11.1 interface for the Arterials module. The left sidebar includes a map of California and various navigation links like 'Freeway Details' and 'Featured Sections'. The main content area is titled 'Facilities & Devices > Arterials > Intersections'. It displays a table of intersections with columns for ID, Intersection Name, and Timing Plan Available?.

ID	Intersection Name	Timing Plan Available?
10000	RAMP/TELEGRAPH CANYON	No
10001	TELEGRAPH CANYON/CANYON PLAZA	Yes
10002	CREST/TELEGRAPH CANYON/OLEANDER	Yes
10003	TELEGRAPH CANYON/PASEO DEL REY	Yes
10004	TELEGRAPH CANYON/MEDICAL CENTER DR	Yes
10005	TELEGRAPH CANYON/PASEO LADERA	Yes
10006	TELEGRAPH CANYON/PASEO RANCHERO/HERITAGE	Yes
10007	TELEGRAPH CANYON/BUENA VISTA	Yes
10008	TELEGRAPH CANYON/OTAY LAKES/LA MEDIA	Yes
10009	OTAY LAKES/RUTGERS	Yes
10010	OTAY LAKES/VILLAGE 5 LOCAL	Yes

Transit

Users can access available transit data reports by going to Facilities & Devices pull down menu and selecting Transit Agencies link from the PeMS home page. This report lists transit agencies available for analysis within the system. Statistics shown in the table are all based on the current schedule configuration. The numbers are average daily values computed over a week.

PeMS Arterial Module for Spatial Level Reports (Facilities & Devices > Transit Agencies)

The screenshot shows the PeMS 11.1 interface for the Transit Agencies module. It displays a table of transit agencies with columns for Name, Routes, Patterns, Stops, Route miles, and Updated.

Name	Routes	Patterns	Stops	Route miles	Updated
MTS	103	428	4,817	1,452	01/30/2011
North County Transit Dist	38	135	1,888	604	01/12/2011

PeMS Application Guide

PeMS application steps are presented here for freeway station level analysis of traffic flow and speed performance measures. The main purpose of the illustrations in this section is to provide few examples of how to use PeMS to pull some of the basic traffic performance measure reports and conduct analysis. There are many more ways to pull the same data reports and many more data reports that can be generated that are not presented here. There are just too many to cover. Users are encouraged to try out on their own or with others the many different ways to navigate PeMS and query different types of reports.

For illustrative purposes, a vehicle detector station (VDS) location on the Orange County freeway, I-405, was selected to provide the examples: VDS ID 1201100 (IRVINE C1) Mainline Northbound. This VDS is located just to the north of the I-5 junction within the suburbs of Orange County.

In regards to the PeMS navigational approach, the use of the freeway inventory, although it can more tedious at times with repetitive steps as compared to the use of maps for example, is primarily used here for consistency and to build a standardized routine for new users. If users ever forget the short cuts that they have learned, they can always go back to this standard navigational approach. With this approach, we always start from the PeMS home page.

HOW TO USE THIS GUIDE

- Topic**
- Subtopic**
- PeMS location**

Highlighted pull-down menu

Steps to follow

Enter parameter input value per step instruction

Plot or Table query result

Data report summary and discussion points

Section number

Page no. (Ch-Sec-#)

Chapter number

Introduction to PeMS Manual

FLOW (VOLUME) AADT

VDS – Performance > Planning Analysis > AADT

In Mainline VDS 1201100 – IRVINE C1 page,

- Move mouse pointer to Performance > Planning Analysis > AADT (click AADT)
- Select Jan 2009 under From
- Select Jan 2011 under To
- Click VIEW TABLE

Starting Month	Fry	CA	Abs	PM	VDS	Name	Type	Average Mean	ASTM 14.2 AASHTO AASHTO	Sum of Annual Avg	Mod. Avg	Mod. Conv.	Mod. Conv.	Mod. Data Used	% Data Used
01/01/2009	1405	93	0.70	1201100	IRVINE	Mainline	C1	75.032	75.315	75.474	75.374	75.315	75.474	75.362	94.794
01/01/2009	1405	93	0.70	1201100	IRVINE	Mainline	C1	75.634	75.371	75.477	75.541	75.371	75.477	75.472	93.579
01/01/2009	1405	93	0.70	1201100	IRVINE	Mainline	C1	75.694	75.371	75.477	75.541	75.371	75.477	75.472	93.603
01/01/2009	1405	93	0.70	1201100	IRVINE	Mainline	C1	75.327	75.497	75.497	75.621	75.497	75.497	75.579	93.611
01/01/2009	1405	93	0.70	1201100	IRVINE	Mainline	C1	75.320	75.559	75.559	75.630	75.559	75.559	75.621	93.611
01/01/2009	1405	93	0.70	1201100	IRVINE	Mainline	C1	75.387	75.605	75.714	75.766	75.605	75.714	75.714	92.827
01/01/2009	1405	93	0.70	1201100	IRVINE	Mainline	C1	75.381	75.741	75.741	75.840	75.381	75.741	75.840	79.839
01/01/2009	1405	93	0.70	1201100	IRVINE	Mainline	C1	75.128	75.887	75.887	75.941	75.887	75.887	74.872	74.872
09/01/2009	1405	93	0.70	1201100	IRVINE	Mainline	C1	74.915			75.724	75.695	74.556	75.685	67.672
10/01/2009	1405	93	0.70	1201100	IRVINE	Mainline	C1	74.844			75.722				60.835
11/01/2009	1405	93	0.70	1201100	IRVINE	Mainline	C1	74.691			75.746				55.688
12/01/2009	1405	93	0.70	1201100	IRVINE	Mainline	C1	74.612			75.351				53.872
01/01/2010	1405	93	0.70	1201100	IRVINE	Mainline	C1	75.052			75.616				52.672
02/01/2010	1405	93	0.70	1201100	IRVINE	Mainline	C1	75.918			75.207				45.833

As shown, the table presents the AADT for each month from January 2009 to the last available data for AADT at this station. The AADT_1 (Arithmetic Mean) is about 75,000 for data available in 2009 and 2010. Note that for the other methods there is insufficient data points (note % Data Used column) to calculate their values; hence they are shown blank.

Section I – Freeway Station Level Analysis

4-I-9

Chapter 4 (PeMS Example 1)

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Chapter 4 (PeMS Example 1)

FLOW (VOLUME)**STATION (VDS) ANALYSIS - FLOW (VOLUME)**

From PeMS home page (*click on PeMS icon upper left corner*)

- 1.** Jump to **District 12: Orange County** home page from **Quick Links** pull down menu
(click on **Jump to default page for district...** pull down arrow, select and click on **D12: Orange County**)

From PeMS home page (*click on PeMS icon upper left corner*)

1. Jump to **District 12: Orange County** home page from **Quick Links** pull down menu
(click on **Jump to default page for district...** pull down arrow, select and click on **D12: Orange County**)

Users should see **District 12: Orange County** (District 12 home page)

FLOW (VOLUME)

VDS – Performance > Aggregates > Time Series

- From District 12: Orange County home page
2. Move mouse pointer to Facilities & Devices > Freeways
(click Freeways)

Welcome tchoe My Home Help Logout

District 12: Orange County

Facilities & Devices ▾

Status Chart

Report Finder

Freeways Devices My Routes

Travel Time Reliability

Announcements

PeMS Server Maintenance September 18, 2011

► PeMS will be down for server maintenance on Monday, September 19th from 10:00 AM to 1:00 PM

- In District 12:Orange County Facilities & Devices > Freeways page,
3. Click on 181 (I405-N row - #VDSs column) [this is the total number of available vehicle detector stations (VDS) on the selected roadway facility]

Welcome tchoe My Home Help Logout

District 12: Orange County

Facilities & Devices ▾

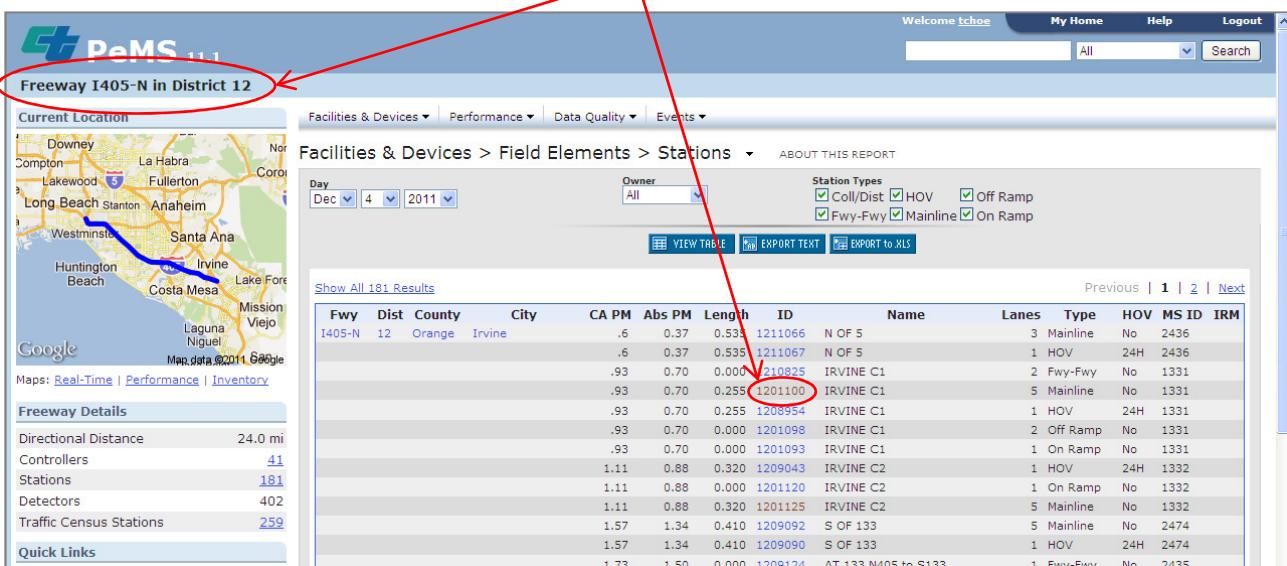
Facilities & Devices > Freeways

Facility	Detection				Mainline Facilities			HOV Facilities			Ramps				
	# LDSs	# VDSs	# Detectors	Total Miles	# VDSs	Lane Miles	# VDSs	Lane Miles	# VDSs	Lane Miles	Fwy Off	Fwy On	Fwy Off		
I5-N	83	319	733	44.4	102	44.4	202.7	36.8	36.8	90	36.8	44.3	44	59	20
I5-S	70	311	747	44.4	99	44.4	208.4	36.8	36.8	86	36.8	43.4	52	52	18
I405-N	41	181	402	23.9	57	23.9	107.8	50.5	50.5	55	23.9	24.2	21	30	11
I405-S	45	180	410	23.9	55	23.9	112.4	0	0.0	57	0.0	24.3	19	27	17
I605-N	1	5	11	2.0	2	2.1	8.2	22.3	22.3	1	2.1	2.1	1	1	0
I605-S	2	7	13	2.0	2	2.1	8.2	1.6	1.6	2	1.6	8.2	2	2	0
SR1-N	0	0	0	33.7	0	0.0	0	0.0	0	0	0.0	0	0	0	0
SR1-S	0	0	0	33.7	0	0.0	0	0.0	0	0	0.0	0	0	0	0
SR22-E	24	111	220	13.3	39	13.3	45.5	11.0	11.0	35	11.0	13.3	16	13	8
SR22-W	25	106	225	13.3	41	13.3	47.7	11.0	11.0	32	11.0	13.3	11	16	6
SR39-N	0	0	0	21.8	0	0.0	0	0.0	0	0	0.0	0	0	0	0
SR39-S	0	0	0	21.8	0	0.0	0	0.0	0	0	0.0	0	0	0	0
SR55-N	22	107	230	17.9	36	17.6	70.3	11.3	11.3	26	11.3	14.3	16	16	13
SR55-S	23	94	199	17.9	31	17.6	66.8	11.3	11.3	22	11.3	14.7	15	15	11
SR57-N	26	95	193	11.9	29	11.9	50.1	16.2	16.2	32	11.9	11.9	12	17	5
SR57-S	20	89	188	12.0	28	12.0	51.5	11.7	11.7	28	11.7	12.0	9	17	7
SR72-N	0	0	0	0.5	0	0.0	0	0.0	0	0	0.0	0	0	0	0
SR72-S	0	0	0	0.5	0	0.0	0	0.0	0	0	0.0	0	0	0	0

FLOW (VOLUME)

VDS – Performance > Aggregates > Time Series

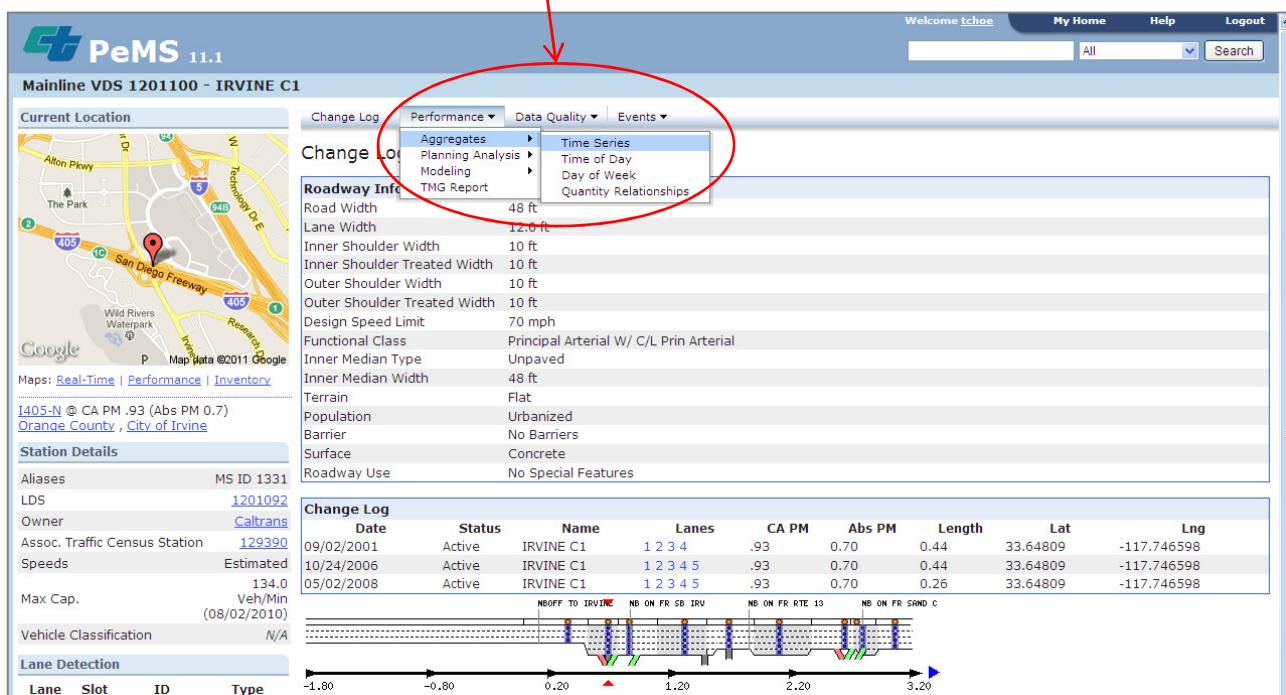
- In Freeway I405-N in District 12 page,**
4. Click on ID 1201100 (IRVINE C1) Mainline VDS



The screenshot shows the 'Facilities & Devices > Field Elements > Stations' report. The top navigation bar includes 'Welcome to PeMS', 'My Home', 'Help', and 'Logout'. Below the map, there are filters for 'Day' (Dec 4, 2011), 'Owner' (All), and 'Station Types' (Coll/Dist, HOV, Off Ramp, Fwy-Fwy, Mainline, On Ramp). The main table lists 181 results, with the 1201100 entry highlighted by a red circle.

Fwy	Dist	County	City	CA PM	Abs PM	Length	ID	Name	Lanes	Type	HOV	MS ID	IRM
I405-N	12	Orange	Irvine	.6	0.37	0.533	1211066	N OF 5	3	Mainline	No	2436	
				.6	0.37	0.535	1211067	N OF 5	1	HOV	24H	2436	
				.93	0.70	0.000	1210825	IRVINE C1	2	Fwy-Fwy	No	1331	
				.93	0.70	0.255	1208954	IRVINE C1	5	Mainline	No	1331	
				.93	0.70	0.000	1201093	IRVINE C1	1	HOV	24H	1331	
				.93	0.70	0.000	1201120	IRVINE C2	2	Off Ramp	No	1332	
				1.11	0.88	0.320	1209043	IRVINE C2	1	HOV	24H	1332	
				1.11	0.88	0.000	1201125	IRVINE C2	1	On Ramp	No	1332	
				1.11	0.88	0.320	1209092	S OF 133	5	Mainline	No	1332	
				1.57	1.34	0.410	1209090	S OF 133	5	Mainline	No	2474	
				1.57	1.34	0.410	1209090	S OF 133	1	HOV	24H	2474	
				1.73	1.50	0.000	1209124	AT 133 N405 to S133	1	Fwy-Fwy	No	2435	

- In Mainline VDS 1201100 – IRVINE C1 page,**
**5. Move mouse pointer to Performance > Aggregates > Time Series
(click Time Series)**



The screenshot shows the 'Mainline VDS 1201100 - IRVINE C1' page. The top navigation bar includes 'Welcome to PeMS', 'My Home', 'Help', and 'Logout'. The 'Performance > Aggregates > Time Series' menu option is highlighted with a red circle. The main content area displays station details, a change log table, and a lane detection diagram.

Date	Status	Name	Lanes	CA PM	Abs PM	Length	Lat	Lng
09/02/2001	Active	IRVINE C1	1 2 3 4	.93	0.70	0.44	33.64809	-117.746598
10/24/2006	Active	IRVINE C1	1 2 3 4 5	.93	0.70	0.44	33.64809	-117.746598
05/02/2008	Active	IRVINE C1	1 2 3 4 5	.93	0.70	0.26	33.64809	-117.746598

FLOW (VOLUME)

6. Select Nov 6 2011 0 under **From** and Nov 19 2011 23 under **To**

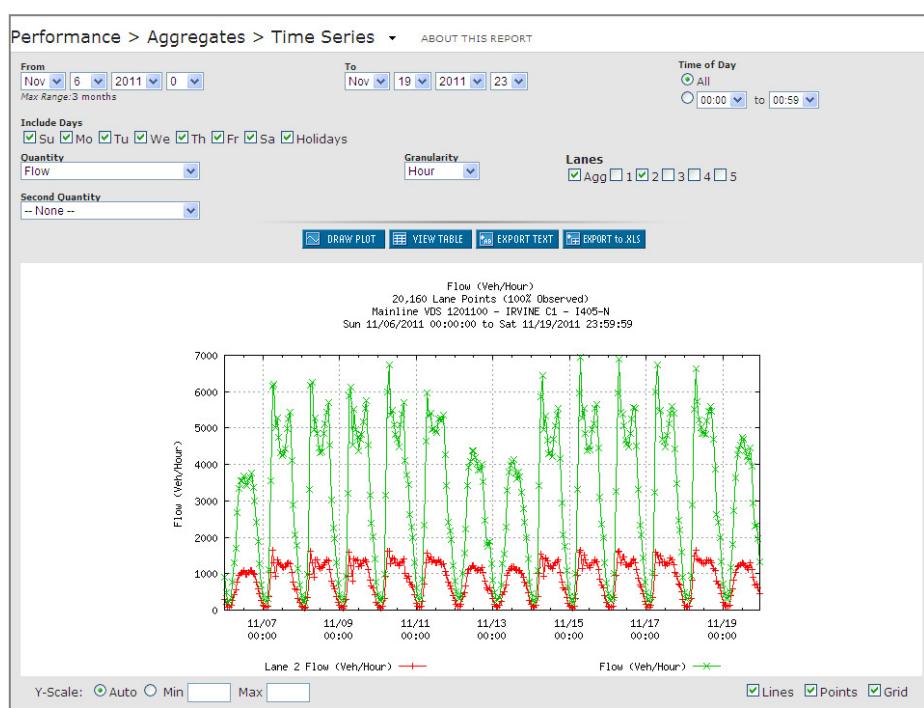
VDS – Performance > Aggregates > Time Series

7. Select Hour under **Granularity**

8. Deselect 1 3 4 5 under **Lanes**

9. Select Flow in **Quantity**

10. Click **DRAW PLOT**



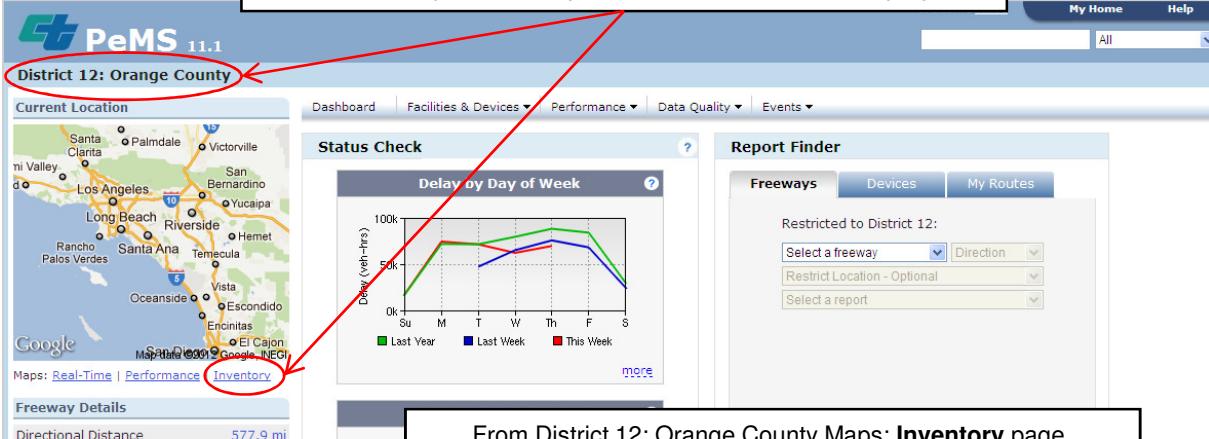
The above result is a plot of the actual hourly flow (volume) on Northbound I-405 mainline at Irvine Center Drive (at station ID 1201100) between the period of November 6, 2011 (0:00) and November 19, 2011 (24:00) for lane 2 shown in red and all lanes aggregate shown in green. As indicated, the peak hourly flow rate for a single lane (lane 2) is about 1,700 vehicles per hour, whereas the mainline flow rate (all lanes combined) is about 6,800 vehicles per hour. The two weeks period queried included Veterans Day holiday (November 11, 2011) where the flow is slightly less than the other weekdays but higher than the weekends. Also note that, under the second plot title heading, the data quality is at 100% observed (0% imputed data).

Note that users can select other lanes and click on **VIEW TABLE** to view a table of flow rates for each time granularity of each lane selected for that time period. Users will see that lane 5 (auxiliary lane) had the lowest flow rate as compared to the other lanes.

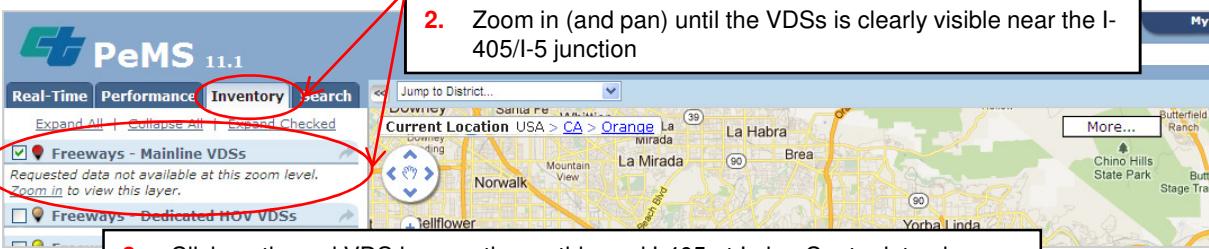
SHORT CUT TIP

Although navigating from the inventory page is the standard, there are many other ways to get to the same place. In this *short cut tip* example, navigating from the maps page is illustrated.

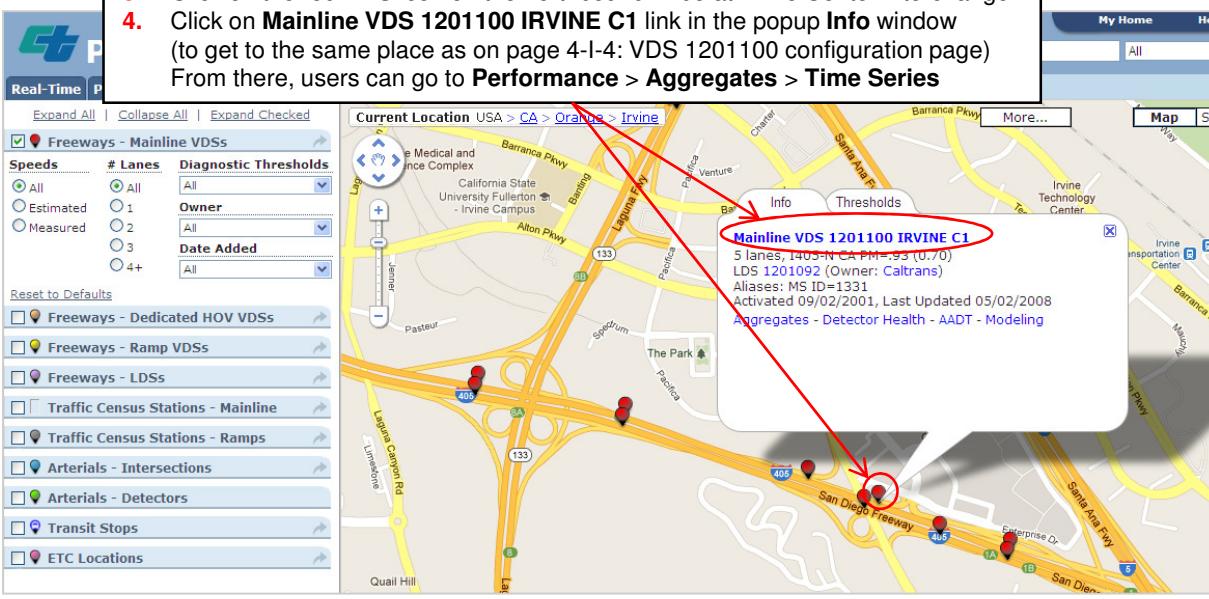
- From District 12: Orange County home page**
1. Click on Maps: **Inventory** link below the District 12 map figure



- From District 12: Orange County Maps: Inventory page, under **Freeways – Mainline VDSs** (box checked), it states that the user will need to zoom in to view the VDSs icon links**
2. Zoom in (and pan) until the VDSs is clearly visible near the I-405/I-5 junction



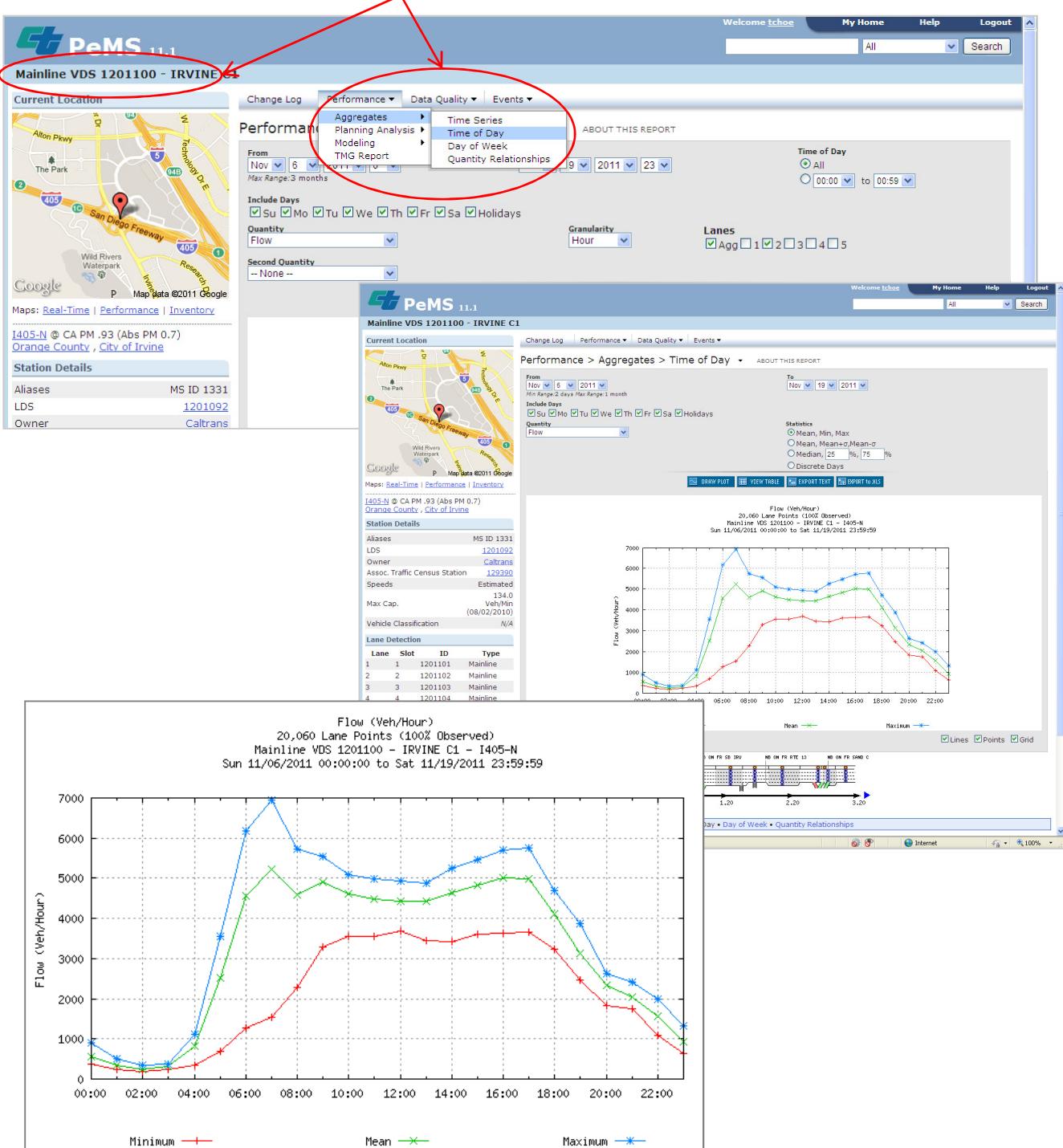
3. Click on the red VDS icon on the northbound I-405 at Irvine Center interchange
 4. Click on **Mainline VDS 1201100 IRVINE C1** link in the popup Info window (to get to the same place as on page 4-I-4: VDS 1201100 configuration page)
- From there, users can go to **Performance > Aggregates > Time Series**



FLOW (VOLUME)

VDS – Performance > Aggregates > Time of Day

- In Mainline VDS 1201100 – IRVINE C1 page,
11. Move mouse pointer to **Performance > Aggregates > Time of Day** (click **Time of Day**)

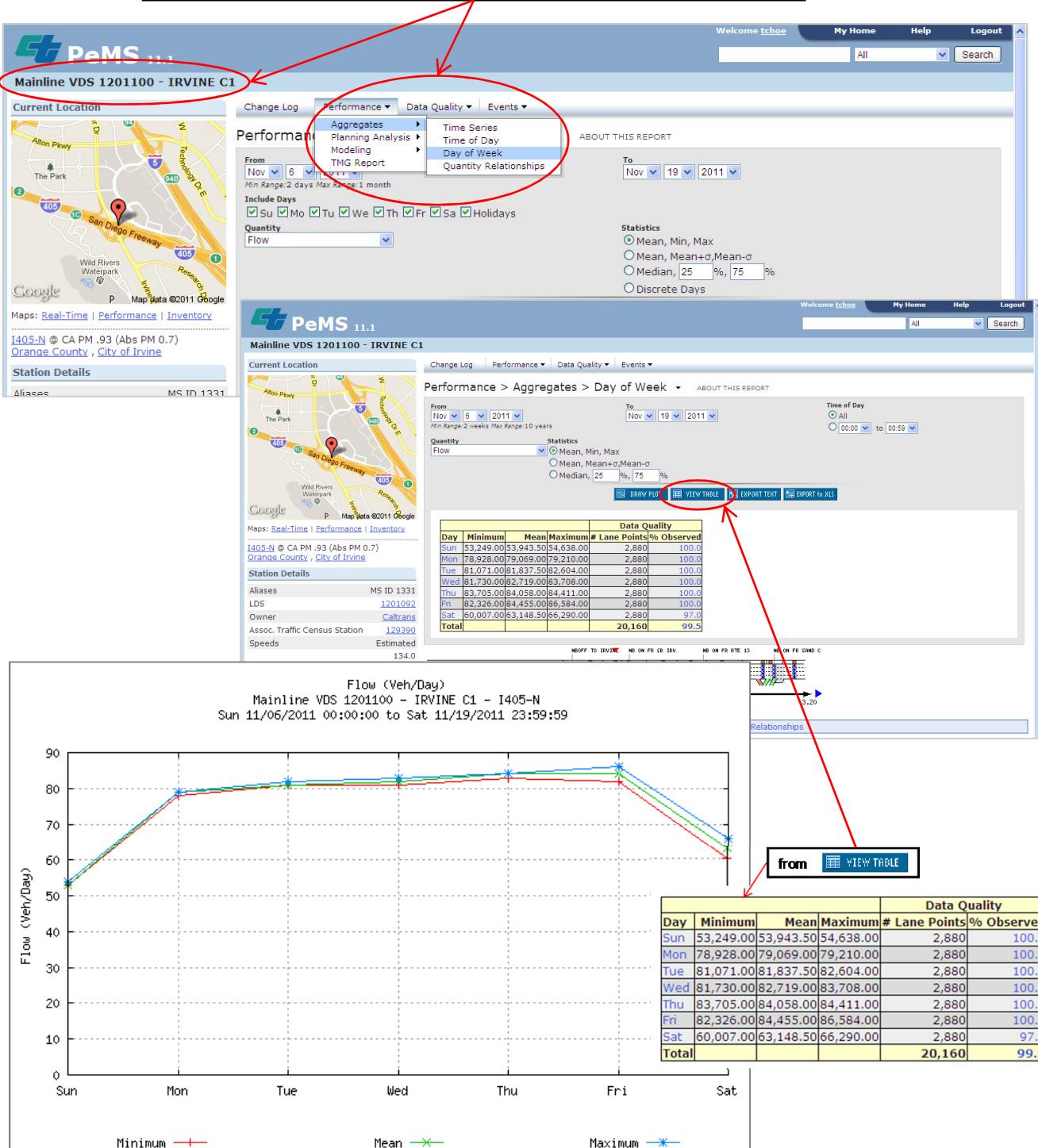


The above result is a Time of Day plot that shows, in a 24-hour graph, the hourly flow averages for up to two weeks maximum time period. As shown, the peak is at 7 am in the morning where flow reaches nearly 7,000 vehicles per hour. Note that users can deselect weekends (Su for Sunday and Sa for Saturday) and Holidays to limit the averages to regular working weekdays only.

FLOW (VOLUME)

VDS – Performance > Aggregates > Day of Week

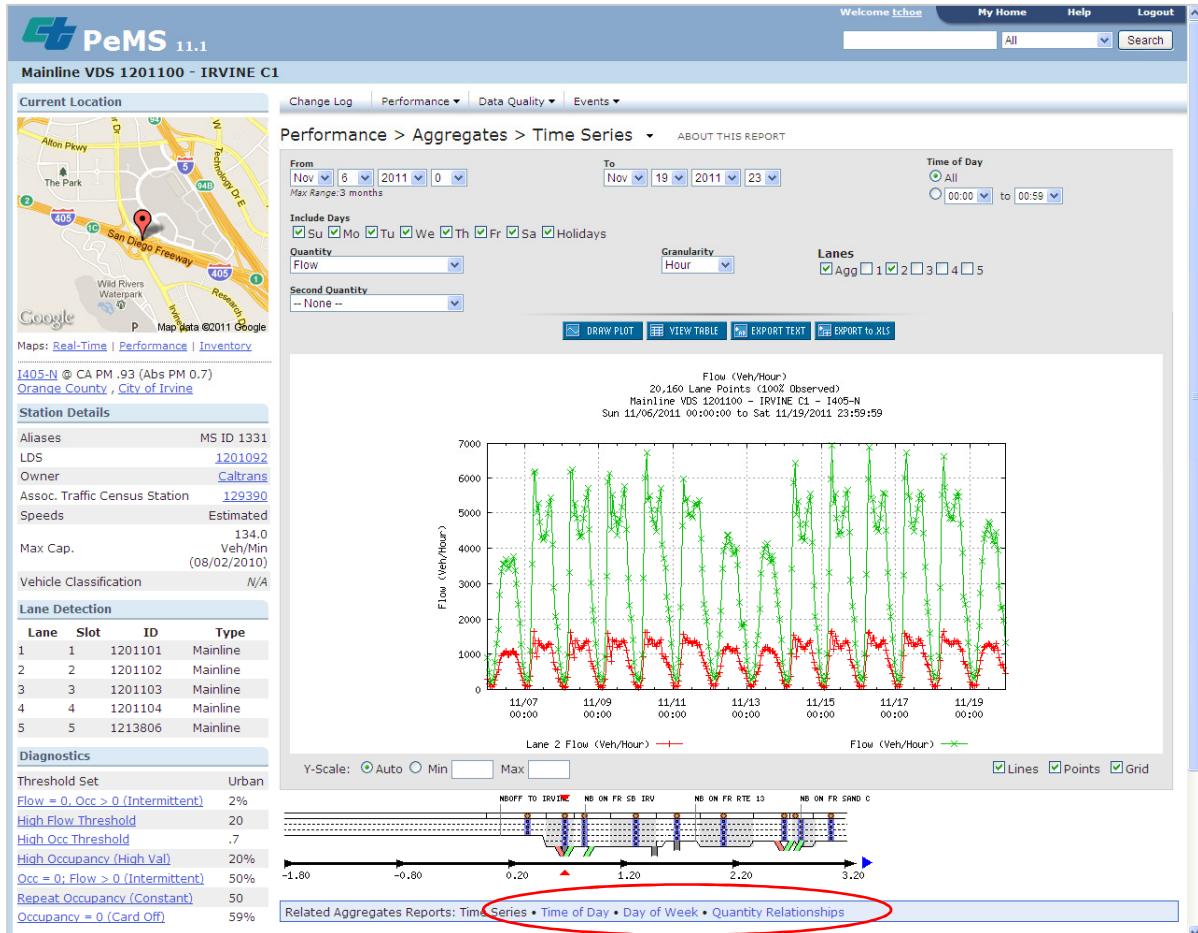
- In Mainline VDS 1201100 – IRVINE C1 page,
12. Move mouse pointer to Performance > Aggregates > Day of Week
 (click Day of Week)



The above result is a Day of Week plot that shows the daily flow average by each day in a week, for the two week period, indicating that Friday has the highest flow, at about 85,000 vehicles per day.

SHORT CUT TIP

There is an easier way to move back and forth between Time Series, Time of Day, and Day of Week reports without going through the pull down menu.



To move between **Performance > Aggregates > Time Series**, **Time of Day**, and **Day of Week** pages, users can use the links at the bottom of the pages:

**FLOW (VOLUME)
ADT**
VDS – Performance > Aggregates > Day of Week

PeMS 11.1

Mainline VDS 1201100 - IRVINE C1

Current Location

Performance > Aggregates > Day of Week

From: Nov 6, 2011 To: Nov 19, 2011

Quantity: Flow Statistics: Mean, Min, Max

Time of Day: All (0:00 to 00:59)

VIEW TABLE (highlighted with a red circle)

Day	Minimum	Mean	Maximum	# Lane Points	% Observed
Sun	53,249.00	53,943.50	54,638.00	2,880	100.0
Mon	78,928.00	79,069.00	79,210.00	2,880	100.0
Tue	81,071.00	81,837.50	82,604.00	2,880	100.0
Wed	81,730.00	82,719.00	83,708.00	2,880	100.0
Thu	83,705.00	84,058.00	84,411.00	2,880	100.0
Fri	82,326.00	84,455.00	86,584.00	2,880	100.0
Sat	60,007.00	63,148.50	66,290.00	2,880	97.0
Total				20,160	99.5

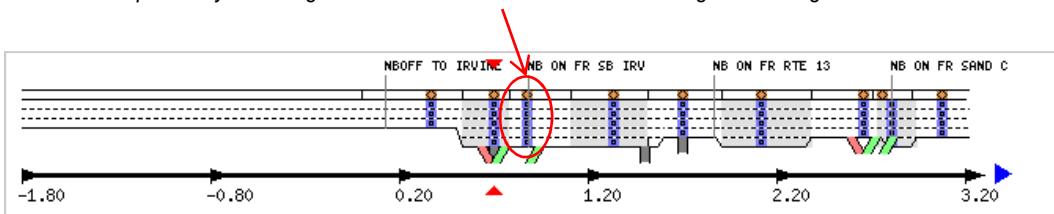
NBOFF TO IRVINE NB ON FR SB IRV NB ON FR RTE 13 NB ON FR SAND C

Related Aggregates Reports: Time Series • Time of Day • Day of Week • Quantity Relationships

from **VIEW TABLE**

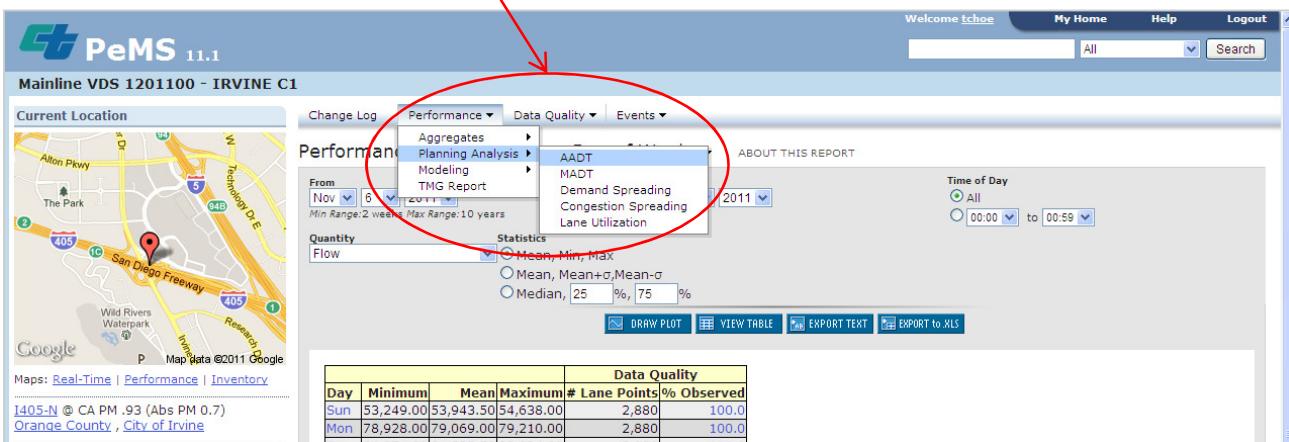
Day	Minimum	Mean	Maximum	# Lane Points	% Observed
Sun	53,249.00	53,943.50	54,638.00	2,880	100.0
Mon	78,928.00	79,069.00	79,210.00	2,880	100.0
Tue	81,071.00	81,837.50	82,604.00	2,880	100.0
Wed	81,730.00	82,719.00	83,708.00	2,880	100.0
Thu	83,705.00	84,058.00	84,411.00	2,880	100.0
Fri	82,326.00	84,455.00	86,584.00	2,880	100.0
Sat	60,007.00	63,148.50	66,290.00	2,880	97.0
Total				20,160	99.5

The same Day of Week plot (see previous page for steps) shows the ADT (daily flow average by each day in a week), for the two week period, indicating that Friday has the largest flow, at about 85,000 vehicles per day. Users can get ADT along the corridor for the same period by selecting the mainline VDS link on the lane configuration diagram below the table.



FLOW (VOLUME)
AADT
VDS – Performance > Planning Analysis > AADT

In Mainline VDS 1201100 – IRVINE C1 page,
13. Move mouse pointer to **Performance > Planning Analysis > AADT**
 (click **AADT**)



Mainline VDS 1201100 - IRVINE C1

Current Location: Map showing Alton Pkwy, Technology Dr E, San Diego Freeway, and Research Dr. Map data ©2011 Google.

Performance > Planning Analysis > AADT

From: Nov 6, 2011
To: Nov 6, 2011
Min Range: 2 weeks, Max Range: 10 years

Quantity: Flow
Statistics: Mean, Min, Max, Mean+σ, Mean-σ, Median, 25%, 75%

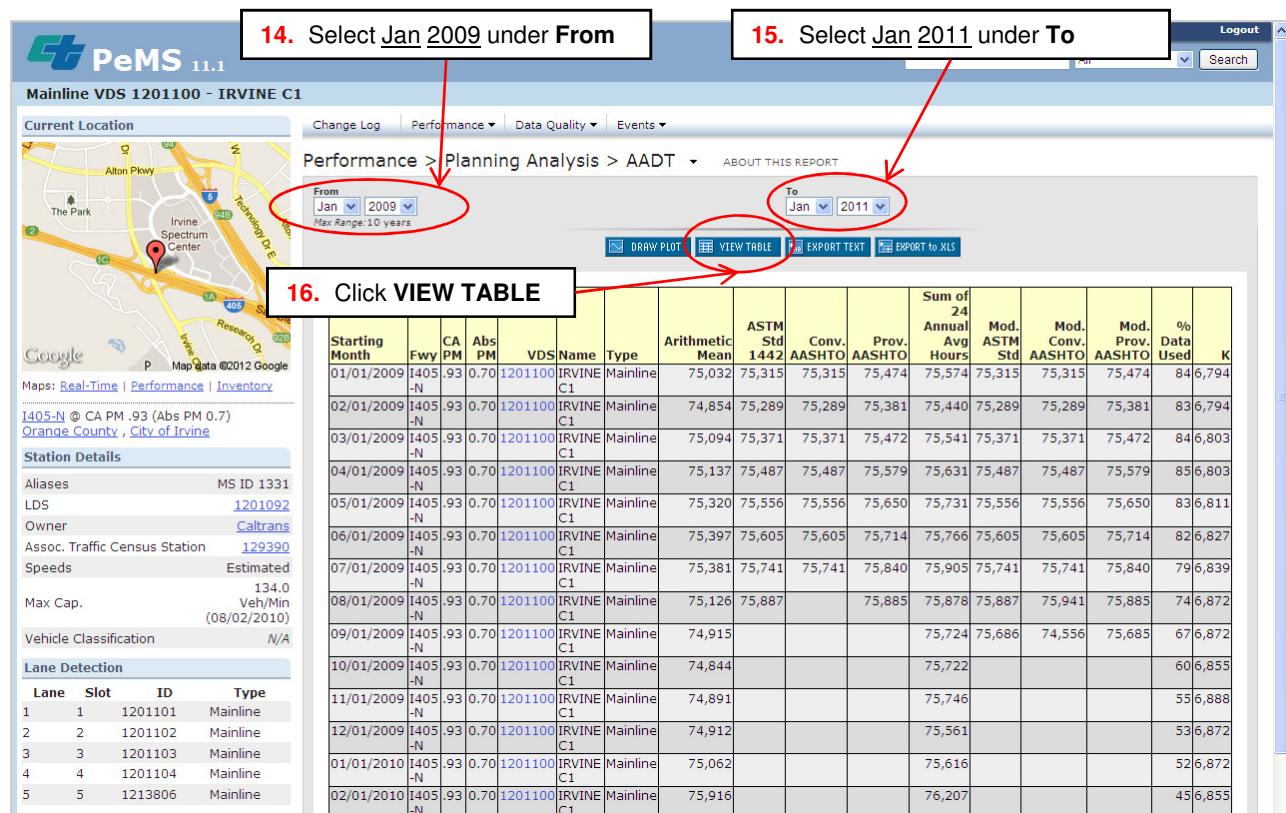
Data Quality:

Day	Minimum	Mean	Maximum	# Lane Points	% Observed
Sun	53,249.00	53,943.50	54,638.00	2,880	100.0
Mon	78,928.00	79,069.00	79,210.00	2,880	100.0
Tue	81,071.00	81,027.00	81,604.00	2,880	100.0

Demand Spreading, Congestion Spreading, Lane Utilization

Time of Day: All, 0:00 to 00:59

Buttons: DRAW PLOT, VIEW TABLE, EXPORT TEXT, EXPORT to XLS



Mainline VDS 1201100 - IRVINE C1

Current Location: Map showing Alton Pkwy, Technology Dr E, San Diego Freeway, and Research Dr. Map data ©2012 Google.

Performance > Planning Analysis > AADT

From: Jan 2009
To: Jan 2011
Max Range: 10 years

Buttons: DRAW PLOT, VIEW TABLE, EXPORT TEXT, EXPORT to XLS

14. Select Jan 2009 under From

15. Select Jan 2011 under To

16. Click VIEW TABLE

Table Data:

Starting Month	Fwy	CA PM	Abs PM	VDS	Name	Type	Arithmetic Mean	ASTM Std 1442	Conv. AASHTO	Prov. AASHTO	Sum of 24 Annual Avg Hours	Mod. ASTM Std	Mod. Conv. AASHTO	Mod. Prov. AASHTO	% Data Used	K
01/01/2009	I405	.93	0.70	1201100	IRVINE C1	Mainline	75,032	75,315	75,315	75,474	75,574	75,315	75,315	75,474	846,794	
02/01/2009	I405	.93	0.70	1201100	IRVINE C1	Mainline	74,854	75,289	75,289	75,381	75,440	75,289	75,289	75,381	836,794	
03/01/2009	I405	.93	0.70	1201100	IRVINE C1	Mainline	75,094	75,371	75,371	75,472	75,541	75,371	75,371	75,472	846,803	
04/01/2009	I405	.93	0.70	1201100	IRVINE C1	Mainline	75,137	75,487	75,487	75,579	75,631	75,487	75,487	75,579	856,803	
05/01/2009	I405	.93	0.70	1201100	IRVINE C1	Mainline	75,320	75,556	75,556	75,650	75,731	75,556	75,556	75,650	836,811	
06/01/2009	I405	.93	0.70	1201100	IRVINE C1	Mainline	75,397	75,605	75,605	75,714	75,766	75,605	75,605	75,714	826,827	
07/01/2009	I405	.93	0.70	1201100	IRVINE C1	Mainline	75,381	75,741	75,741	75,840	75,905	75,741	75,741	75,840	796,839	
08/01/2009	I405	.93	0.70	1201100	IRVINE C1	Mainline	75,126	75,887		75,885	75,878	75,887	75,941	75,885	746,872	
09/01/2009	I405	.93	0.70	1201100	IRVINE C1	Mainline	74,915				75,724	75,686	74,556	75,685	676,872	
10/01/2009	I405	.93	0.70	1201100	IRVINE C1	Mainline	74,844				75,722				606,855	
11/01/2009	I405	.93	0.70	1201100	IRVINE C1	Mainline	74,891				75,746				556,888	
12/01/2009	I405	.93	0.70	1201100	IRVINE C1	Mainline	74,912				75,561				536,872	
01/01/2010	I405	.93	0.70	1201100	IRVINE C1	Mainline	75,062				75,616				526,872	
02/01/2010	I405	.93	0.70	1201100	IRVINE C1	Mainline	75,916				76,207				456,855	

As shown, the table presents the AADT for each month from January 2009 to the last available data for AADT at this station. The AADT_1 (Arithmetic Mean) is about 75,000 for data available in 2009 and 2010. Note that for the other methods there are insufficient data points (note % Data Used column) to calculate their values; hence they have no values and are shown blank.

FLOW (VOLUME)

MADT

VDS – Performance > Planning Analysis > MADT

In Mainline VDS 1201100 – IRVINE C1 page,

- 17.** Move mouse pointer to **Performance > Planning Analysis > MADT**
(click **MADT**)

Starting Month	Fwy	CA PM	Abs PM	VDS	Name	Type	Arithmetic Mean	ASTM Std 1442	Conv. AASHTO	Prov. AASHTO	Sum of 24 Annual Avg Hours	Mod. ASTM Std	Mod. Conv. AASHTO	Mod. Prov. AASHTO	% Data Used
01/01/2009	1405	93	0.70	1201100	IRVINE C1	Mainline	75,032	75,315	75,315	75,474	75,574	75,315	75,315	84,6,794	
02/01/2009	1405	93	0.70	1201100	IRVINE C1	Mainline	74,854	75,289	75,289	75,381	75,440	75,289	75,289	83,6,794	
03/01/2009	1405	93	0.70	1201100	IRVINE C1	Mainline	75,094	75,371	75,371	75,472	75,541	75,371	75,371	84,6,803	

- 18. Select 2009 under From**

- 19. Select 2011 under To**

20. Select Weekdays under Days

21. Click DRAW PLOT

Starting Month	2009	2010	2011
Jan	75,686	75,948	0
Feb	79,071	80,527	0
Mar	81,215	82,862	81,134
Apr	81,999	82,828	81,827
May	81,033	81,896	80,847
Jun	83,443	84,937	83,879
Jul	83,460	85,851	82,590
Aug	84,055	0	84,500
Sep	81,315	0	83,010
Oct	81,647	82,713	82,404
Nov	82,370	78,678	79,167
Dec	76,983	78,959	77,771

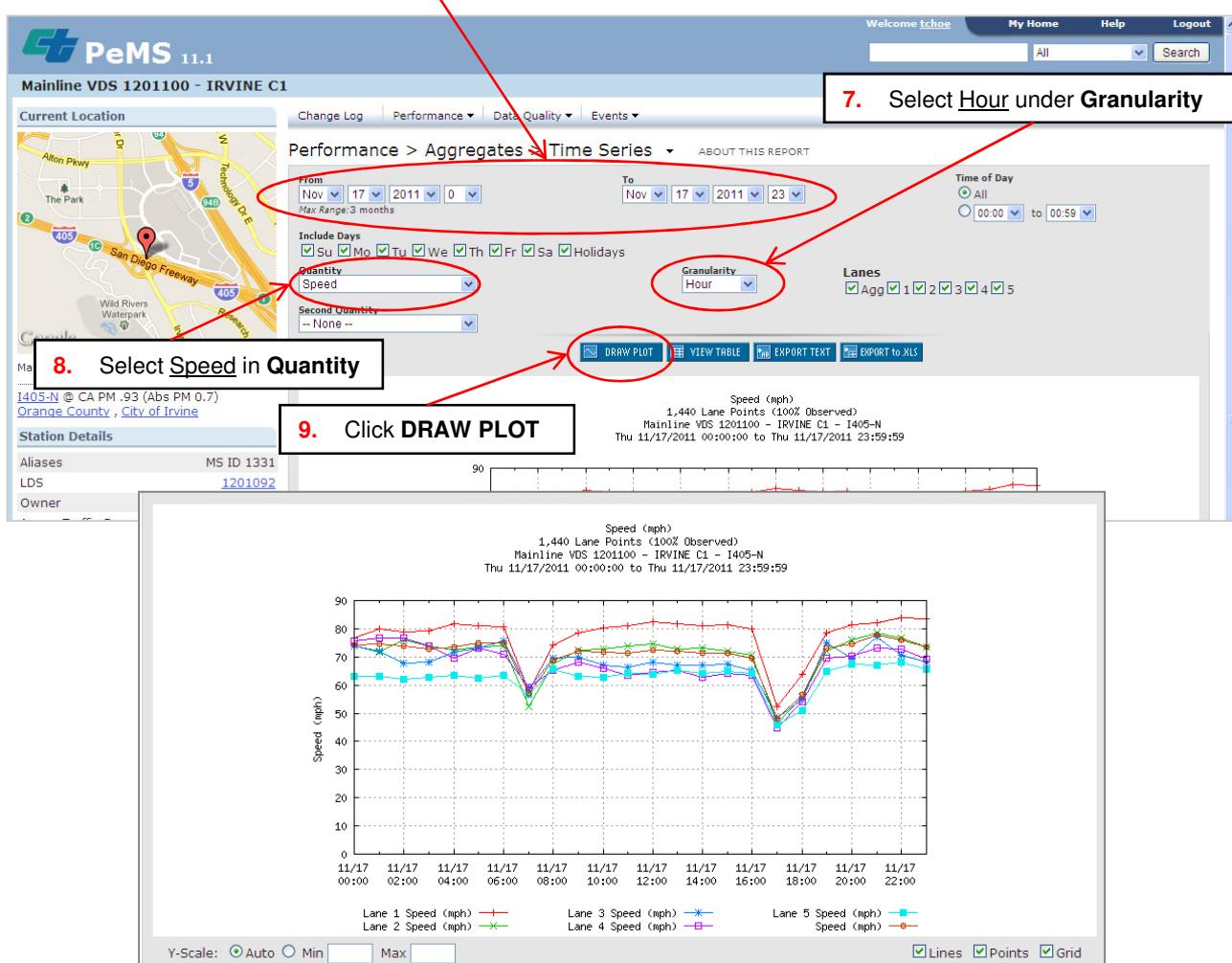
In this Monthly ADT (MADT) plot, average ADT is plotted for each month in a calendar year period, for the time period selected (in this case from 2009 to 2011). This plot also allows the user to limit the averages to only weekdays or weekends. As shown above, the weekday MADT is highest during summer months with the peak in August at around 84,000.

STATION (VDS) ANALYSIS - SPEED

(Initial navigational steps are same as for Flow – see page 4-I-1)

- From PeMS homepage
- 1. Jump to **District 12: Orange County** homepage
- 2. Move mouse pointer to **Facilities & Devices > Freeways** (click **Freeways**)
- 3. Find row **I405-N**, under Detection #**VDSs** column, click on **181**
- 4. Click on **ID 1201100 (IRVINE C1 Mainline VDS)**
- 5. Click Move mouse pointer to **Performance > Aggregates > Time Series** (click **Time Series**)

- 6.** Select Nov 17 2011 0 under **From** and Nov 17 2011 23 under **To**



The above example is a plot of the actual speeds on Northbound I-405 mainline at Irvine Center Drive (at station ID 1201100) between the period of November 17, 2011 (0:00) and November 17, 2011 (24:00) for all lanes and aggregate shown in different colors. As indicated, the speeds slow during the am and pm peak hours, falls to 55 miles per hour at 7 am and 45 miles per hour at 5 pm. Also note that, under the second plot title heading, the data quality is at 100% observed (0% imputed data).

Note that users can select or deselect specific lanes and click on **VIEW TABLE** to view a table of hourly speeds for each lane selected for that time period. Users will see that lane 5 (auxiliary lane) has the slowest speed compared to the other lanes, as would be expected. Lane-by-lane speeds are only available at the five-minute and hourly granularities.

- In Mainline VDS 1201100 – IRVINE C1 page,
10. Move mouse pointer to **Performance > Aggregates > Time of Day** (click **Time of Day**)

Mainline VDS 1201100 - IRVINE C1

Performance > Aggregates > Time of Day

From: Nov 17 2011 To: Nov 23 2011

Include Days: Su Mo Tu We Th Fr Sa Holidays

Quantity: Speed

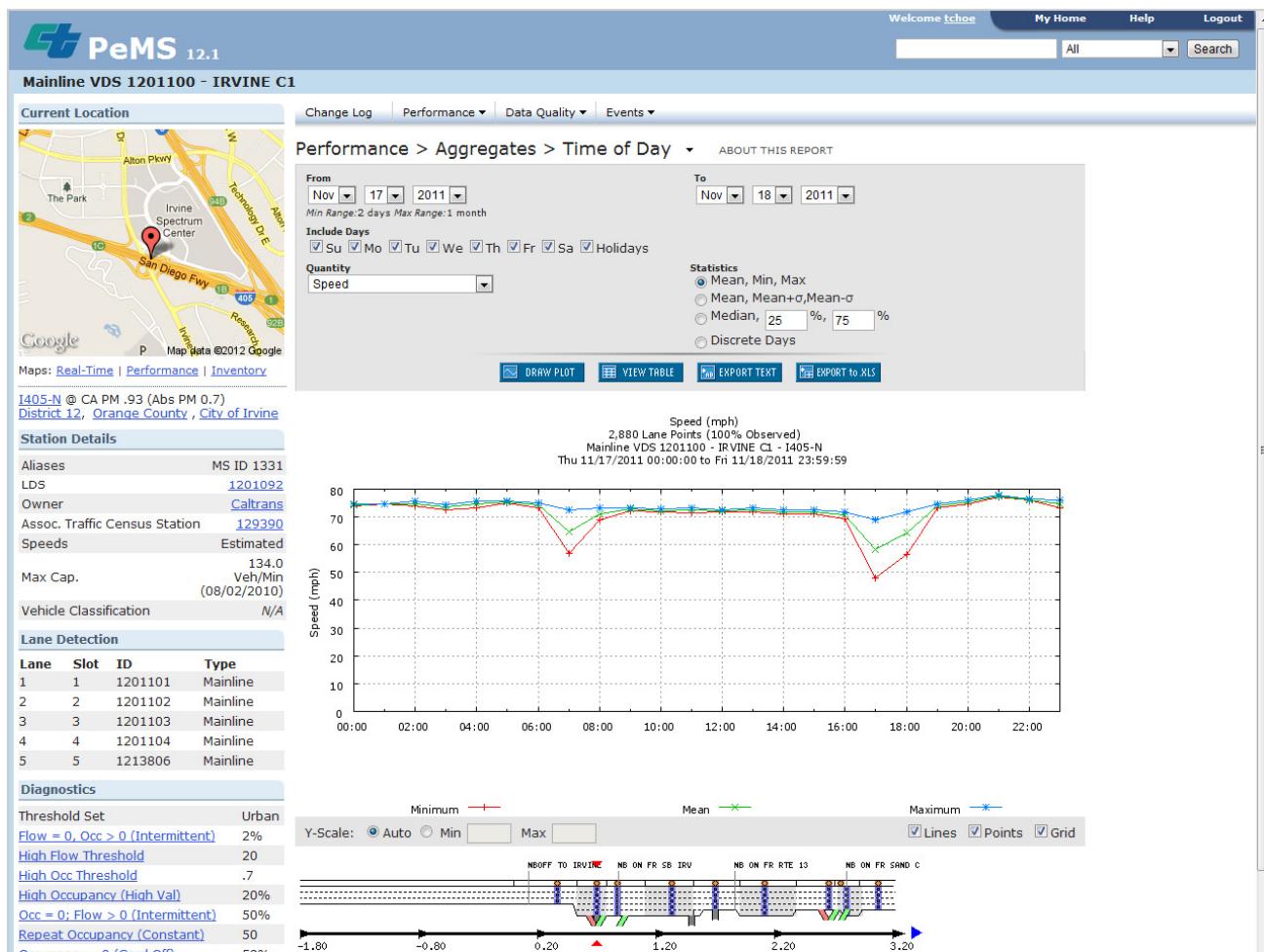
Second Quantity: --None--

Granularity: Hour

Lanes: All Lanes

Time of Day: All 00:00 to 00:59

DRAW PLOT VIEW TABLE EXPORT TEXT EXPORT to XLS

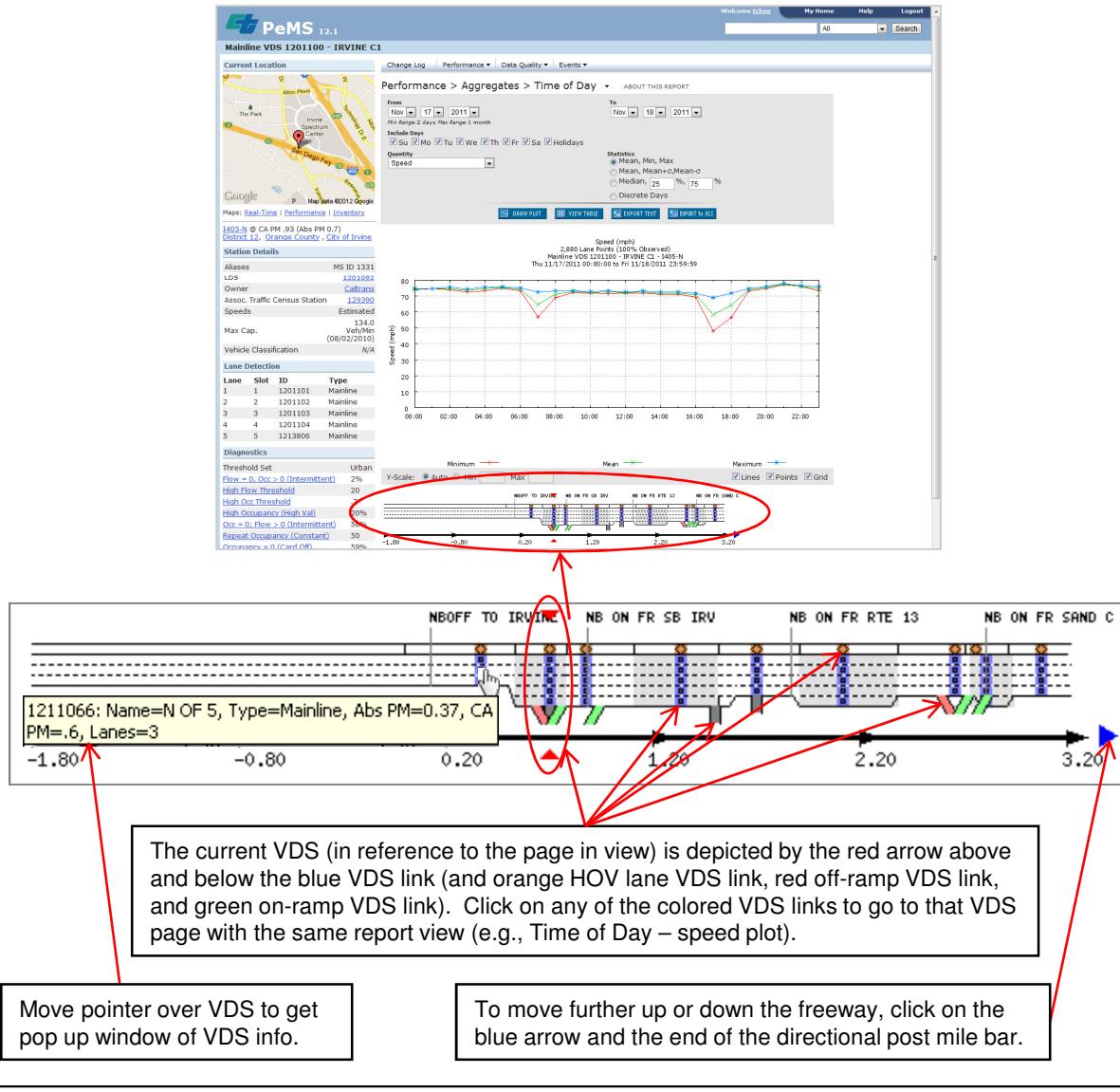


The Time of Day plot shows the hourly speeds, in a 24-hour graph, of the average of the two day period. As shown, the slowest speeds are at 7 am and 5 pm. Note that users can select longer periods of up to one month and deselect weekends (Su for Sunday and Sa for Saturday) and Holidays to limit the average to weekdays only.

Note that you can click on **VIEW TABLE** to view a table of average hourly speeds for each hour of the day.

SHORT CUT TIP

There is a simple way to move up and down the freeway and view other VDS locations, including ramps and freeway connectors, (e.g., to see similar reports such as flow or speed performance measures) by using the roadway configuration figure at the bottom of the page.



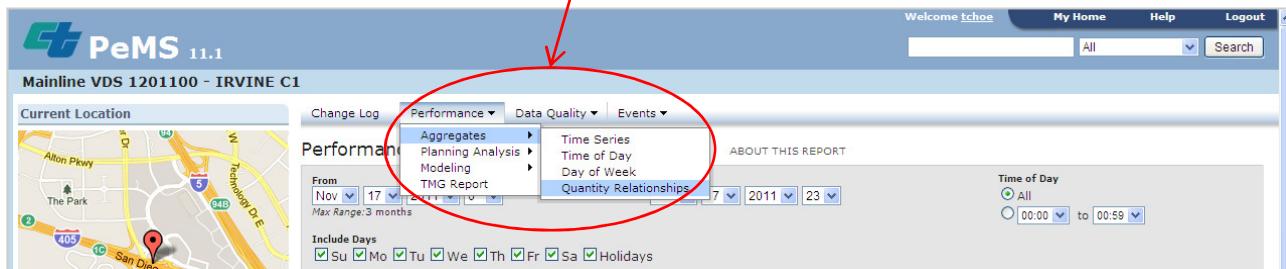
FLOW VERSUS SPEED

VDS – Performance > Aggregates > Quantity Relationships

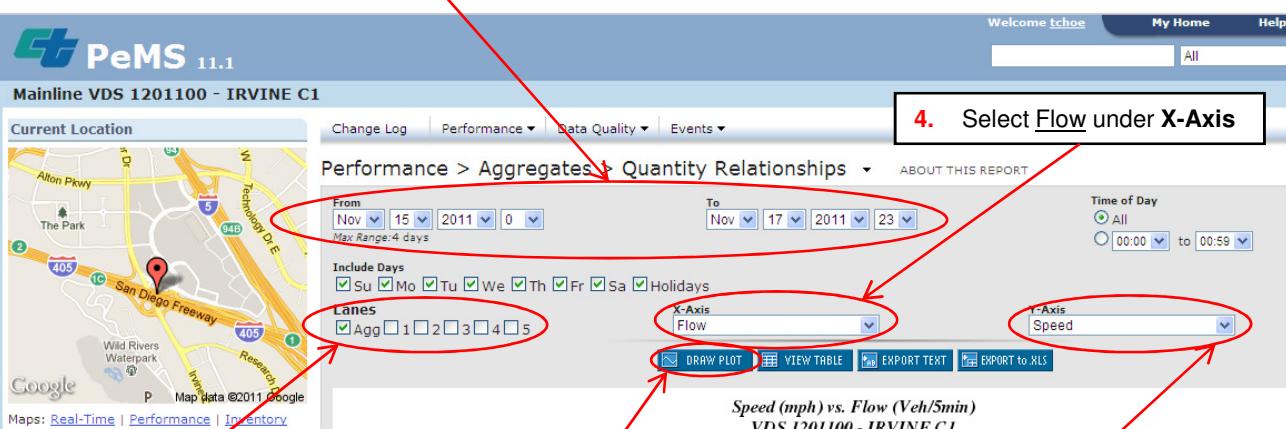
Now that users can plot flow data and speed data, and plot them against each other in Quantity Relationship reports.

In Mainline VDS 1201100 – IRVINE C1 page,

1. Move mouse pointer to **Performance > Aggregates > Quantity Relationships** (click **Quantity Relationships**)



2. Select Nov 15 2011 0 under **From** and Nov 17 2011 23 under **To**

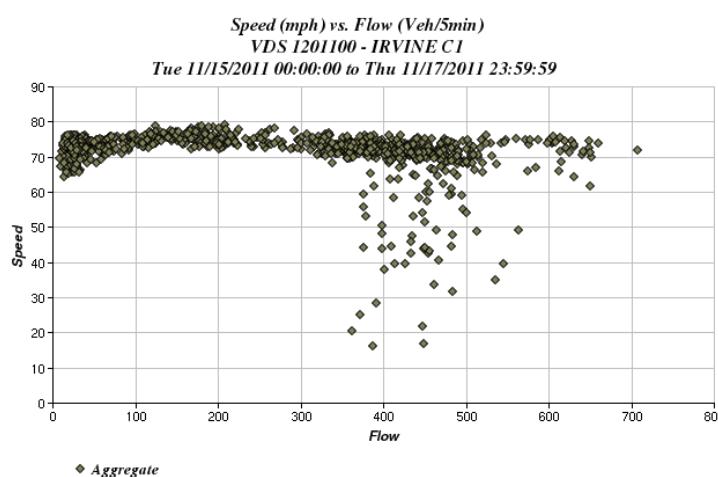


3. Deselect lanes 1 2 3 4 5

6. Click **DRAW PLOT**

4. Select Flow under **X-Axis**

5. Select Speed under **Y-Axis**



This is a common traffic theory plot of the flow versus speed used to determine the speed at which the maximum flow occurs. At this station, during the selected period between November 15, 2011 and November 17, 2011, it appears that the critical speed is around 70 miles per hour where flow reaches its peak.

FLOW VERSUS SPEED

VDS – Performance > Aggregates > Quantity Relationships

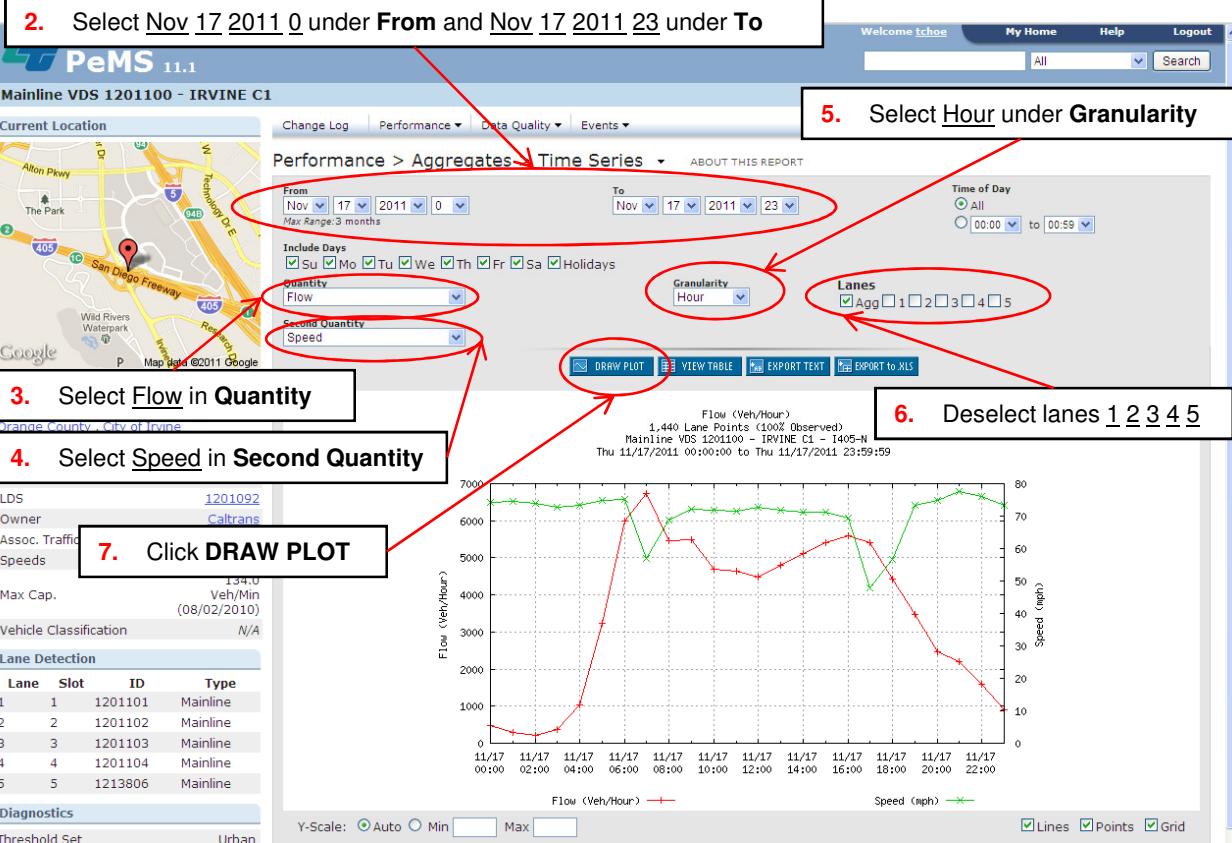
QUANTITY RELATIONSHIPS USING TIME SERIES REPORT

You can also plot two quantities such as flow and speed on the same plot using **Performance > Aggregates > Time Series** reports.

- In Mainline VDS 1201100 – IRVINE C1 page,
1. Move mouse pointer to **Performance > Aggregates > Time Series**
(click **Time Series**)

2. Select Nov 17 2011 0 under **From** and Nov 17 2011 23 under **To**

5. Select Hour under **Granularity**



The above example is a plot of the actual flow and speeds on Northbound I-405 mainline at Irvine Center Drive (at station ID 1201100) between the period of November 17, 2011 (0:00) and November 17, 2011 (24:00) for aggregate lanes (sum of flows and average of speeds across all lanes). As indicated for that specific day, the flow is highest where the speeds are about 50 miles per hour during the am and pm peak hours. This is likely due to the peak demand during the peak commuting hours, which also affects the speeds as the demand reaches the roadway capacity. Also note that, under the second plot title heading, the data quality is at 100% observed (0% imputed data). Also note that users can manually scale the Y-Scale (bottom left corner).

CHAPTER 4 EXERCISES

Flow

1. What is the VDS ID number for District 3 – Eastbound I-80 at Richard Boulevard?
2. At that station, what is the total number of lanes?
3. What is the highest recorded one hour flow between 11/6/2011 and 11/19/2011? At what date and time? What is the percent data observed for that aggregate data?
4. Which lane typically has the lowest flow values among all lanes?
5. What is the peak hour in terms of the highest (mean) flow rate during this two week period?
6. Which day of the week has the highest flows during this two week period?
7. What is the peak ADT during this two week period? At what date?
8. Which month had the highest MADT in 2011?

Speed

9. Among all the lanes, which lane is typically slowest during this two week period?
10. If it typically has the lowest flow rates, why would the speeds also be the lowest among the lanes?

Density

11. Calculate the density at this station at 4pm on November 17, 2011. What is the density value per lane (vehicles/hour/lane)?
12. How might this PeMS value differ from the Highway Capacity Manual calculation value?

Answers are provided in the Appendix.

DELAY

SPATIAL (FREEWAY SEGMENT) ANALYSIS

For illustrative purposes, the Orange County freeway, I-405, was selected to provide the examples: I405-N Mainline Northbound, from the I-5 junction to the I-605 interchange.

- From PeMS home page (click on PeMS icon upper left corner)
1. Jump to **District 12: Orange County** home page from **Quick Links** pull down menu
(click on **Jump to default page for district...** pull down arrow, select and click on **D12: Orange County**)

Status Check

- Delay by Day of Week**: A line graph showing delay in vehicle-hours per week across days Su through S. The Y-axis ranges from 0 to 1000k. The legend indicates Last Year (green), Last Week (blue), and This Week (red). The graph shows a peak on Friday.
- Travel Time Reliability**: Two circular gauge charts showing reliability levels for 5-10 AM and 3-8 PM. Both are at 100%.
- Detector Health**: A line graph showing the percentage of working detectors over time from 01/13/11 to 01/12/12. The statewide goal is 90%, and yesterday's health was 64%.

Report Finder

Announcements

- PeMS Server Maintenance**: September 18, 2011. PeMS will be down for server maintenance on Monday, September 19th from 10:00 AM to 1:00 PM.
- PeMS 11.1**: August 31, 2011. This release includes new and improved navigational controls along with many bug fixes and performance enhancements. You may have noticed that the Tools drop down menu has been removed. Maps can now be accessed by clicking on one of the three links -- Real-Time, Performance, or Inventory -- directly below the Current Location map in the upper left-hand corner of any page. A link to the Data Clearinghouse is under the Tools heading on the left side of every page. [Read more...](#)
- Welcome to PeMS 11!**: May 24, 2011. Welcome to the new PeMS, version 11! PeMS 11 features an updated User Interface design and a number of other improvements. [Read more...](#)
- Route Sharing**: July 27, 2010.

Users should see **District 12: Orange County** (District 12 home page)

District 12: Orange County

Status Check

Report Finder

DELAY

- From District 12: Orange County home page
2. Move mouse pointer to **Facilities & Devices > Freeways**
(click **Freeways**)

Welcome tchoe My Home Help Logout

District 12: Orange County

Facilities & Devices ▾

Status Chart

Report Finder

Freeways Devices My Routes

Travel Time Reliability

Announcements

PeMS Server Maintenance September 18, 2011

More

5-10 AM

Freeway Details	Directional Distance	577.9 mi
Controllers	629	
Stations	2,318	
Detectors	5,284	
Traffic Census Stations	959	

- In District 12:Orange County Facilities & Devices > Freeways page,
3. Click on I405-N (under Detection Fwy column)

Welcome tchoe My Home Help Logout

District 12: Orange County

Facilities & Devices ▾

Facilities & Devices > Freeways ABOUT THIS REPORT

Fwy	Detection			Mainline Facilities			HOV Facilities			Ramps		
	# LDSS	# VDSs	# Detectors	Total Miles	# VDSs	Lane Miles	Miles	# VDSs	Lane Miles	Fwy Off	On	Fwy
I5-N	83	319	733	44.4	102	44.4	202.7	36.8	36.8	90	36.8	44.3
I5-S	70	311	747	44.4	99	44.4	208.4	36.8	36.8	86	36.8	43.4
I405-N	41	181	402	23.9	57	23.9	107.8	50.5	50.5	55	23.9	24.2
I405-S	45	180	410	23.9	55	23.9	112.4	0	0.0	57	0.0	24.3
I605-N	1	5	11	2.0	2	2.1	8.2	22.3	22.3	1	2.1	2.1
I605-S	2	7	13	2.0	2	2.1	8.2	1.6	1.6	2	1.6	8.2
SR1-N	0	0	0	33.7	0	0.0	0	0.0	0	0	0.0	0
SR1-S	0	0	0	33.7	0	0.0	0	0.0	0	0	0.0	0
SR22-E	24	111	220	13.3	39	13.3	45.5	11.0	11.0	35	11.0	13.3
SR22-W	25	106	225	13.3	41	13.3	47.7	11.0	11.0	32	11.0	13.3
SR39-N	0	0	0	21.8	0	0.0	0	0.0	0	0	0.0	0
SR39-S	0	0	0	21.8	0	0.0	0	0.0	0	0	0.0	0
SR55-N	22	107	230	17.9	36	17.6	70.3	11.3	11.3	26	11.3	14.3
SR55-S	23	94	199	17.9	31	17.6	66.8	11.3	11.3	22	11.3	14.7
SR57-N	26	95	193	11.9	29	11.9	50.1	16.2	16.2	32	11.9	11.9
SR57-S	20	89	188	12.0	28	12.0	51.5	11.7	11.7	28	11.7	12.0
SR72-N	0	0	0	0.5	0	0.0	0	0.0	0	0	0.0	0
SR72-S	0	0	0	0.5	0	0.0	0	0.0	0	0	0.0	0

DELAY

I405-N: Performance > Aggregates > Time Series

- In Freeway I405-N in District 12 page,**
4. Move mouse pointer to Performance > Aggregates > Time Series
 (click Time Series)

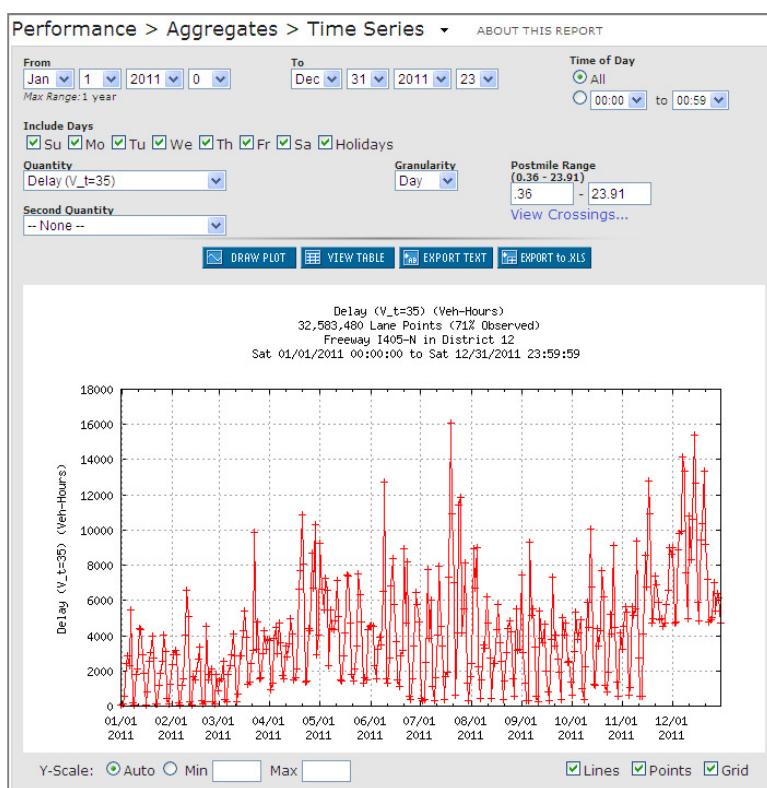
Fwy	Dist	County	City	CA PM	Abs PM ID	Name	Line	Drop MS ID
I405-N	12	Orange	Irvine	.93	0.70 1201092	IRVINE C1	35	4 1331
				1.11	0.88 1201119	IRVINE C2	35	1 1332
					NB ON FR SB IRVINE CNTR (0.89)			
					SEG NB OFF IRVINE CTR DR (0.43)			
					SB ON NB IRVINE CENTER (0.55)			
					NB ON FR NB IRVINE CNTR (0.69)			
I405-N	12	Orange	Irvine	2.35	2.12 1209050	LAGUNA CANYON RD	35	20 2041
					NB OFF TO SB RTE 133 (1.54)			
					NB ON FR RTE 133 (1.87)			
I405-N	12	Orange	Irvine	2.89	2.66 1213951	SAND CANYON 1	35	8 5515
				2.99	2.76 1201150	SAND CANYON 2	35	5 1551
I405-N	12	Orange	Irvine	3.31	3.08 1209051	N OF SAND CANYON	35	7 2040

- 5. Select Jan 1 2011 0 under From and Dec 31 2011 23 under To**

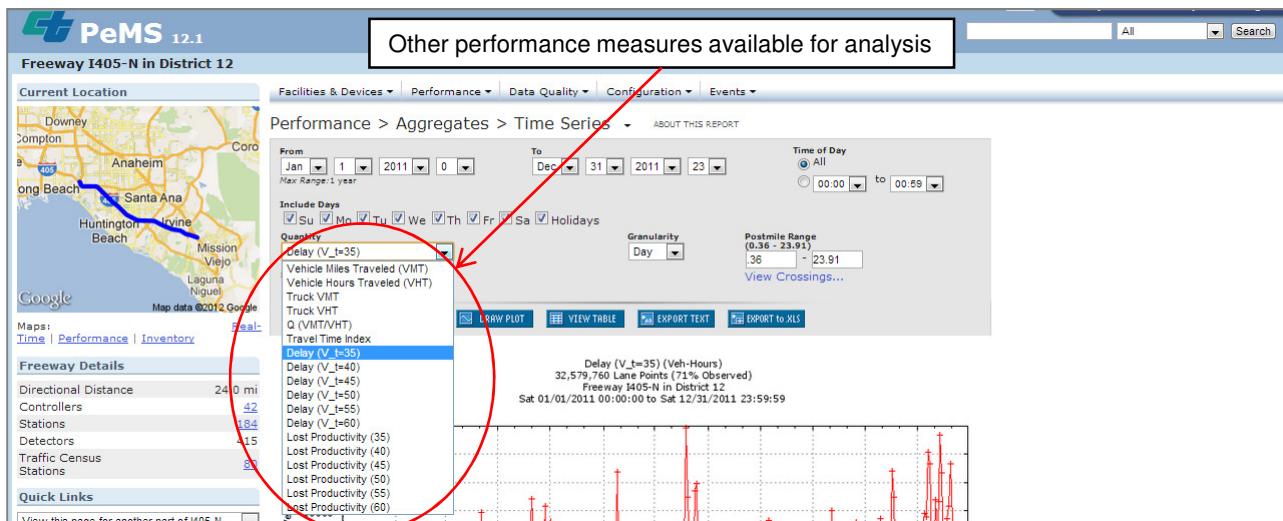
6. Select Day under Granularity

7. Select Delay (V_t=35) under Quantity

8. Click DRAW PLOT

DELAY**I405-N: Performance > Aggregates > Time Series**

In PeMS, delay is the amount of extra time spent by all the vehicles beyond the time it takes to traverse a freeway segment at a threshold speed. In other words, it is the amount of additional time that vehicles spend on the roadway due to congestion. PeMS can compute the amount of delay using different threshold speeds (i.e., 35, 40, 45, 50, 55, 60, and 65 miles per hour). Time Series reports allow the user to view delay for a freeway segment over time (maximum range is 1 year if the granularity is by day, week, or month; maximum range is 3 weeks if by hour). The above result is a plot of the daily delay (for speeds below threshold speed of 35 miles per hour) of the Northbound I-405 mainline freeway in Orange County for all of 2011. As indicated, the peak delay occurred during July/August and November/December months. The typical peak daily delay appears to be around 8,000 to 10,000 vehicle-hours per day based on just visual observation of the plot. Atypical single day peak of 16,000 in late July could be due to an incident on the freeway that may have occurred on that day. Click on View Table to view the table of delay quantity values. As indicated, the 2011 annual delay for this freeway segment was 1,474,345 vehicle-hours. Also note that, under the second plot title heading, the data quality is at 71% observed (29% imputed data).



In Freeway I405-N in District 12 page,
9. Move mouse pointer to **Performance > Spatial Analysis > 2-D**
 (click 2-D)

PeMS 11.1

Freeway I405-N in District 12

Performance >

From: Jan 1 2011
Postmile Range: 0.36 - 23.91

	Data Quality				
Day	Minimum	Mean	Maximum	# Lane Points	% Observed
Sun	31.10	1,406.15	5,489.30	4,638,840	72.0
Mon	239.00	3,460.07	11,426.90	4,642,560	72.0
Tue	876.80	4,637.53	11,886.20	4,642,560	71.0

DRAW PLOT VIEW TABLE EXPORT TEXT EXPORT to XLS

10. Select Nov 3 2011 17 0 under Time (5 PM)

PeMS 11.1

Freeway I405-N in District 12

Performance > Spatial Analysis > 2-D

Time: Nov 3 2011 17 0

Crossings: Show More

Quantity: Speed

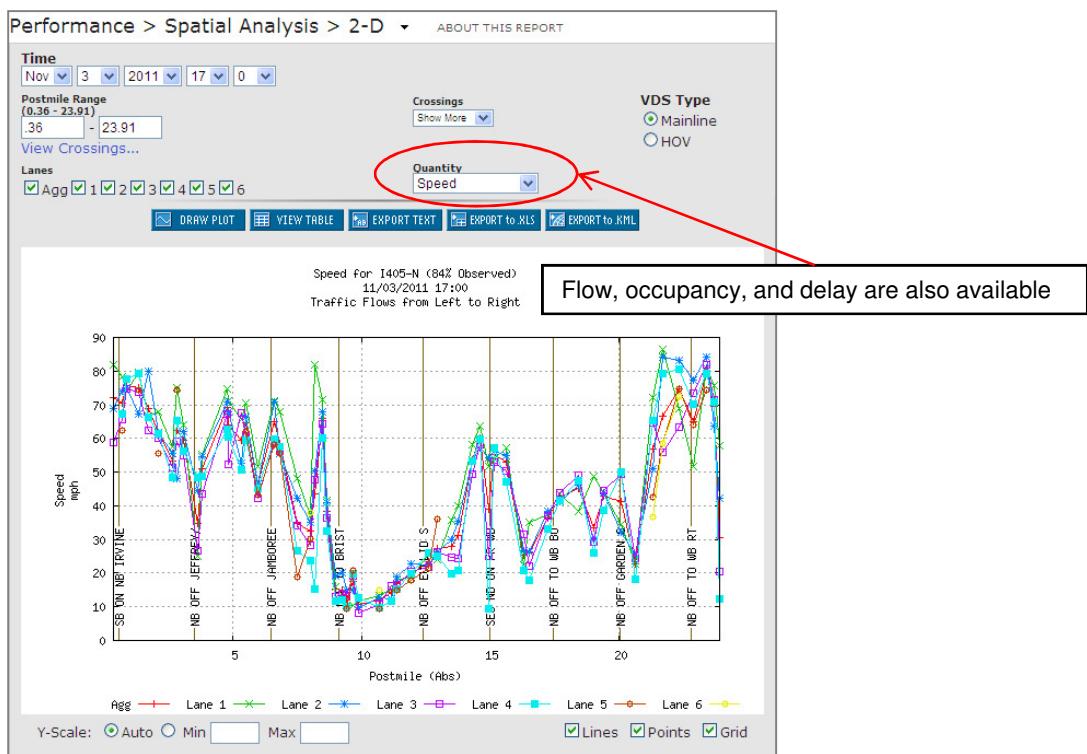
DRAW PLOT

Speed for I405-N (84% Observed)
11/03/2011 17:00
Traffic Flows from Left to Right

13. Click DRAW PLOT

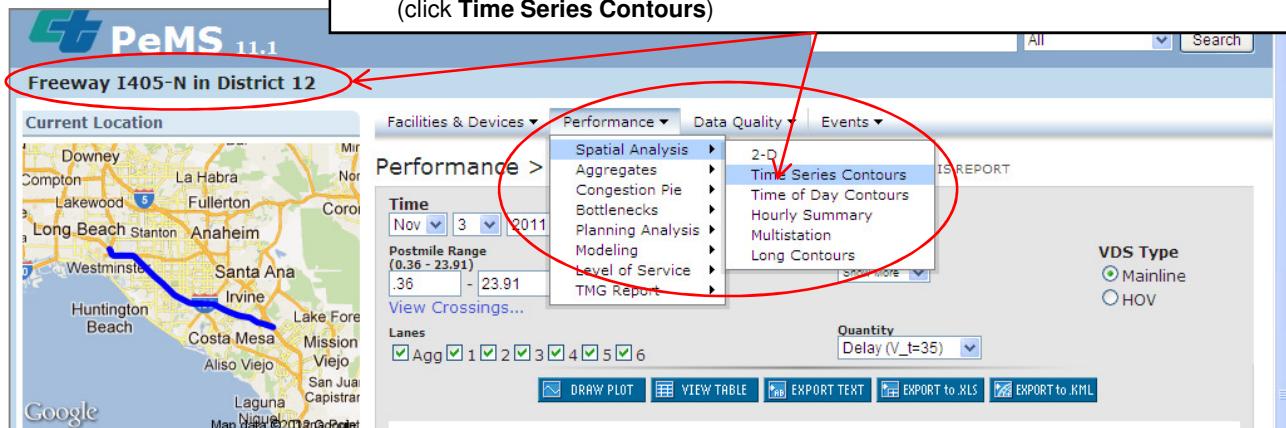
11. Select Show More under Crossings (freeway crossing labels along x-axis)

12. Select Speed under Quantity

SPEED (2-D) PROFILE
I405-N: Performance > Spatial Analysis > 2-D


This report allows users to see the various performance measure quantities down the freeway corridor segment at a given time. This report is useful when attempting to view performance characteristics along a freeway, such as identifying where slowdowns occur. Users can identify sections of the freeway and step through different time slices to see how the traffic progresses. This feature can be used to determine when congestion or bottlenecks form or when they end. The following quantities are available in this report: flow, speed, occupancy, and delay. The speed plot as shown above is commonly used to identify potential bottleneck locations, general congested areas, approximate queue lengths, and typical operational conditions, at peak times. The above result is a plot of the speed profile of the Northbound I-405 mainline freeway in Orange County at 5:00 p.m. on November 3, 2011. This plot shows the recorded (5-minute aggregate average) speeds at each detector station by lane (for every detector stations) along the freeway segment. It can be interpreted as the traffic stream traveling speed experienced by a vehicle traversing through the freeway segment (from left to right in the x-axis), where speeds slow down in traffic congestion as it reaches absolute post mile 7 and increases back to near free flow conditions as it reaches absolute post mile 14, only to slow down again at post mile 16. Also note that, under the plot title heading, the data quality is at 84% observed (16% imputed data).

In Freeway I405-N in District 12 page,
14. Move mouse pointer to Performance > Spatial Analysis > Time Series Contours (click Time Series Contours)



SPEED CONTOUR

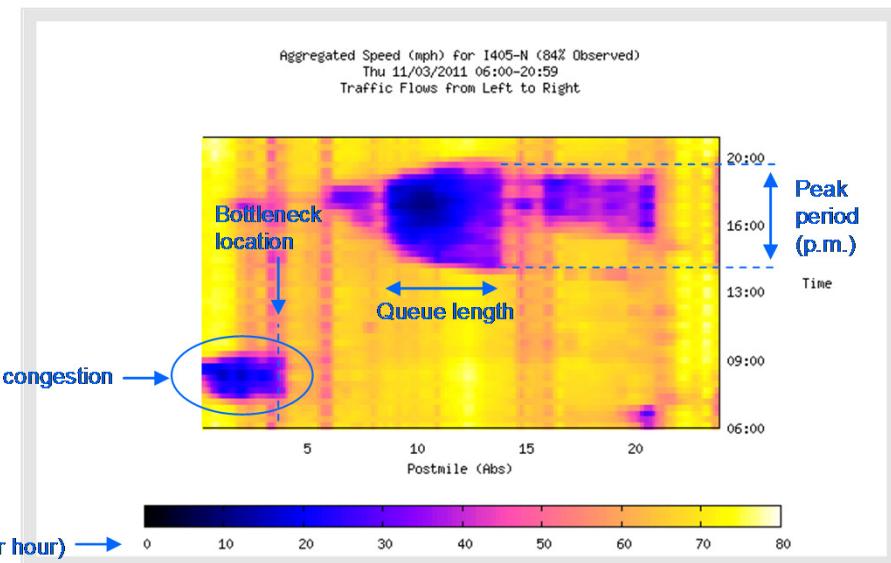
I405-N: Performance > Spatial Analysis > Time Series Contours

15. Select Nov 3 2011 under Day and 6 - 20 under Hours (6 AM to 8 PM)

16. Select Speed under Quantity

18. Click DRAW PLOT

17. Select Transpose X-Y Axis and select Smoothing (rotate plot view and smooth out the colors)



The above result is a plot of the speed contour of the Northbound I-405 mainline freeway in Orange County for November 3, 2011, from 6:00 a.m. to 8:00 p.m. period. This plot shows the recorded (5-minute aggregate average) speeds (by color) at every detector station (and estimated in between detectors) along the freeway segment for every 5 minutes within that period. This plot is essentially the 2-D speed profile (depicted by color) plot stacked vertically at every 5-minute increments. It can be interpreted as the traffic stream traveling speed experienced by a vehicle traversing through the freeway segment (from left to right in the x-axis) at every 5-minutes within that period. This plot is commonly used to identify potential bottleneck locations, general congested areas, approximate queue lengths, and typical operational conditions, and peak periods of congestion. Where the previous 2-D plot only showed one time slice at 8:00 a.m., this plot allows users to view speeds throughout the corridor throughout the day. This plot shows that the a.m. congestion occurred only between absolute post mile 0 to 5 on this day, whereas the p.m. congestion occurred from absolute post mile 7 to 22, with queues reaching over 5 miles in length and peak period of over 5 hours (from about 2:00 p.m. to about 7:00 p.m.). By selecting different quantities, users can view contour plots of other performance measures including flows, delays, and occupancies. Users can also view averages of longer periods such as several weeks, month, or quarter, by going to Performance > Spatial Analysis > Time of Day Contours or Performance > Spatial Analysis > Long Contours. Also note that, under the plot title heading, the data quality is at 84% observed (16% imputed data).

HELPFUL TIP

There is a simple way to view freeway crossing description, its corresponding absolute post mile, and corresponding Caltrans post mile by using View Crossings... link, under the Postmile Range.

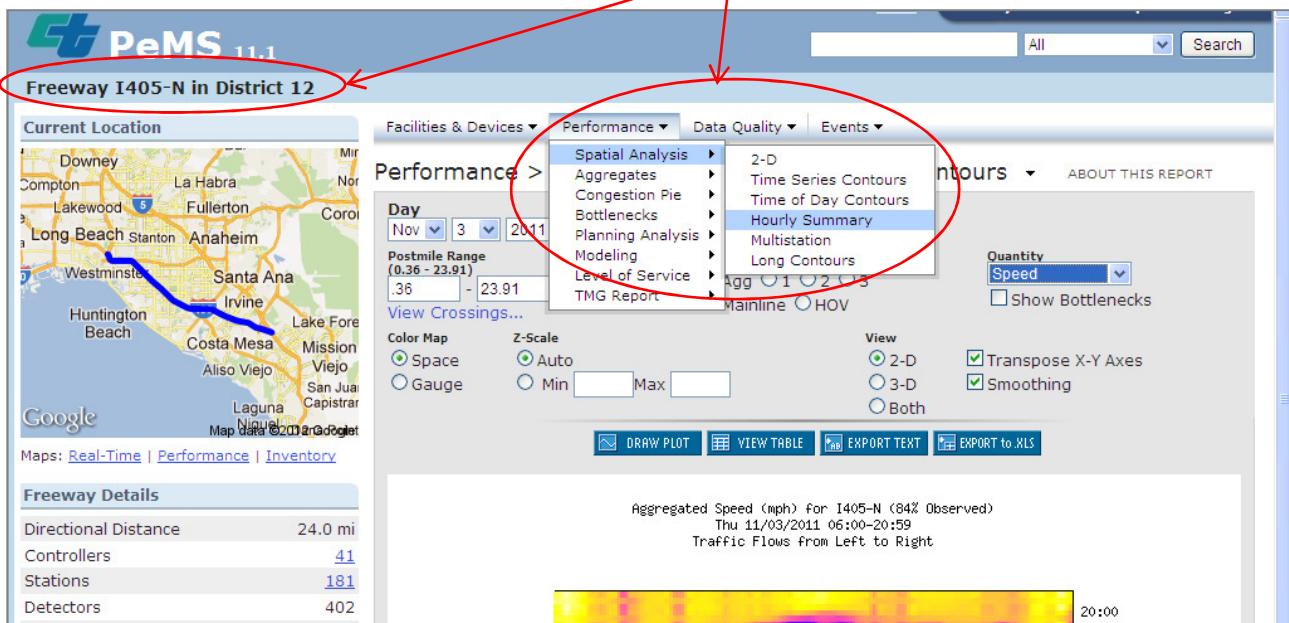
Click on the View Crossings... link to open a pop-up window.

Abs PM	CA PM	Description
0.13	.361	NBOFF TO IRVINE CTR DR
0.39	.624	NBON LAKE FOREST/BAKE
0.43	.659	SEG NB OFF IRVINE CTR DR
0.55	.783	SB ON NB IRVINE CENTER
0.69	.921	NB ON FR NB IRVINE CNTR
0.89	1.116	NB ON FR SB IRVINE CNTR
1.54	1.77	NB OFF TO SB RTE 133
1.87	2.099	NB ON FR RTE 133
2.40	2.63	NB OFF TO SAND CYN AVE
2.81	3.04	NB ON FR SAND CYN AVE
3.49	3.721	NB OFF JEFFREY/UNVRSTY
3.58	3.809	SBON NB JEFFREY/UNVRSTY
3.64	3.873	NBON NB JEFFREY/UNVRSTY
3.85	4.082	NBON SB JEFFREY/UNVRSTY
5.18	5.405	NB OFF CULVER DR
5.23	5.463	SB ON NB CULVER DR
5.33	5.562	NB ON NB CULVER DR
5.50	5.733	NB ON SB CULVER DR
6.49	6.717	NB OFF JAMBOREE BLVD
6.57	6.796	NB ON NB JAMBOREE BLVD
6.63	6.855	NB ON FR NB JAMBOREE BV
6.81	7.036	NB ON SB JAMBOREE BLVD
7.35	7.58	NB OFF TO MACARTHUR
7.53	7.758	NB ON FR MACARTHUR
8.11	8.341	NB OFF TO RTE 55
8.24	8.469	SEG NB OFF TO SB RTE 55
8.31	8.535	SBON FR NB OFF RTE 55
8.69	8.916	DUM NB ON FR SB RTE 55
8.78	9.005	SB OFF TO NB RTE 55

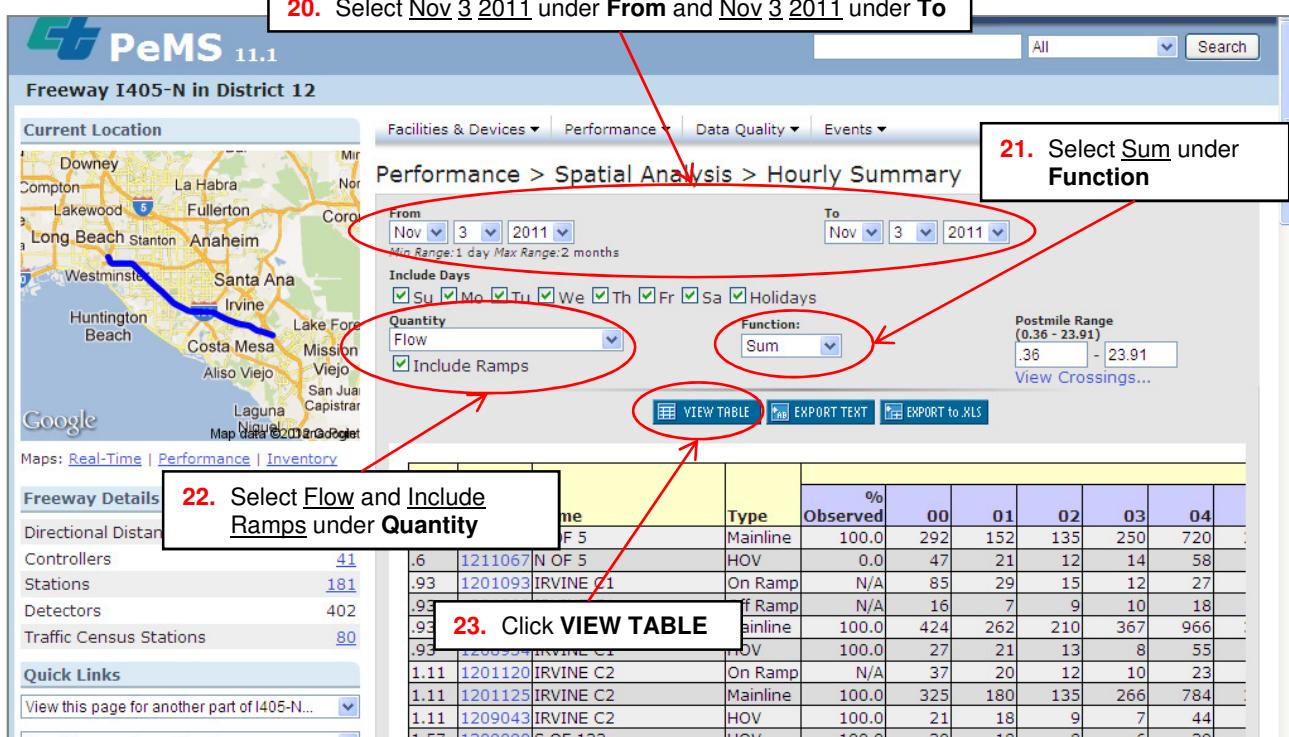
CORRIDOR FLOW

I405-N: Performance > Spatial Analysis > Hourly Summary

- In Freeway I405-N in District 12 page,
19. Move mouse pointer to **Performance > Spatial Analysis > Hourly Summary**
 (click Hourly Summary)



- 20.** Select Nov 3 2011 under **From** and Nov 3 2011 under **To**



CORRIDOR FLOW

I405-N: Performance > Spatial Analysis > Hourly Summary

Performance > Spatial Analysis > Hourly Summary

From: Nov 3 2011 To: Nov 3 2011

Include Days: Su Mo Tu We Th Fr Sa Holidays

Quantity: Flow (Sum) Postmile Range: 0.36 - 23.91

Include Ramps

EXPORT to XLS

VMT, VHT, delay, and lost productivity are also available

CA PM	VDS	Name	Type	% Observed	00	01	02	03	04
.6	1211066	N OF 5	Mainline	100.0	292	152	152	152	152
.6	1211067	N OF 5	HOV	0.0	47	21	17	16	16
.93	1201093	IRVINE C1	On Ramp	N/A	85	2	0	0	0
.93	1201098	IRVINE C1	Off Ramp	N/A	16	0	0	0	0
.93	1201100	IRVINE C1	Mainline	100.0	424	262	230	307	260
.93	1208954	IRVINE C1	HOV	100.0	27	21	13	8	55
1.11	1201120	IRVINE C2	On Ramp	N/A	37	20	12	10	23

Click EXPORT to .XLS to open a separate Excel file

The above result is a summary table of the hourly flows for every detector station, including mainline, HOV lanes, and ramps along the Northbound I-405 mainline freeway in Orange County on November 3, 2011, for 24-hour period, from midnight to midnight. Due to the screen size limitation, users need to scroll to the right to view the rest of the period and down to see the rest of the detectors along the corridor. As shown, the columns include the Caltrans post mile, VDS (vehicle detector station) identification number, description or Name of the VDS in the configuration file, detector Type, % Observed (data fidelity), and each hour of the day. The rows are always presented in the ascending order of the post mile of the detector locations, regardless of the direction of the freeway segment. For % Observed at 100.0, the data represent the actual aggregate sum of the hour (e.g., 00 hour represents the aggregate sum of the 5-minute flows from 12:00 midnight to 1:00 a.m.). For % Observed less than 100.0, some or all of the data are imputed by PeMS algorithm. For ramps, % Observed is indicated by N/A since ramp data are not imputed and data fidelity is therefore not applicable. For ramps, the data shown is either completely observed or 0 if the detector was not working 100%.

Note that users can click on **Export to XLS** to open a separate Microsoft Excel spreadsheet file of the same summary table. With the Excel table, users can sort the data, reformat the table, and create their own graphical charts. Also note that if multiple days are selected, the summary table can show the results by summing the flows for the selected days or show the results by averaging the flows (mean) for the selected days.

By selecting different quantities, users can get other performance measure reports including, vehicle miles traveled, vehicle hours traveled, and delay and lost productivity (by user selected threshold speed).

LEVEL OF SERVICE

I405-N: Performance > Level of Service > Time Series

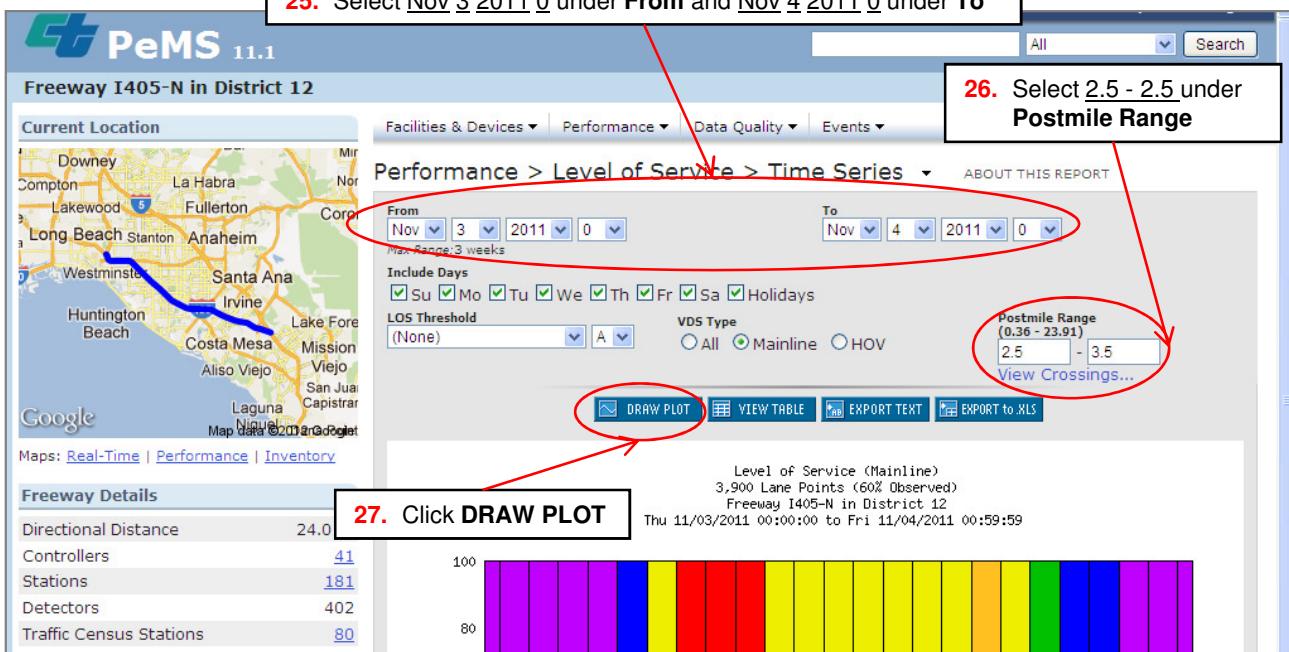
- In Freeway I405-N in District 12 page,
24. Move mouse pointer to **Performance > Level of Service > Time Series**
 (click Time Series)

The screenshot shows the PeMS 11.1 interface. At the top, there's a map of Southern California with a blue line indicating the route of Freeway I405-N. Below the map, the title "Freeway I405-N in District 12" is circled in red. The main menu bar has "Performance" selected, which is also circled in red. A dropdown menu under "Performance" shows "Level of Service" selected, and "Time Series" is highlighted with a red circle. To the right, there's a table titled "Hourly Summary" showing traffic data for various segments of the freeway. At the bottom, there are buttons for "VIEW TABLE", "EXPORT TEXT", and "EXPORT to XLS".

- 25.** Select Nov 3 2011 0 under **From** and Nov 4 2011 0 under **To**

- 26.** Select 2.5 - 2.5 under **Postmile Range**

- 27.** Click **DRAW PLOT**



LEVEL OF SERVICE

I405-N: Performance > Level of Service > Time Series

LOS	Density (veh/mi/ln)	Volume/Capacity (FFS=65mph)	Traffic Flow Description
A	0 <= x < 11	x <= 0.3	Virtually free flow; completely unimpeded.
B	11 <= x < 18	0.3 < x <= 0.5	Stable flow with slight delays; reasonably unimpeded.
C	18 <= x < 26	0.5 < x <= 0.71	Stable flow with delays; less freedom to maneuver.
D	26 <= x < 35	0.71 < x <= 0.89	High density, but stable flow.
E	35 <= x < 45	0.89 < x <= 1.0	Operating conditions at or near capacity; unstable flow.
F	45 <= x	1.0 <= x	Forced flow, breakdown conditions.



Level of Service (LOS) reports allow users to see the quality of service along the freeway system. The freeway LOS is a way to classify the service that vehicles are experiencing using a grading system ranging from A to F. Typically, LOS is identified using either the density of vehicles on the freeway or the volume-to-capacity (v/c) ratio. PeMS estimates the LOS using density only. The relationship between LOS and the density of vehicles on a freeway is defined in the Highway Capacity Manual (HCM 2000). The table summarizes this relationship and provides a description of the traffic condition (quality of service) at each level from LOS A to LOS F. PeMS computes the density at each detector for each hour from the flow and speed (where Density = Flow/Speed). PeMS calculates the number of vehicles experiencing this particular density by multiplying the density of the segment by the length of the segment. This results in the number of vehicles experiencing each LOS. PeMS uses the estimated density and the number of vehicles to compute the distributions. This means that when the percentage for LOS A is 40 percent the interpretation is that 40 percent of the vehicles on the freeway system are operating in LOS A at that time. The PeMS algorithm assumes a constant flow and speed over the entire segment during the hour.

The above result is a chart of the PeMS calculated Level of Service (LOS) for the Northbound I-405 mainline freeway segment, from Sand Canyon Ave interchange to Jeffrey/University interchange, in Orange County on November 3, 2011, for 24-hour period, using the Highway Capacity Manual (HCM2000) criteria definition of LOS. As indicated, the worst LOS condition occurred at 8:00 a.m. peak hour and 9:00 a.m. where LOS was F, on November 3, 2011, for this segment of the roadway. HCM2000 calculation results indicate same conclusion. PeMS LOS is determined from density calculation derived on measured flow and calculated speeds, whereas HCM2000 LOS is determined from density calculation derived from flow and various factors. Note that HCM2000 Basic Freeway Segment LOS analysis is conducted hourly, typically for the peak hour. Users can also plot Time of Day plots to view averages of multiple days and Day of the Week plots to view averages by day of the week to compare among days.

TOP BOTTLENECKS

I405-N: Performance > Bottlenecks > Top Bottlenecks

- In Freeway I405-N in District 12 page,
- 27.** Move mouse pointer to **Performance > Bottlenecks > Top Bottlenecks**
(click **Top Bottlenecks**)

The screenshot shows the PeMS 11.1 interface for Freeway I405-N in District 12. The 'Performance' dropdown menu is open, with the 'Bottlenecks' option selected. Under 'Bottlenecks', the 'Top Bottlenecks' option is highlighted with a red circle. The main panel displays a table of data quality metrics for various times of day.

Time	LOS A	LOS B	LOS C	LOS D	LOS E	LOS F	# Lane Points	% Observed
00:00	100.00	0.00	0.00	0	0.0	0.0	468	48.7
01:00	100.00	0.00	0.00	0	0.0	0.0	468	48.7
02:00	100.00	0.00	0.00	0	0.0	0.0	468	48.7
03:00	100.00	0.00	0.00	0	0.0	0.0	468	48.7

- 28.** Select Jan 1 2011 under **From** and Dec 31 2011 under **To**

The screenshot shows the 'Performance > Bottlenecks > Top Bottlenecks' page. The 'From' field is set to 'Jan 1 2011' and the 'To' field is set to 'Dec 31 2011'. Other settings include 'Number of Bottlenecks to Show: 10', 'Postmile Range (0.36 - 23.91)', and 'Time Period: AM, PM, Noon'. A red box highlights the 'VIEW TABLE' button at the bottom of the page.

Bottleneck Characteristics									
VDS	Name	Shift	Day	Abs PM	CA PM	# Days Active	Avg Extent (Miles)	Total Delay (veh-hrs)	Total Duration (mins)
1201157	SAND CANYON	NOON	I405-N	2.76	2.99	250	4.2	507,642	49,730
1201157	SAND CANYON	PM	I405-N	2.76	2.99	196	0.2	1,339	49,715
1201157	SAND CANYON	AM	I405-N	2.76	2.99	195	0.2	1,857	47,510
1201157	SAND CANYON	AM	I405-N	2.76	2.99	195	0.2	1,920	40,555

30. Select 0.36 – 23.91 under **Postmile Range** (entire corridor length)

31. Click **VIEW TABLE**

TOP BOTTLENECKS

I405-N: Performance > Bottlenecks > Top Bottlenecks

Performance > Bottlenecks > Top Bottlenecks [ABOUT THIS REPORT](#)

From: Jan 1 2011 To: Dec 31 2011
 Min Range: 1 day Max Range: 20 years

Include Days: Su Mo Tu We Th Fr Sa Holidays

Number of Bottlenecks to Show: 10

Postmile Range (0.38 - 23.91): 0.38 - 23.91

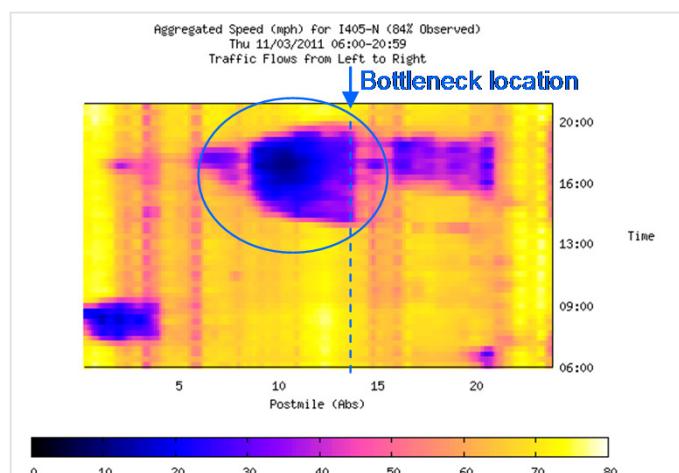
Time Period: AM PM Noon

							Bottleneck Characteristics			
VDS	Name	Shift	Fwy	Abs PM	CA PM	# Days Active	Avg Extent (Miles)	Total Delay (veh-hrs)	Total Duration (mins)	
1201671	BROOKHURST 2	PM	I405-N	13.74	13.97	250	4.2	507,642	49,730	
1201157	SAND CANYON	NOON	I405-N	2.76	2.99	196	0.2	1,339	49,715	
1201157	SAND CANYON	PM	I405-N	2.76	2.99	196	0.2	1,857	47,510	
1201157	SAND CANYON	AM	I405-N	2.76	2.99	195	0.2	1,920	40,555	
1201451	BRISTOL 1	NOON	I405-N	9.23	9.46	133	0.6	1,628	38,725	
1213651	HYLAND	PM	I405-N	11.37	11.6	234	1.3	36,032	36,310	
1201451	BRISTOL 1	PM	I405-N	9.23	9.46	133	0.6	2,694	29,680	
1201451	BRISTOL 1	AM	I405-N	9.23	9.46	133	0.5	843	23,335	
1201185	JEFFREY 1	AM	I405-N	3.63	3.86	210	0.4	21,014	21,985	
1209291	NEWLAND	AM	I405-N	15.64	15.87	163	0.6	31,978	21,055	

Table truncated at 10 of 263 rows. Use Export to XLS or Text to download everything.

The above result is a table of the PeMS determined list of top bottlenecks for the Northbound I-405 mainline freeway in Orange County from 2011 aggregate data. As indicated, the top bottleneck as according to PeMS is the Brookhurst bottleneck that occurred during the PM peak period (shift in PeMS). As indicated, this bottleneck located at absolute post mile 13.74 and Caltrans post mile 13.97 occurred in 250 days (#Days Active), essentially every weekday, that totaled 507,642 vehicle-hours of delay. The small shadow box in the Total Duration column title indicates that this table is sorted in descending order by the total accumulated duration of this bottleneck in 2011. Users can select different columns highlighted in blue text to choose the criteria for the top 10 bottlenecks selection order. Note at the bottom of the table indicates that the list of top bottlenecks include 263 rows of bottlenecks in prioritized order. To view the entire list, users can click on Export to XLS button to open a separate Microsoft Excel spreadsheet file of this table.

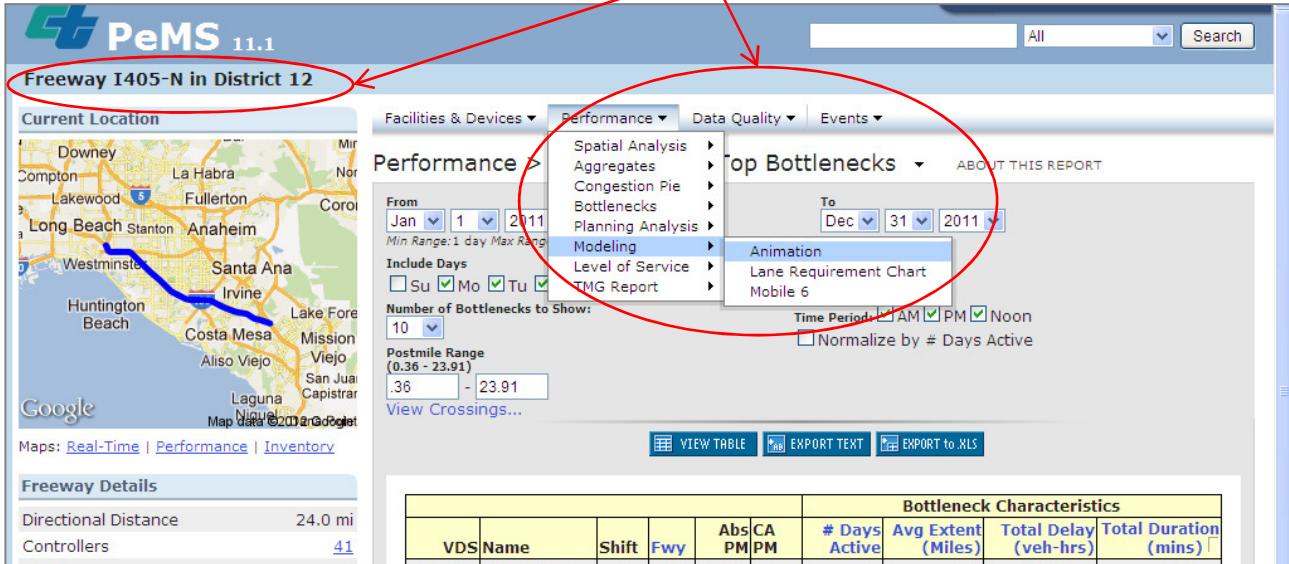
Users can refer back to the Performance > Spatial Analysis > Time Series Contours to view this bottleneck in a speed contour plot. As shown, the bottleneck congestion (delay) is indicated by the blue oval and the location of the Brookhurst bottleneck is evident by the abrupt differences in speeds at absolute post mile 13.7.



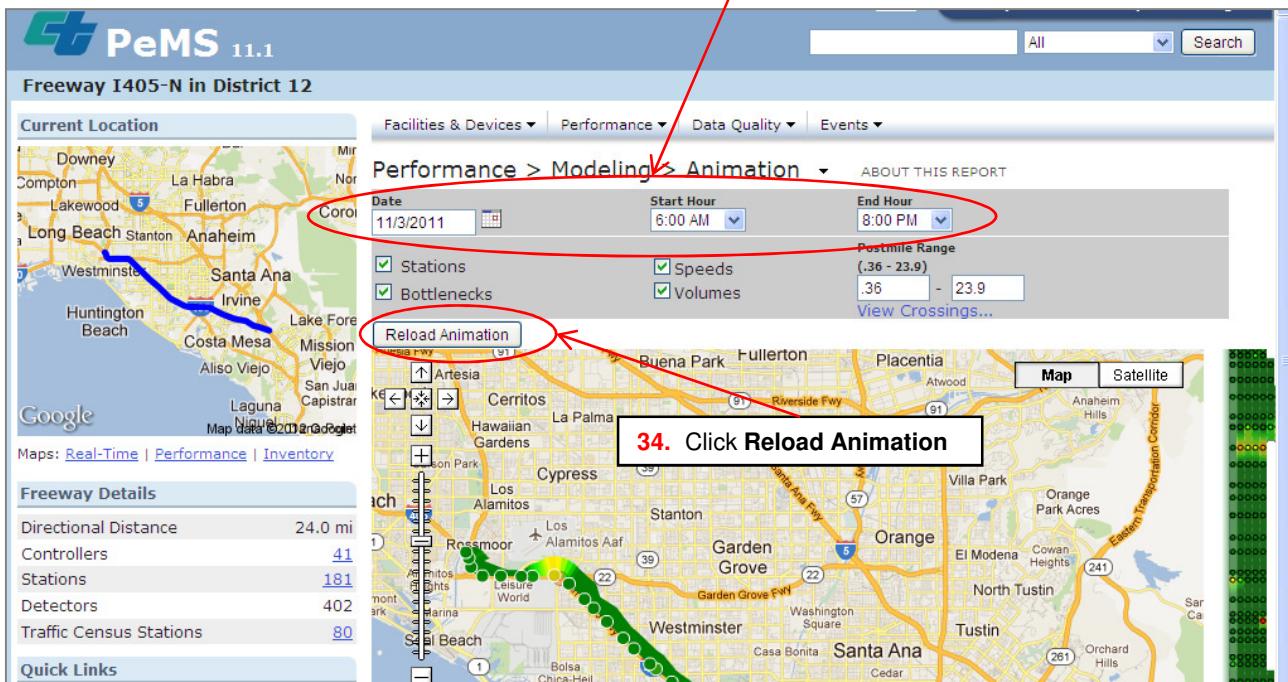
ANIMATION

I405-N: Performance > Modeling > Animation

- In Freeway I405-N in District 12 page,
32. Move mouse pointer to **Performance > Modeling > Animation**
 (click Animation)

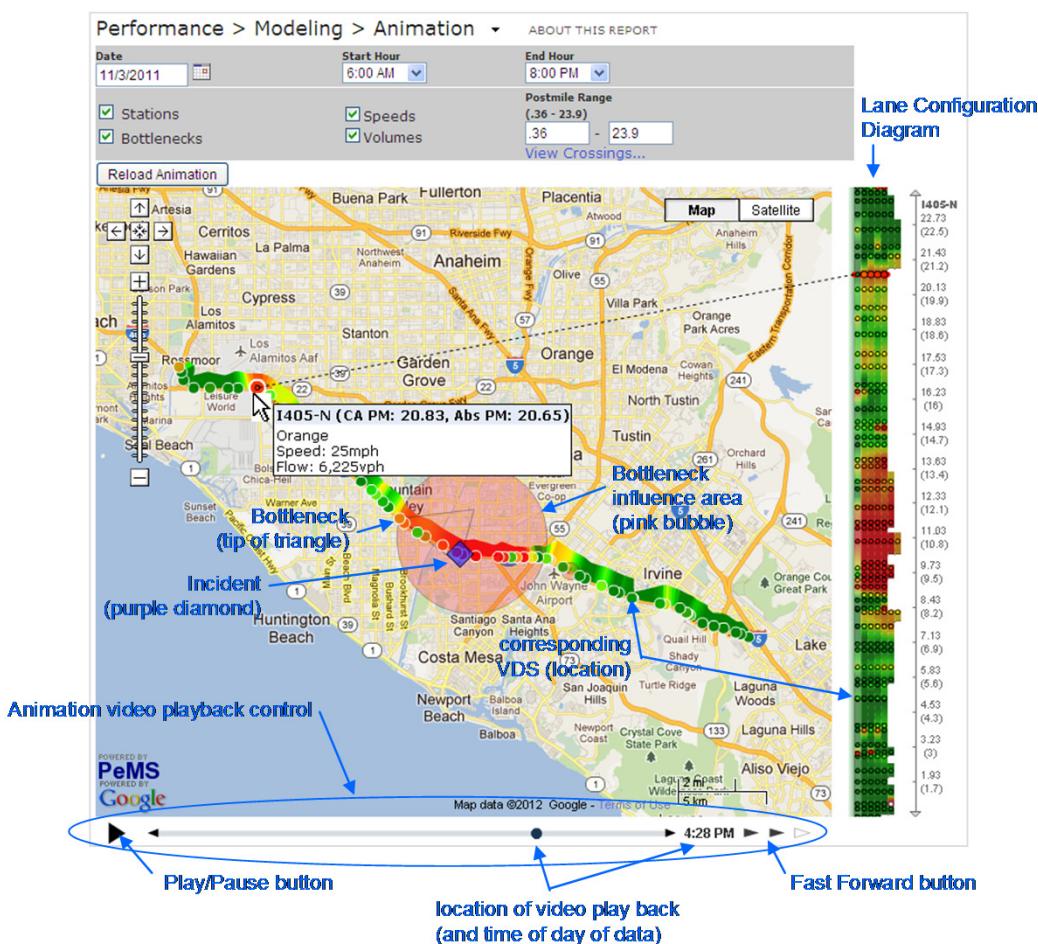


- 33.** Select 11/3/2011 under **Date** and 6:00 AM under **Start Hour** and 8:00 PM under **End Hour**



ANIMATION

I405-N: Performance > Modeling > Animation



PeMS provides performance animation modeling reports for any selected freeway segment. These reports allow users to view speeds, volumes, and bottlenecks over time in a data animation video sequence. The performance animation is presented on top of a Google map showing the selected freeway segment. PeMS collects many types of detailed, raw data in real-time and in batch mode.

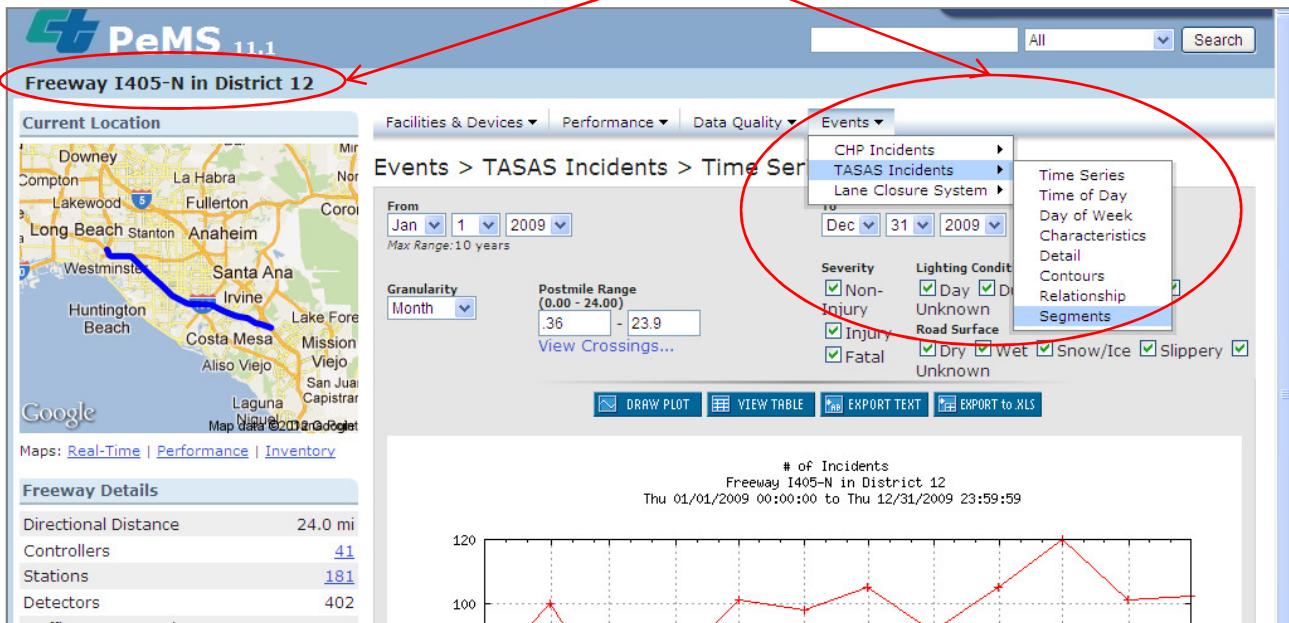
The above result is the animation video of the recorded November 3, 2011 detector data for the Northbound I-405 mainline freeway in Orange County. The small colored circles both on the map and the lane configuration diagram to the right of the map represent vehicle detectors. Users can move their mouse pointer to any of the detectors either on the map or on the lane configuration diagram to open a small window that provides the detector location (post mile) and speed and hourly flow rate at the time of the video play back. A dashed line corresponds the detector location on the map to the location on the lane configuration diagram, and vice versa. As shown, the detector station on the map at location absolute post mile 20.65 indicates speed of 25 miles per hour and flow rate of 6,225 vehicles per hour (all lanes total) at 4:28 PM (video play back time shown on the bottom below the map). The colors on the corridor represents the speeds where red is congested speed and green is the free flow speed. The thickness of the colors on the map corridor represents relative flow rate amount (thicker represents higher flows). Below the map is the video play back control. Users can use the Play/Pause/Fast Forward button to view video among the selected period from 6:00 a.m. to 8:00 p.m. Users can also click and hold the video position icon (black dot indicating location of video play back) and drag forwards or backwards to different play times.

The animation is useful in visually verifying bottleneck locations and congestion on a map at different times of a day and also to see if there is any impact from incidents. There are many other advantageous benefits of using the animation such as flow monitoring for productivity levels, bottleneck formation time determination, identifying potential causes (e.g., lane drop or lane merge), etc. Users can zoom in on the map to view a closer look at any location and click on Satellite button for aerial photograph map layer to view the roadway geometrics. Users can also use a third party software to record the animation video and play it back during presentations.

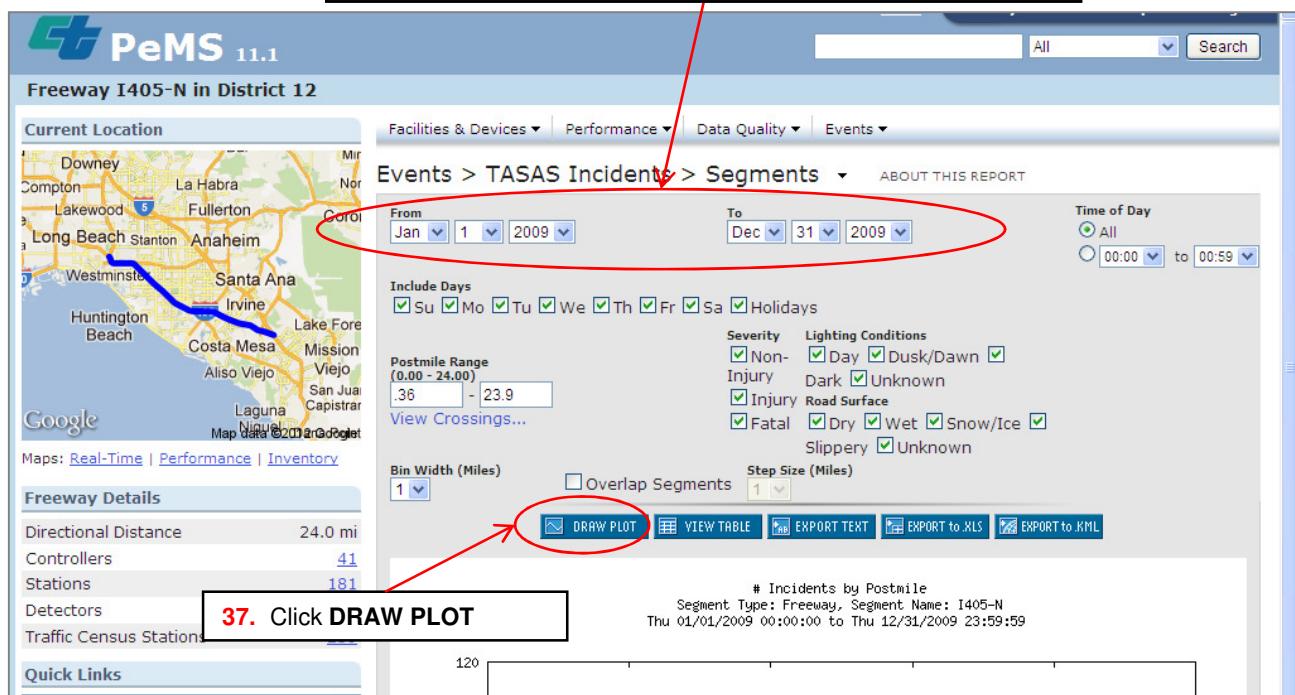
TASAS and CHP Incidents

I405-N: Events > TASAS Incidents > Segments

- In Freeway I405-N in District 12 page,
- 35.** Move mouse pointer to **Events > TASAS Incidents > Segments**
(click Segments)

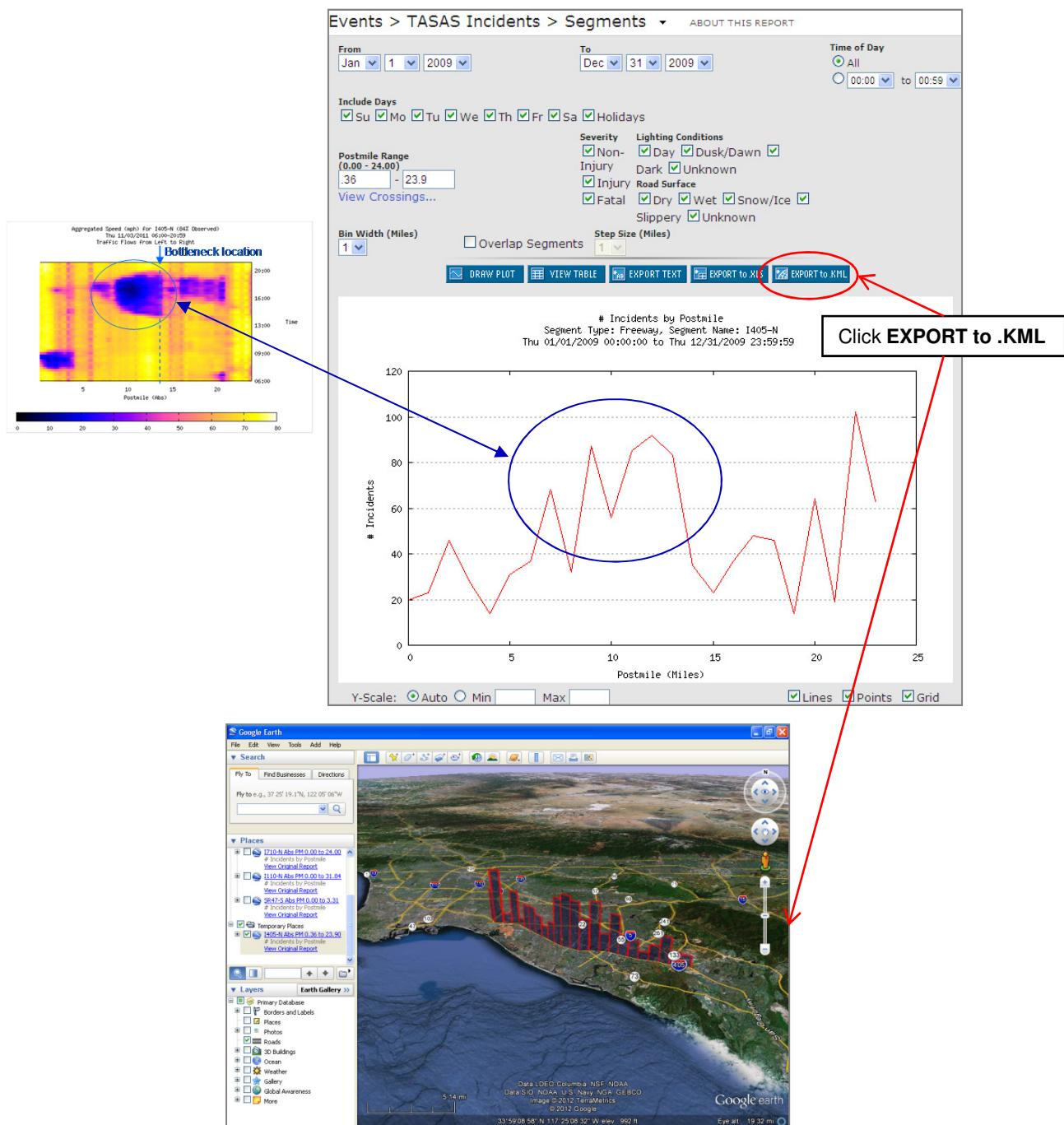


- 36.** Select Jan 1 2009 under **From** and Dec 31 2009 under **To**



TASAS and CHP Incidents

I405-N: Events > TASAS Incidents > Segments



The above result is a plot of the TASAS collision data for the Northbound I-405 mainline freeway in Orange County in 1 mile increments (bins) for year 2009. As indicated the range of collisions vary significantly along the freeway corridor, as low at below 20 and as high as above 100. In comparing this plot with the speed 2-D plot or contour plot, it appears that the higher collision locations coincide with the locations of congested speeds.

The report is useful in reviewing the collisions along the corridor. Another useful incident report is viewing this plot against aerial photograph overlay segment. Users will need to have Google Earth software loaded into their computers in order for this feature to work, by clicking on the Export to KML button.

Similarly, users can access Events > CHP Incidents to analyze incident data from the CHP's computer aided dispatch (CAD) system.

CHAPTER 4 EXERCISES

Delay

1. What is a typical or average weekday daily delay ($V_t=60$) in the month of April 2012 for District 11 northbound I-805 (I805-N)? [hint: Aggregate plot]

Speeds & Bottlenecks

2. Plot the speed contour plot of District 11 I805-N mainline on April 12, 2012 from 6am to noon (6 to 12 hours).
 - Where are the major bottlenecks (what absolute postmiles)?
 - What are the congestion period and longest queue lengths?

Flow

3. What is the highest recorded hourly flow on District 11 I805-N on April 12, 2012? Where and what time of the day? What is the %Observed data quality for that station on that time and day?

Answers are provided in the Appendix.

SPATIAL (OTHER FACILITIES MODULES) ANALYSIS

From any District home page, under Facilities & Devices pull down menu, there are several other modules besides Freeways that are available in PeMS to perform performance analysis. For illustrative purposes, the Orange County freeway, I-405, was selected to provide the examples.

- In District 12: Orange County home page,
**38. Move mouse pointer to Facilities & Devices > Routes
(click Routes)**

ROUTES

In District 12 Facilities & Devices > Routes page,
39. Click on CMIA D12 405N from I5 to LA Co. line

Dist	Name	Start	End	Roadway	Length (Miles)	HOV (Miles)	# Stations
D12	5CSMP	5-N/Coast Hwy	5-N/Botryoides, Blvd	Freeway	42.8	36.8	191
D12	CMIA D12 22 from I-405/605 to SR-55	22-E/Garden Grove Blvd	22-E/Tustin/Sebastopol St	Freeway	11.5	10.5	71
D12	CMIA D12 405N from I5 to LA Co. line	405-W/Lake Forest Dr	405-N/Woodruff/Palo Verde Ave	Freeway	25.0	25.3	116
D12	CMIA D12 57N from SR22/I5/SR57 to LA Co. line	57-N/Chapman Ave	57-N/State Hwy 30	Freeway	22.6	15.7	73

A Route is a pre-defined freeway corridor with a specific starting point and a specific ending point. Most of the performance measure reports found in the freeway spatial level analysis are also available in the Routes. Unlike the freeway segments selected from the freeway facilities inventory list, users cannot redefine the segment lengths of Routes. All Routes have fixed segment lengths. With Routes, PeMS allows users to view the travel time statistics of the route over time.

In Route 2138: CMIA D12 405N from I5 to LA Co. line page,
40. Move mouse pointer to Performance > Travel Time > Time-of-Day
(click Time-of-Day)

Seg#	Type	Seg Name	Start	End
1	Fwy	405 N	N	24.964 (Abs PM=24.964; CA PM=.23) Woodruff/Palo Verde Ave (Abs PM=0; CA PM=1.016)

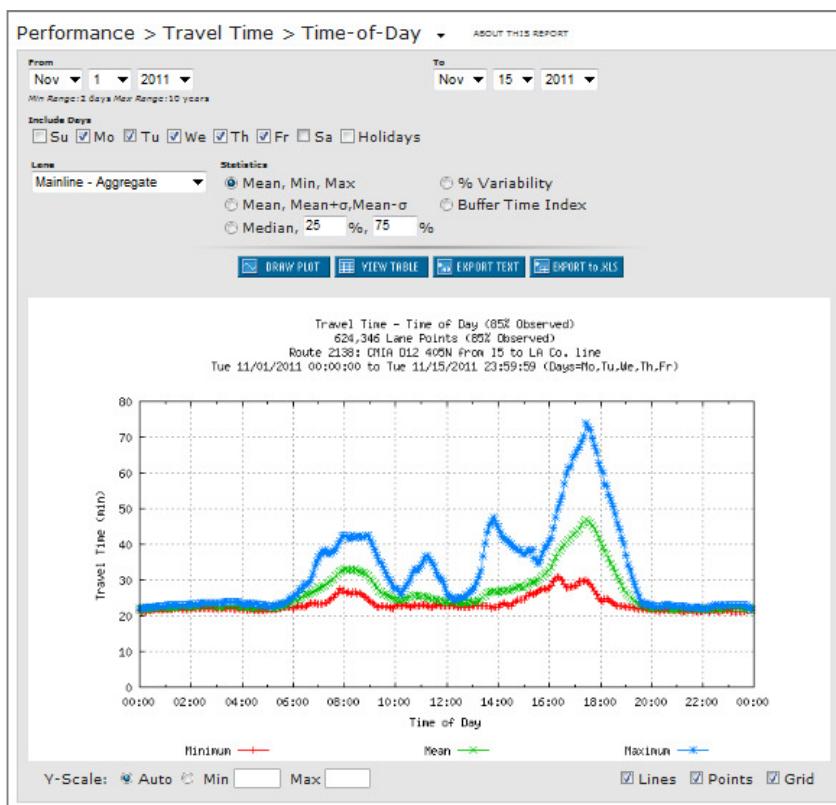
ROUTES: TRAVEL TIME

I405-N: Performance > Travel Time > Time-of-Day

41. Select Nov 1 2011 under From and Nov 15 2011 under To

42. Select weekdays only

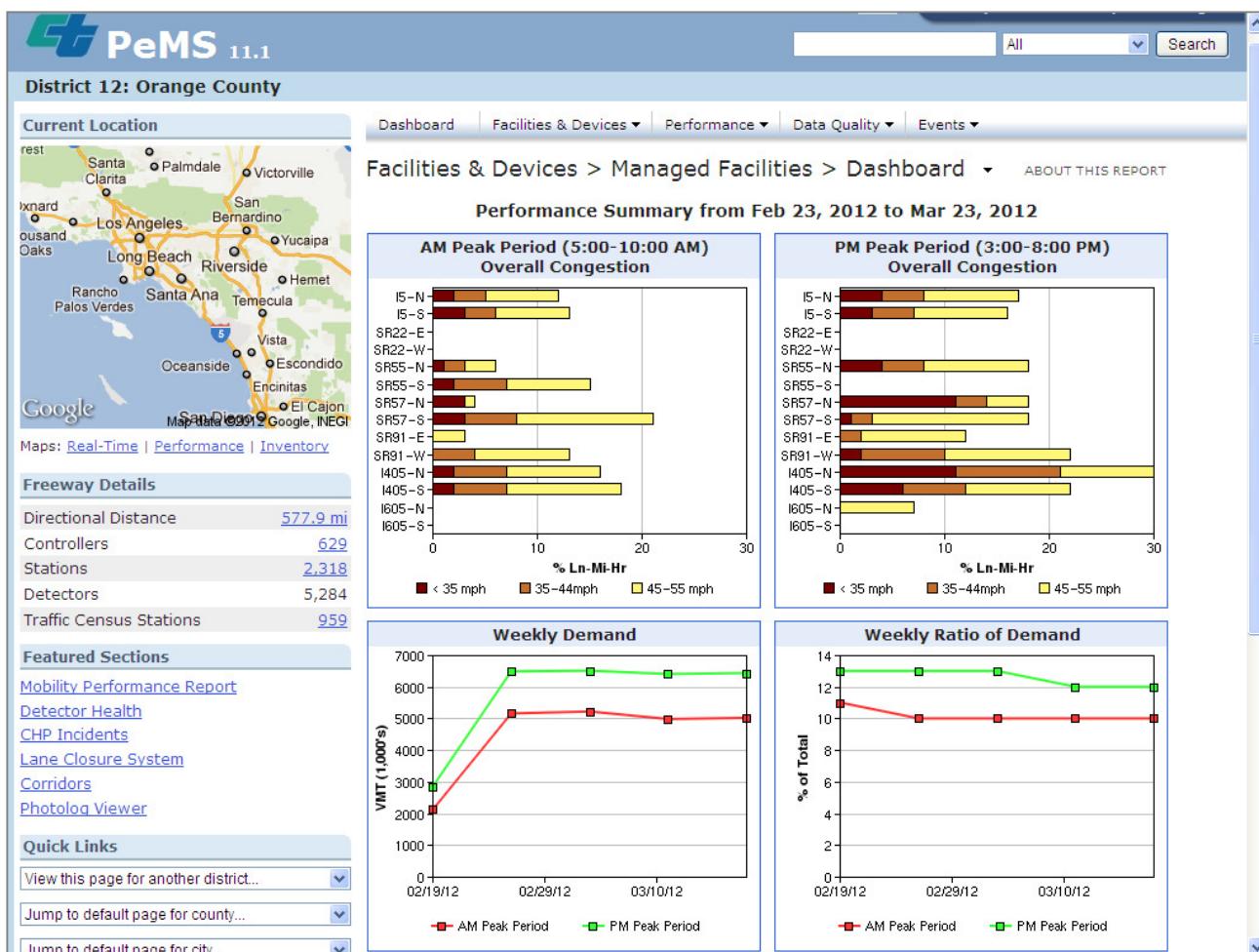
43. Click DRAW PLOT



The above result is a plot of the average weekday travel times computed by PeMS along the 25 mile Northbound I-405 mainline freeway corridor in Orange County from November 1, 2011 to November 15, 2011. As indicated the Time of Day plot shows that the average peak hour travel time is about 35 minutes during the a.m. peak hour at 8:00 a.m. and about 48 minutes during the p.m. peak hour at 5 p.m. The maximum peak hour travel time computed during this period is about 75 minutes, likely due to an incident on the freeway during the two week time period. Also note that, the data quality is at 85% observed (15% imputed data).

MANAGED FACILITIES

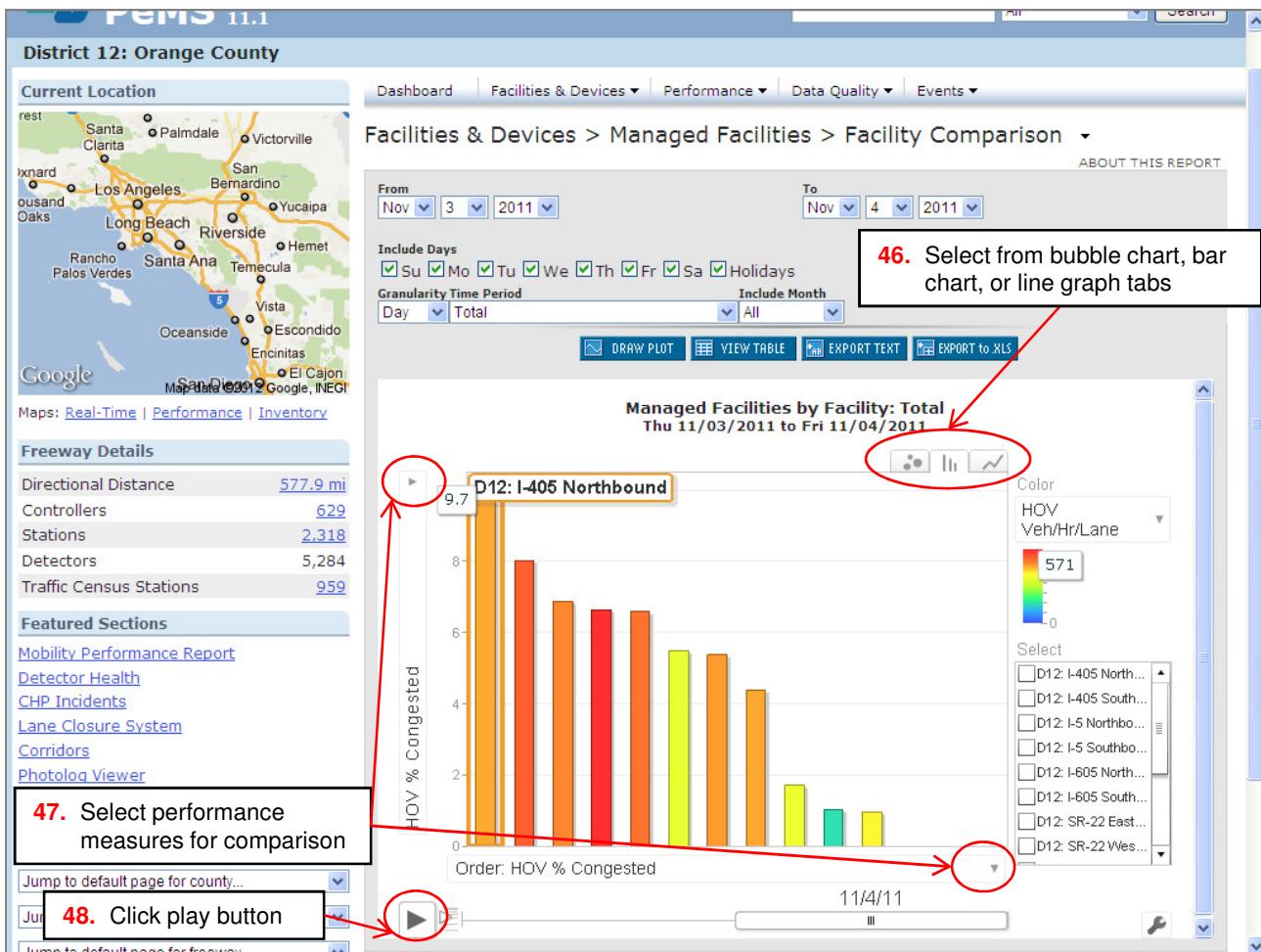
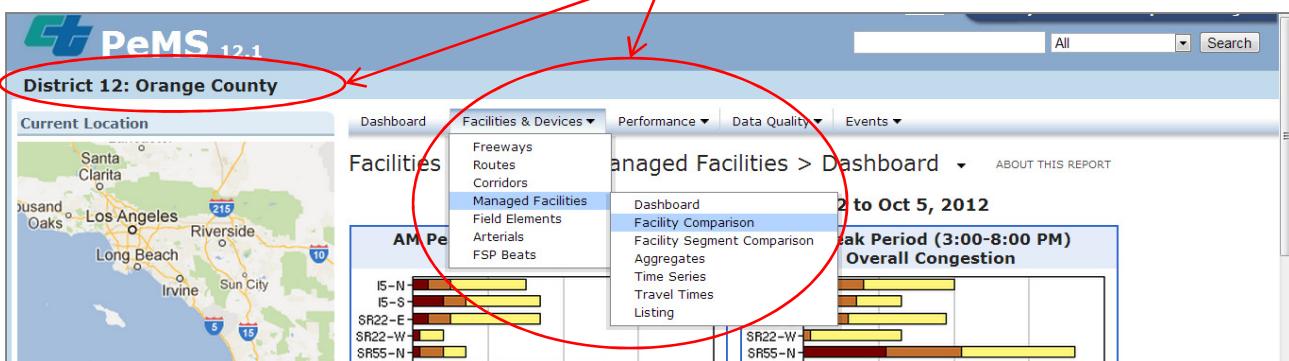
In District 12: Orange County home age,
44. Move mouse pointer to **Facilities & Devices > Managed Facilities > Dashboard**
(click **Dashboard**)



The above is the dashboard page of the District 12 Managed Facilities module. This page shows a number of charts that provide an overview of the performance for a set of managed facilities or for a single managed facility over the past few months. These charts may specify AM or PM, in which case they represent the performance during the AM or PM peak period of the day over the duration. The Performance Summary provides an overview of the congestion with delay thresholds set at 35, 45 or 55 mph, where each bar represents a facility.

MANAGED FACILITIES

- In District 12: Orange County home page,
45. Move mouse pointer to **Facilities & Devices > Managed Facilities > Facility Comparison** (click **Facility Comparison**)



The above presents comparative performance measures of the managed facility against other managed facilities or mainline freeway in District 12, presented in various ways – bubble plot, bar chart, and line graph, for the selected date range.

CHAPTER 4 EXERCISES

Travel Time

1. What is the District 7 I605-N Routes?
 - What is the distance of that Route?
2. Plot the mainline weekday travel time by time of day for month of April, 2012
 - What is the free flow travel time
 - What is the am and pm peak hour mean travel time?
3. Plot the HOV weekday travel time
 - What is the am and pm peak hour mean travel time?

GLOSSARY

About this Report	Almost every PeMS report contains an ABOUT THIS REPORT link to the right of the report title (breadcrumb). Clicking on this link opens a pop-up dialog box describing the current page.
Absolute Postmile	See Postmile.
Account	Manage user's account by clicking on the Welcome <u>Name</u> link on top right corner of any page.
ADT and AADT	The Average Daily Traffic (ADT) is the average of the daily volumes (flow) for each day of the selected period of interest. In PeMS, daily traffic volume (flow) is available only at the station level. A PeMS report commonly used for obtaining ADT for short periods is the <i>Performance > Aggregates > Day of Week</i> report. This report plots the ADT by day of week for the selected period. Annual Average Daily Traffic (AADT) is the total vehicle volume (flow) per day, averaged over a year-long period. Conventional methods for calculating AADT values require that the input data meet certain completeness standards. Pathway: VDS > Performance > Planning Analysis > AADT.
Aggregates	Aggregated data is data that is summarized into larger time or space intervals to provide a higher-level perspective. For example, PeMS receives data points from each detector every 30-seconds. This data is aggregated across time (to five-minute, hourly, daily, etc. values) and across space (across all lanes at a station, along a freeway, and across a geographic region) in various PeMS reports.
Animation	PeMS provides performance animation modeling reports for any selected freeway segment. These reports allow users to view speeds, volumes, and bottlenecks over time in an animation video sequence. The performance animation is presented on top of a Google map showing the selected freeway segment. Pathway: Freeway > Performance > Modeling > Animation.
Arterials	Arterials are defined in PeMS as any segment of road that is not a freeway. PeMS has modeled the arterial networks with three objects: intersections, links, and link lines. These three objects are defined over portions of the arterial network for which detectors are deployed. Pathway: homepage > Facilities & Devices > Arterials.
Breadcrumb	A breadcrumb is a navigational tool that tells users where they are and how they got to a particular web page. In PeMS, report headers are styled as breadcrumbs, which indicate how the user arrived at the current report using the Report Selector menu. For example, a Breadcrumb of Facilities & Devices > Field Elements > Stations tells the user that they are looking at the list of Stations for their Current Location, which can be found by using the Report Selector menu to go to Facilities & Devices, then Field Elements, then clicking on Stations.
Bottleneck	A bottleneck is a localized roadway segment on which volumes are restricted. Bottlenecks can be caused by lane drops, lane closures, incidents, weaving sections, etc. PeMS has an Automated Bottleneck Algorithm that uses detector data to estimate bottleneck locations, durations, queue length, and delay. Bottlenecks can also be visually identified in PeMS using Contour Plots.
Buffer Time Index	PeMS uses the Buffer Time Index (BTI) to report its reliability statistics. The BTI indicates the percentage of extra travel time that travelers must add to planned trip times in order to arrive on time most days. BTI is defined as the buffer time (the 95th percentile travel

time minus the median travel time) divided by the median travel time. The PeMS dashboard calculates BTI for each 5-minute period over the past five weekdays for each CSMP route. A route is considered reliable when the BTI is less than 0.2 for the given time period. The route is moderately reliable when the BTI is between 0.2 and 0.4 and unreliable when the BTI exceeds 0.4.

Capacity	The capacity of a roadway segment is the maximum number of vehicles that can pass a point on that segment every hour. PeMS lets users enter the expected per lane capacity of a roadway segment on capacity analysis reports.
Capacity Analysis	Capacity Analysis reports in PeMS let the user enter a hypothetical capacity for a roadway to explore the estimated impacts of capacity restrictions like incidents and lane closures
CA Postmile	See Postmile.
Census Station	Also called Traffic Census Stations. Traffic census stations are managed through the Caltrans Census Program. PeMS receives counts from mainline and traffic census stations on a periodic basis (not in real-time). All census stations in PeMS contain counts, and there are also some specialized census stations that report counts by vehicle class (see Vehicle Classification Stations) and truck weight information (see WIM stations).
Change Log	The Change Log can be considered the station homepage. Clicking on a station ID in PeMS takes users to the Change Log page, which summarizes roadway information at the station location and the station's configuration history.
CHP Incident	PeMS collects real-time incident data from the California Highway Patrol media feed website.
Contour Plot	A contour plot, also known as a "heat map", is a way of visualizing data over multiple dimensions. In PeMS, contour plots show traffic data along a freeway over both space (postmile) and time (hour). A common use for a contour plot is to view speeds by postmile over a single day to view bottleneck locations and durations. In PeMS, this is the Timeseries Contour.
Controller	Also called LDS (Loop Detector Stations), controllers are the physical cabinets on the side of the roadway that collect data from detectors. In PeMS, you cannot find traffic data at an LDS- LDSs are only used for detector health diagnostics.
Corridors	PeMS allows users to investigate the performance of Corridors through the freeway system. A Corridor is a pre-defined freeway corridor with a specific starting point and a specific ending point that corresponds to specific Corridor System Management Plan (CSMP) facility as designated by Caltrans. Unlike the freeway segments selected from the freeway facilities inventory list, users cannot redefine the segment lengths of Corridors. All Corridors have fixed segment lengths. The Corridor Module offers unique reports that are not available in the other modules or from the freeway facilities inventory list such as Congestion reports. Also the Corridor animation allows users to view both directions of the freeway Corridor at the same time. Pathway: homepage > Facilities & Devices > Corridors.
Current Location	PeMS navigation is built around the concept of the Current Location. The Current Location is always indicated by the map in the top-left hand corner of the page, as well as the text above the map (for example, "State of California", "District 3", "Freeway SR99-N

in District 3”, “D3: Full Closure C99MA Log #13”, “Mainline VDS 317552- JSO Simmerhorn Rd”). In general, there are three levels of Current Locations: (1) the geographic level, such as a district or a county; (2) the freeway segment level; and (3) the detector station level. The Current Location that you are at in PeMS affects what options are available in the Quick Links and in the Report Selector Menu.

Dashboard	Dashboards are at-a-glance summaries of key information needed to make decisions. PeMS has various dashboards to summarize different types of data for different locations, including the Statewide Dashboard, the District Dashboard, and the Lane Closure Current Activity Dashboard.
Data Clearinghouse	The data clearinghouse provides a single access point for downloading PeMS data sets. Users can use this page (by clicking on the link from the PeMS homepage left menu under Tools) to quickly locate data by district, month and format. Instructions are available in the help page under Topics. Note that data clearinghouse topic is not covered in this manual.
Data Fidelity	PeMS conducts diagnostics to determine which detectors are working by checking whether various criteria are met. For those detectors not reporting “good” data, PeMS estimates the missing data through a process called data imputation. The data fidelity reports give users the ability to see how many points in the data set were imputed. It also provides a way to view the data to see exactly how the imputation decisions were made by the data processing programs. Two commonly used data fidelity reports include: Percent (%) Observed and Imputation Methods. The percent observed means how much data is observed (actual data received that met all diagnostic tests) as opposed to imputed. In PeMS, the smallest data samples (in terms of spatial and temporal aggregation) are individual 5-minute lane points. These points can be imputed or observed. Each report is made up of a number of these individual data samples. The percentage of these points that are observed is a proxy for the quality of the data in the report. Using the homepage or freeway or VDS > Data Quality > Data Fidelity > % Observed report, users can plot the percentage of data points observed over time.
Data Quality Menu	The Data Quality menu is located in the Report Selector Menu, and lists PeMS reports that can be used to investigate the data quality at the Current Location. In PeMS, the term “data quality” is most commonly used in relation to VDS data, since PeMS performs extensive data quality checks on these data sets. See Detector Health, Percent Observed, and Imputation for related topics.
Delay	In PeMS, delay measures the amount of extra time that vehicles spend on the roadway traveling at slow speeds. It has units of vehicle-hours, because it sums up delay across all vehicles that traveled along the segment. Computing delay requires defining a speed below which vehicles are assumed to be delayed. PeMS lets users choose this threshold speed for delay, ranging from 35mph to 60mph in 5mph increments. This is denoted by the v_t notations (for example, $v_t=35$, $v_t=60$).
Density	Density is a performance measure quantity that is calculated, not measured. Density is a spatial quantity that represents the number of vehicles on a roadway segment averaged over a spatial distance, usually expressed as vehicles per mile or vehicles per mile per lane. PeMS calculates density by dividing flow by speed (Density = Flow/Speed) at each detector station, and it is used to determine the operating Level of Service (LOS).
Detector	In PeMS, the term detector refers to the sensor collecting traffic data in an individual travel lane. Detectors report flow, occupancy, and/or speed at a certain interval (most

commonly every 30-seconds). In PeMS, detectors are grouped into stations, or VDSs.

Detector Health	Detector Health is a way of describing whether PeMS is receiving good data from a detector at a given time. PeMS has extensive algorithms that look at the data sent by each detector at the end of every day to determine whether the detector sent good data, bad data, or no data during that day. If the detector sent no data or bad data, PeMS makes a diagnosis of the problem (for example, the data feed was down, or the controller was broken, or the detector was broken). If the detector did not send good data, PeMS will impute data for that detector on the following day, and for all days until the detector sends good data. See Imputation and Percent Observed for related topics.
District Dashboard	The District Dashboard summarizes recent data and trends district-wide, and is the jumping off point for finding roadways and lane closures in a particular district. The easiest way to get to the District Dashboard is to use the Quick Links on the Statewide Dashboard. Once you are on the District Dashboard, the Quick Links, Report Finder, and Report Selector Menu only display options for that District's data and reports.
Facilities & Devices Menu	The Facilities & Devices menu is located in the Report Selector Menu and lists all of the freeways and detection devices located within the Current Location. The contents of the Facilities & Devices menu change depending on the Current Location.
Field Elements	The term Field Elements refers to all of the different types of detection devices monitoring traffic in PeMS. Field Elements is an option under the Facilities & Devices menu.
Flow	In PeMS, traffic flow (volume) is a quantity representing the number of vehicles that passed over each detector on the roadway in a given time period. The units are usually reported in terms of vehicles per time period (i.e. 5-min flow, hourly flow, etc.). Freeways typically have a capacity of approximately 2,000 hourly flow (vehicles per hour) per lane (at one individual detector). In PeMS reports, flow refers to the number of vehicles per time period of granularity. The flow is available only at the detector station level since flow or volume is an individual point measure. There are four types of aggregates reports to obtain flow data: Time Series, Time of Day, Day of Week, and Quantity Relationships. Pathway: VDS > Performance > Aggregates > Time Series.
Freeway	PeMS users can navigate to any monitored roadway in the state from the list of Freeways in the Quick Links or the Facilities & Devices menu. Freeways are the primary place for viewing information like delay along a section of roadway. The freeway reports in PeMS let users enter the absolute postmile range over which they want to compute measures.
Granularity	Granularity refers to the level of detail of a particular data set. Many reports in PeMS contain an option to select the "Granularity" of the results, ranging from as small as five-minutes to as high as a year. Selecting a granularity of one day, for example, will return a data point for each day in the selected date range.
Help Link	The Help link at the top right of each PeMS page contains helpful background information about PeMS data and calculations.
Holidays	Holidays included in PeMS calculations and reports are found by going to the holidays page by clicking on the holidays link from the PeMS home page left menu under Tools and selecting the year.

Homepage	The PeMS homepage is the page that you arrive at when you log-in to PeMS. The default homepage for all users is the State of California Dashboard (statewide dashboard). Users can select a different homepage using PeMS account management tools.
Hourly Summary	The Hourly Summary report is a table that shows the hourly (aggregate) values for every hour and detector within a selected freeway segment on user-selected days. Users commonly use this table to collect data for other analyses. The quantities are available by minimum, mean, maximum, percentile, or sum. For flow or occupancy measures, values are also available from the ramp detectors. To get values for a single day, rather than average or sum over multiple days, users can select the same “from” and “to” dates in the date range.
Imputation	When PeMS determines that a detector did not send good data over the previous day (see Detector Health), it imputes data for that detector on the following day, and for all subsequent days until the detector sends good data. Imputation is the process of filling in the holes to ensure a complete data set. PeMS has multiple ways of imputing data, depending on the scenario. The most common ways are to impute data for a broken detector based on data from nearby detectors, or based on historical data observed at the broken detector during the same day of week and time of day over recent weeks. Full descriptions of the imputation methods can be accessed by clicking on the Help link. Every data point and report summarizes the amount of imputed data with the Percent Observed.
Incidents	PeMS provides California Highway Patrol (CHP) computer-aided dispatch (CAD) incident reports as well as the Caltrans Traffic Accident and Surveillance Analysis System (TASAS) data reports. The CHP incident reports in PeMS include all incident data found in the CHP CAD. The TASAS records include all accidents that occur on State Highways. The TASAS records are manually verified by Caltrans staff, so the reporting to PeMS lags by approximately 6 to 9 months. PeMS obtains TASAS records that include the starting time, freeway, direction, post mile, severity and location of each incident. The records do not have information on the duration of incidents. Pathway: homepage or freeway > Events > TASAS Incidents or CHP Incidents.
Inventory Map	The PeMS Inventory Map displays all of the detection devices in the state.
Lane Closure System	PeMS extracts lane closure data from the Caltrans Lane Closure System (LCS) in real-time and allows users to view various reports related to LCS. LCS is a tracking system used by Caltrans District Traffic Managers and contractors to request, review, and approve lane closures on the freeway system. There are a number of elements common to all reports that PeMS can generate from the LCS data. Depending on the report, users can filter the results to a subset of the lane closures. All of the reports (except for the Listing tab) have the ability to present results in a plot, a table, as text, or to export values to a spreadsheet. Pathway: homepage or freeway > Events > Lane Closure System.
Lane-Point	Every PeMS report summarizes the number of lane-points used to calculate the results. The number of lane-points indicates the number of detector data points used to make the computation. A lane-point refers to an individual five-minute data sample for an individual detector. For data at a three-lane station, the number of lane-points used to compute hourly flow is the number of detectors (3) multiplied by the number of five-minute periods in the hour (12), which equals 48. On reports computed along a freeway, the lane-points summarize the number of detectors and number of time periods used to calculate the results.

Level of Service	The Level of Service (LOS) reports allow users to see the quality of service along the freeway system. The freeway LOS is a way to classify the service that vehicles are experiencing using a grading system ranging from A to F. Typically, LOS is identified using either the density of vehicles on the freeway or the volume-to-capacity (v/c) ratio. PeMS estimates the LOS using density only. The relationship between LOS and the density of vehicles on a freeway is defined in the Highway Capacity Manual (HCM2010). PeMS computes the density at each detector for each hour from the flow and speed (where Density = Flow/Speed). PeMS calculates the number of vehicles experiencing this particular density by multiplying the density of the segment by the length of the segment. This results in the number of vehicles experiencing each LOS. PeMS uses the estimated density and the number of vehicles to compute the distributions. The PeMS algorithm assumes a constant flow and speed over the entire segment during the hour. At a freeway segment page, LOS reports can be queried using the Performance pull-down menu and selecting Level of Service. Users can access the four types of Level of Service reports: Time Series, Time of Day, Day of Week, and Cumulative Distribution.
Lost Productivity	PeMS reports lost productivity as the equivalent lane-mile-hours of highway capacity missing due to a freeway operating under congested conditions. PeMS determines that a freeway is congested, when the speed is below a user-defined threshold. For those time periods and locations that a freeway is congested, PeMS calculates the ratio between the measured flow and the capacity. PeMS then multiplies one minus this ratio by the length of the segment to determine the number of equivalent lane-miles-hours of freeway. Users can query lost productivity reports for any freeway (segment) available in PeMS, using the Performance pull-down menu and selecting Aggregates on the PeMS freeway segment page. There are three types of Aggregates reports: Time Series, Time of Day, and Day of Week.
LDS	Loop Detector Station. Also called a Controller.
Managed Lanes	PeMS allows users to investigate the performance of HOV lanes and other Managed Facilities through the freeway system. A Managed Facility in PeMS is a collection of ordered links. A link represents a section of roadway between two points and must include at least one managed lane. Managed lanes include: HOV Lanes, Bus Only Lanes, Toll Lanes and bypasses. Each Managed Facility contains at least one set of ordered links for the primary direction of travel. The facility may also contain a set of ordered links for the secondary direction of travel. Most facilities will contain both sets of links, but exceptions are possible. Each link has a name and optional abbreviation. The link describes a section of roadway defined by two endpoints. Every link contains description of at least one managed lane. Pathway: homepage > Facilities & Devices > Managed Facilities.
Maps	The PeMS maps have been created to help users quickly understand and visualize the traffic data available in PeMS. There are four distinct maps in PeMS: the Real-Time Map, the Performance Map, the Inventory Map, and the Search Map. These maps are accessed from any PeMS report page that has a map in the upper left corner. Just under the map are links that show Inventory, Real-Time, Performance, and Inventory. Click on one of these links to be taken to that particular map. Each map utilizes a Google base map and overlays PeMS-specific information. Like any other Google base map, users can pan and zoom around the map.
MPR	Mobility Performance Reports (MPR) provide users with a view of commonly used freeway performance measures over long periods of time. In addition, it segments the values to commonly used time ranges for peak and off-peak hours. These reports are

only available over the large geographic segments of State, District and County.

My Home	Users can edit preferences in their individual account management by specifying the My Home page. Users will then be directed to this page after successful log in to the PeMS homepage. Users can also jump to this page by clicking the My Home link found in the upper right hand corner of every page.
Occupancy	Occupancy is measured by detectors and is the percentage of time over a given interval (for example, five-minutes) that vehicles were occupying the detection zone. It is a proxy for traffic density.
Percent Observed	The Percent Observed refers to the percentage of data points used to generate a report that were directly observed versus imputed. The higher the Percent Observed, the better the data quality of a report. The Percent Observed is summarized on every PeMS report, and should always be referenced to understand the underlying data quality. See Imputation and Detector Health for related topics.
PeMS	Caltrans PeMS is a real-time Archive Data Management System (rt-ADMS) that collects, stores, and processes raw data in real-time. It is the centralized repository for all of Caltrans' real-time traffic data, enabling easy access to these data that might otherwise be dispersed across multiple districts and more difficult to obtain. PeMS provides a consolidated database of traffic data collected by Caltrans placed on state highways throughout California, as well as other Caltrans and partner agency data sets.
PeMS Forum	The PeMS forum is an external internet website where PeMS users can ask questions about the PeMS, share tips on how to better use it, recommend how PeMS functionality can be improved, and connect with other users that have similar data needs. PeMS forum site can be accessed by clicking on the PeMS Forum link in the left menu under Tools.
Performance Map	The PeMS Performance Map shows historical traffic information, such as bottlenecks and detector health.
Performance Menu	The Performance Menu is located in the Report Selector Menu, and lists all of the traffic data reports for the Current Location.
Photolog Viewer	The Photolog Viewer link is available on the left side, under Featured Sections, of the PeMS home page or any District home page. Clicking on this link takes users to the Caltrans Photolog Viewer page. Users can view any freeway photolog by finding the desired freeway corridor (either by panning/zooming the map or by selecting the appropriate District button) and dragging (clicking and holding the mouse button and moving) the red car icon to the desired freeway location on the map, with the car pointed in the desired direction of travel. These actions trigger the photolog video for the location where the car is on the map.
Postmile	There are two types of postmiles in PeMS. CA PM correspond with Caltrans' postmile system. Abs PM stands for Absolute Postmiles, which are PeMS-generated postmiles that represent actual distances along a roadway, and do not reset at county boundaries. Only Absolute Postmiles can be entered into PeMS reports.
Productivity	See Lost Productivity.

Q	Q is the average speed over a length of roadway. It is calculated by dividing the vehicle miles travelled by the vehicle hours travelled, so it has units of miles per hour.
Quick Links	The Quick Links are a useful tool for navigating to a different Current Location. The available Quick Link drop-down menus and contents update as the user moves to different Current Locations to only list options within the Current Location (for example, if the user's Current Location is District 4, the Freeway Quick Links will only list freeways in District 4).
Real-Time Map	The PeMS Real-Time map displays current traffic, incident, and lane closure information. It automatically refreshed every five minutes.
Report Finder	The Report Finder is a shortcut for jumping directly to a report for a particular freeway, route, or station. It is only available on the statewide and district dashboards.
Report Selector Menu	The Report Selector Menu is located at the top of every PeMS page, and contains a number of pull-down menus (such as Facilities & Devices, Performance, and Data Quality).
Routes	Every PeMS user can create two routes. Routes are user-defined paths of roadways over which PeMS will begin calculating specialized performance measures such as travel times. Users can create routes that begin and end at on- and off-ramps and traverse multiple freeways, and can also share their routes with other users.
Search Tab	The Search view allows users to perform text and location searches over all of the metadata stored in the PeMS database. A search can be performed in two ways: (1) by entering a search in the box that appears at the top right of every page, or (2) by clicking the Search tab from a map page.
Spatial Analysis	Spatial Analysis refers to analysis performed along a section of roadway (such as a freeway or a route), in contrast to analysis performed at a station or over a county.
Speed	Speeds in PeMS are reported for each mainline and HOV detector. Speeds are only viewable for VDSs.
Statewide Dashboard	See Homepage.
Station	A station is a grouping of detectors at the same location along a roadway. There are two main types of stations: VDSs and Census Stations.
TASAS Accidents	TASAS accidents in PeMS come from the Caltrans Traffic Accident Surveillance and Analysis system. They are entered into PeMS approximately every year, so there is usually at least a two-year lag between when an incident happens and when it appears in PeMS. TASAS accidents are only viewable by Caltrans users.
Threshold Speed	Congestion is defined as speeds below a certain threshold speed. Commonly used threshold speed is 35 miles per hour or 60 miles per hour. PeMS compute the delay for various different threshold speeds in order to accommodate different definitions of delay.
Transit Agencies	The transit agencies report lists transit agencies available for analysis within the system. Statistics shown in the table are all based on the current schedule configuration. The numbers are average daily values computed over a week. Users can access available

	transit data reports by going to Facilities & Devices pull down menu and selecting Transit Agencies link from the PeMS home page.
Transportation Management Center	Caltrans transportation management center (TMC) in a District which receives real-time traffic data from vehicle detector stations. PeMS receives this same real-time traffic data from the TMCs' front end processor.
Travel Time	PeMS calculates travel times only on routes. Travel times are computed from the detector speeds. Detailed information on travel time calculations is available using the PeMS Help link.
Travel Time Index	The travel time index (TTI) is the ratio between a measured travel time and the free-flow travel time. Unlike the travel time, the travel time index can be viewed for any station or freeway segment, and can be used to manually estimate the travel time.
2-D Profile	2-D (corridor performance measure profile) report allows users to see the various performance measure quantities down the freeway corridor segment at a given time (i.e., one 5-minute time point). This report is useful when attempting to view performance characteristics along a freeway. Examples include identifying where slowdowns occur, where traffic throughput falls (productivity losses), and where traffic is most dense. Users can identify sections of the freeway and step through different time slices to see how the traffic progresses. This feature can be used to determine when congestion or bottlenecks form or when they end. The following quantities are available in this report: flow, speed, occupancy, and delay. Pathway: freeway > Performance > Spatial Analysis > 2-D.
VDS	Vehicle Detection Station. VDSs are the primary source of traffic data in PeMS; as such, VDS data drives all of the freeway reports. VDSs report data in real-time every 30-seconds. Mainline and HOV VDSs report flow, occupancy, and speed. Ramp and connector VDSs report only flow.
Vehicle Classification Station	Vehicle Classification Stations are specialized Census Stations that report vehicle classification data.
VHT	The vehicle hours traveled (VHT) is the total amount of time spent by all of the vehicles over a freeway segment during a specified time period. When plotted over a spatial segment, this quantity is simply the sum of VHT from the individual detectors. Users can query VHT reports for any freeway (or segment) available in PeMS. At a freeway segment page in PeMS, users can select the VHT reports by using the Performance pull-down menu and selecting Aggregates. There are three types of Aggregates reports: Time Series, Time of Day, and Day of Week.
VMT	The vehicle miles traveled (VMT) is the total miles driven by all of the vehicles over a freeway segment during a specified time period. When plotted over a spatial segment, this quantity is simply the sum of VMT from the individual detectors. Users can query VMT reports for any freeway (or segment) available in PeMS. At a freeway segment page in PeMS, users can select the VMT reports by using the Performance pull-down menu and selecting Aggregates. There are three types of Aggregates reports: Time Series, Time of Day, and Day of Week.
WIM Station	Weigh-in-Motion (WIM) stations are specialized Census Stations that collect individual vehicle weight and axle information.

APPENDIX

**EXERCISE ANSWERS
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Chapter 1 Exercise Answers

Basic Navigation

1. How did District 3 delay compare with District 7 delay on Fridays last year (hint: Dashboards)?
 - A. *The District 3 home page dashboard indicates that the District 3 Friday delay was approximately 27,000 vehicle-hours for (a sample week in April) last year (2012).*
The District 7 home page dashboard indicates that the District 7 Friday delay was approximately 380,000 vehicle-hours for (the same sample week in April) last year.
2. How many VDS locations are there on I-80W in District 4?
 - A. *The District 4 inventory page indicates that there are 117 VDSs on I-80W.*
3. How many miles of HOV lane are there on I-80E in District 4?
 - A. *The District 4 inventory page indicates that there are 15.5 miles of HOV Facility on I-80E*
4. How many Corridors are there in District 4?
 - A. *The District 4 corridors listing page indicates that there are 10 Corridors in District 4.*
5. How many stations are there in District 3?
 - A. *The District 3 home page under Freeway Details indicates that there are 1195 stations (VDSs) in District 3.*
6. What is a TMG Report (hint: Help page)?
 - A. *The TMG Report pages in PeMS assist Caltrans engineers in collecting and properly formatting PeMS data for input into the Caltrans TSN system. The report takes the hourly flow in the geographical segment and places it into the TMG format.*
7. How many PeMS designated holidays were there in 2010?
 - A. *The PeMS Holidays page indicates that there are 11 designated holidays in PeMS.*

Chapter 1 Exercise Answers
Basic Navigation
Question 1 Answer

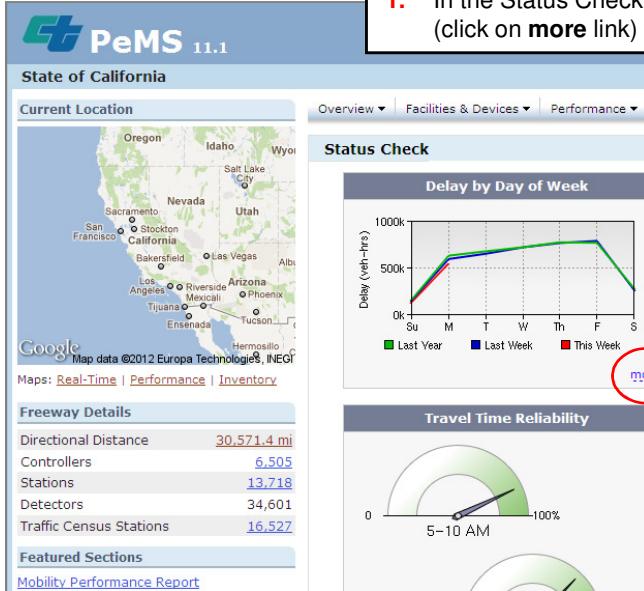
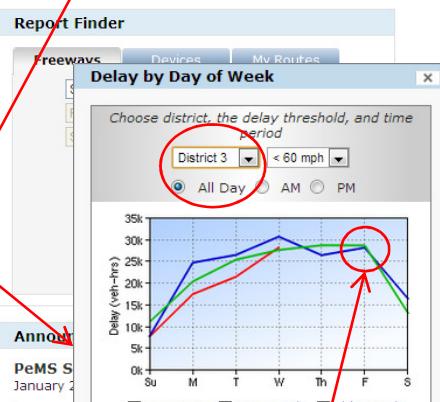
Answer 1

- How did District 3 delay compare with District 7 delay on Fridays last year (hint: Dashboards)?
 - The District 3 home page dashboard indicates that the District 3 Friday delay was approximately 27,000 vehicle-hours for (a sample week in April) last year (2012).

The District 7 home page dashboard indicates that the District 7 Friday delay was approximately 380,000 vehicle-hours for (the same sample week in April) last year.

From the PeMS home page

1. In the Status Check window in the Delay by Day of Week dashboard (click on **more** link) to open a pop-up Delay by Day of Week dashboard window

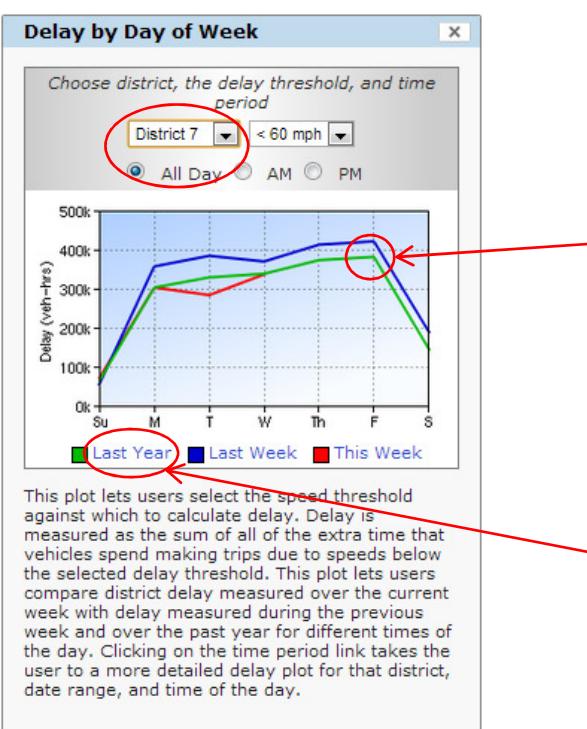



This plot lets users select the speed threshold against which to calculate delay. Delay is measured as the sum of all of the extra time that vehicles spend making trips due to speeds below the selected delay threshold. This plot lets users compare district delay measured over the current week with delay measured during the previous week and over the past year for different times of the day. Clicking on the time period link takes the user to a more detailed delay plot for that district, date range, and time of the day.

Selecting District 3 in the pull down menu for All Day period presents a report that shows the 2012 Friday delay figure of approximately 27,000 vehicle-hours for this week last year.

Selecting District 7 presents a report that shows the 2012 Friday delay figure of approximately 380,000 vehicle-hours for this week last year.

Note: you can click on this link to take you to the query page to specify date/time periods and other parameters for desired report.



This plot lets users select the speed threshold against which to calculate delay. Delay is measured as the sum of all of the extra time that vehicles spend making trips due to speeds below the selected delay threshold. This plot lets users compare district delay measured over the current week with delay measured during the previous week and over the past year for different times of the day. Clicking on the time period link takes the user to a more detailed delay plot for that district, date range, and time of the day.

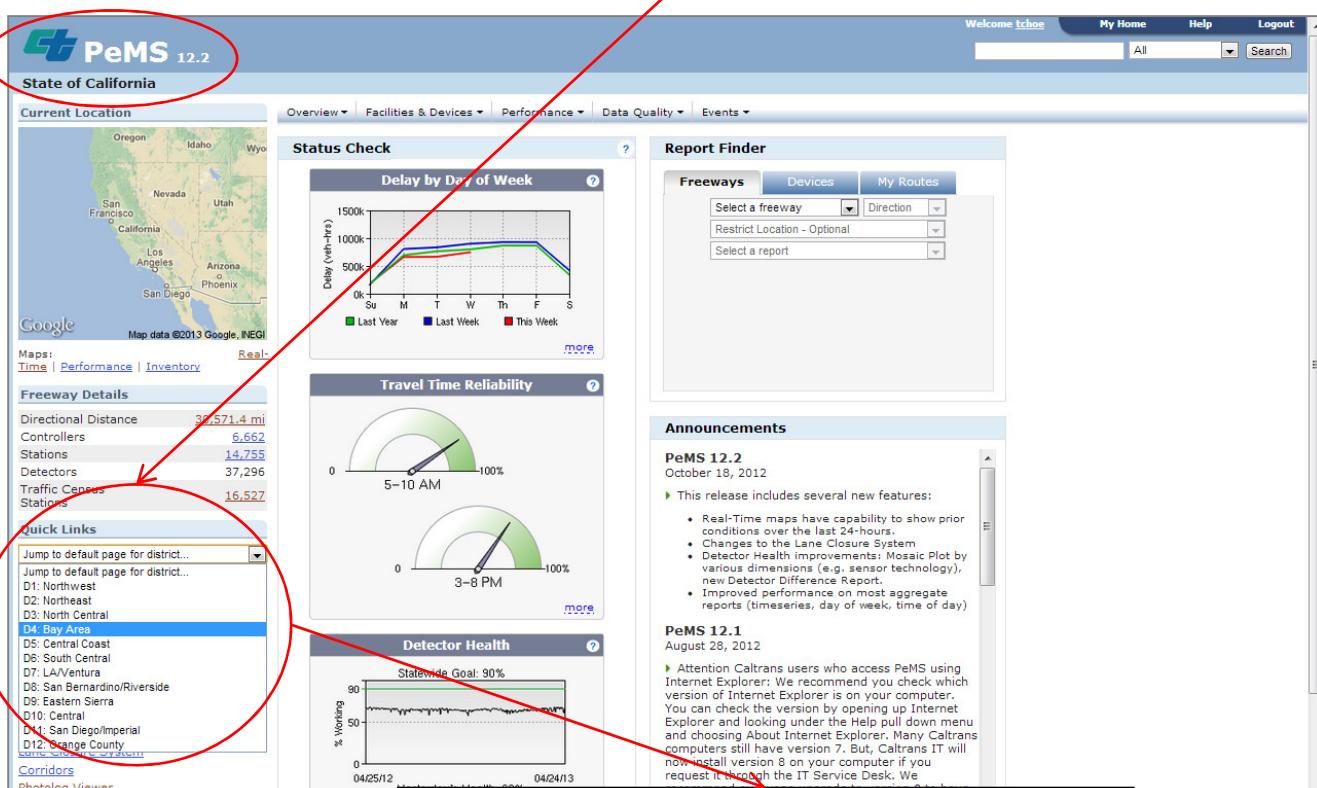
Chapter 1 Exercise Answers
Basic Navigation
Question 2, 3, & 4 Answer

Answer 2, 3 & 4

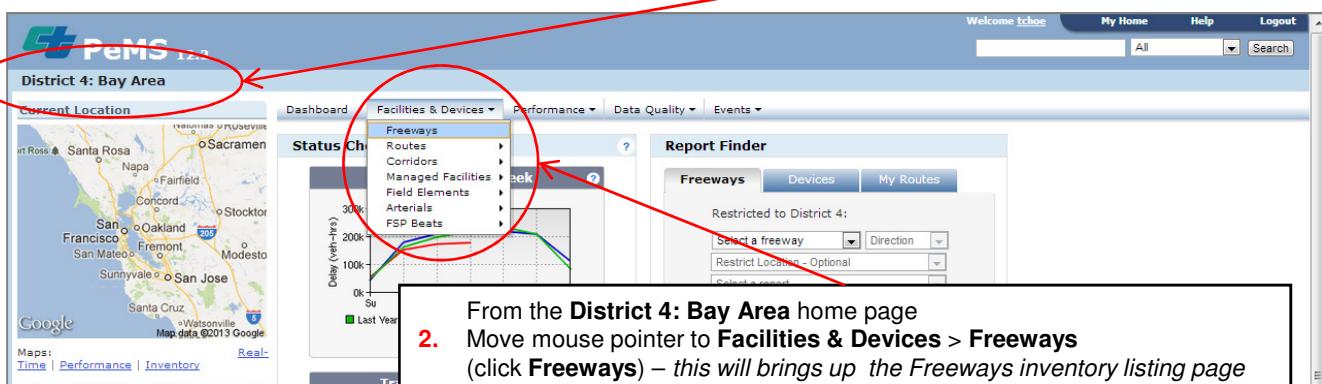
2. How many VDS locations are there on I-80W in District 4?
 A. *The District 4 inventory page indicates that there are 117 VDSs on I-80W.*
3. How many miles of HOV lane are there on I-80E in District 4?
 A. *The District 4 inventory page indicates that there are 15.5 miles of HOV Facility on I-80E.*
4. How many Corridors are there in District 4?
 A. *The District 4 corridors listing page indicates that there are 10 Corridors in District 4.*

From the PeMS home page

1. Jump to the District 4: Bay Area home page from the **Quick Links** pull down menu



The user should see **District 4: Bay Area** (District 4 home page)



From the **District 4: Bay Area** home page
 2. Move mouse pointer to **Facilities & Devices > Freeways**
 (click **Freeways**) – this will bring up the **Freeways inventory listing page**

Chapter 1 Exercise Answers

Basic Navigation

Question 2, 3, & 4 Answers

The user should see **District 4: Bay Area** (District 4 home page)

Fwy	Detection			Mainline Facilities Detection Coverage				HOV Facilities Detection Coverage				
	# LDSs	# VDSs	# Detectors	Total Miles	# VDSs	Miles	Lane Miles	Miles	Lane Miles	# VDSs	Miles	Lane Miles
I80-E	89	112	447	72.2	105	71.0	286.5	15.5	15.5	43	15.5	67.6
I80-W	85	117	473	72.2	110	72.2	298.4	25.0	25.0	62	25.0	115.2
I205-E	0	0	0	0.9	0	0	0.0	0	0.0	0	0	0.0
I205-W	0	0	0	0.9	0	0	0.0	0	0.0	0	0	0.0
I280-N	39	50	197	57.5	46	47.8	203.1	10.7	10.7	8	10.7	46.0
I280-S	39	68	230	57.5	50	48.7	193.3	10.7	10.7	7	10.7	46.0
I380-E	0	0	0	2.1	0	0	0.0	0	0.0	0	0	0.0
I380-W	0	0	0	2.1	0	0	0.0	0	0.0	0	0	0.0
I505-N	0	0	0	10.6	0	0	0.0	0	0.0	0	0	0.0

From the **District 4: Bay Area** home page

1. Move mouse pointer to **Facilities & Devices > Corridors > Listing** (click **Listing**) – this will bring up the **Corridors Listing** page

Fwy	Detection			Mainline Facilities Detection Coverage				HOV Facilities Detection Coverage				
	# LDSs	# VDSs	# Detectors	Total Miles	# VDSs	Miles	Lane Miles	Miles	Lane Miles	# VDSs	Miles	Lane Miles
I80-E	89	112	447	72.2	105	71.0	286.5	15.5	15.5	43	15.5	67.6
I80-W	85	117	473	72.2	110	72.2	298.4	25.0	25.0	62	25.0	115.2
I205-E	0	0	0	0.9	0	0	0.0	0	0.0	0	0	0.0
I205-W	0	0	0	0.9	0	0	0.0	0	0.0	0	0	0.0
I280-N	39	50	197	57.5	46	47.8	203.1	10.7	10.7	8	10.7	46.0
I280-S	39	68	230	57.5	50	48.7	193.3	10.7	10.7	7	10.7	46.0
I380-E	0	0	0	2.1	0	0	0.0	0	0.0	0	0	0.0
I380-W	0	0	0	2.1	0	0	0.0	0	0.0	0	0	0.0
I505-N	0	0	0	10.6	0	0	0.0	0	0.0	0	0	0.0

The District 4 corridors listing page indicates that there are 10 Corridors in District 4.

District ID	Corridor Name	Primary		Secondary	
		Length (mi)	Fwy Dir	Length (mi)	Fwy Dir
4	13: Alameda I-80	20.2	I80-F 1.989 to 14.139	20.2	I80-W 14.139 to 1.989
4	14: I-580	30.5	I580-E 0.393 to R30.807	30.6	I580-W R30.807 to 0.393
4	15: I-880	26.7	I880-N R0.000 to 10.502	20.7	I880-S 10.502 to R0.000
4	16: Sonoma US-101	81.6	SR101-N L0.000 to R54.201	81.6	SR101-S R54.201 to L0.000
4	17: Santa Clara US-101	52.2	SR101-N R26.834 to 26.107	52.2	SR101-S 26.107 to R26.834
4	18: SR24	13.5	SR24-E R1.847 to 9.144	13.5	SR24-W 9.144 to R1.847
4	19: Solano I-80	42.7	I80-E 0.000 to 42.67	42.7	I80-W 42.67 to 0.000
4	20A: SR-4	31.2	SR4-E 0.000 to 31.130	31.2	SR4-W 31.130 to 0.000
4	20B: SR-12	30.7	SR12-E 0.0 to 26.393	30.7	SR12-W 26.393 to 0.0
4	X10: 101/85	38.7	SR101-S 11.677 to 46.987 SR85-S R21.324 to 0	38.7	SR85-N 0 to R21.324 SR101-N 47.023 to 11.713

Chapter 1 Exercise Answers
Basic Navigation
Question 5 Answer

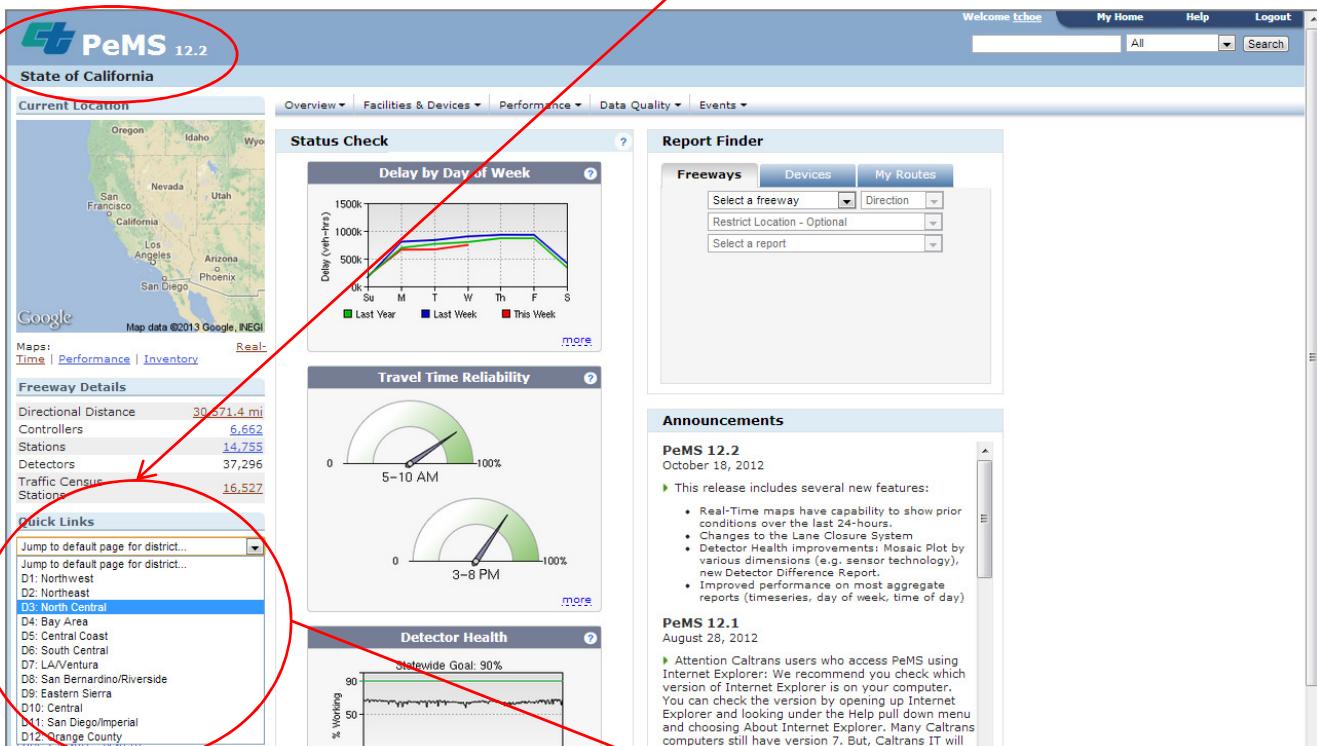
Answer 5

5. How many stations are there in District 3?

A. The District 3 home page under Freeway Details indicates that there are 1198 stations (VDSs) in District 3.

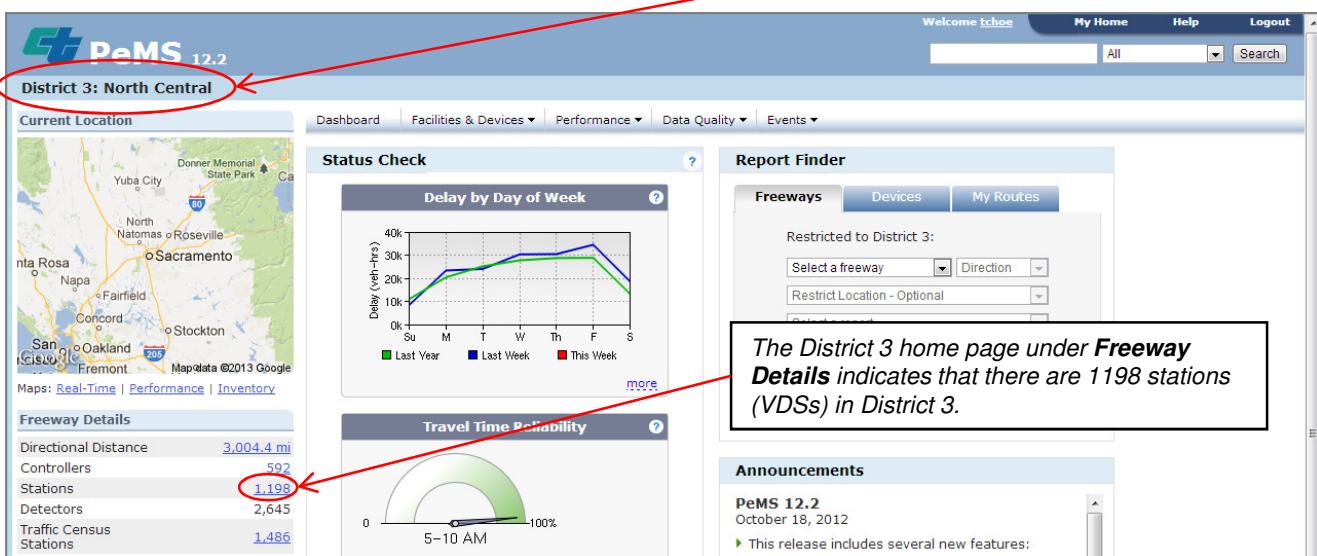
From the PeMS home page

- Jump to the **District 3: North Central** home page from the **Quick Links** pull down menu



The screenshot shows the PeMS 12.2 home page. A red circle highlights the "Quick Links" dropdown menu in the left sidebar. The menu lists various districts, with "D3: North Central" selected and highlighted in blue. Other options include D1: Northwest, D2: Northeast, D4: Bay Area, D5: Central Coast, D6: South Central, D7: LA/Ventura, D8: San Bernardino/Riverside, D9: Eastern Sierra, D10: Central, D11: San Diego/Imperial, and D12: Orange County.

The user should see **District 3: North Central** (District 3 home page)



The screenshot shows the District 3: North Central home page. A red circle highlights the "Stations" row in the "Freeway Details" table, which shows the value 1,198. The table also includes rows for Directional Distance (3,004.4 mi), Controllers (592), Detectors (2,645), and Traffic Census Stations (1,486).

The District 3 home page under **Freeway Details** indicates that there are 1198 stations (VDSs) in District 3.

Chapter 1 Exercise Answers

Basic Navigation

Question 6 Answer

Answer 6

6. What is a TMG Report (hint: Help page)?

A. The TMG Report pages in PeMS assist Caltrans engineers in collecting and properly formatting PeMS data for input into the Caltrans TSN system. The report takes the hourly flow in the geographical segment and places it into the TMG format.

From any page

1. Click on the **Help** link

From the Help page

2. Click on the **Topics** pull down menu and select **TMG Report**

TMG Report

The TMG pages in PeMS assist the Caltrans engineers in collecting and properly formatting data for input into the Caltrans TSN system.

Caltrans has a duplicate set of sensors on the freeway system that don't report data through the normal district data collection systems (and hence the data doesn't come to PeMS). Sometimes these are duplicate stations on the freeway, and in other cases they are the same physical loops but the data is split out at the controller and transported to the district via different means. These are called census stations. The districts are in charge of collecting this data from the census stations, converting it to a special format called the TMG format, and sending it to Caltrans headquarters. They then run it through a system called the TSN system to produce more reports.

The TMG pages in PeMS assist the engineers in a few ways. First, we've performed the mapping between the census stations and the PeMS VDS stations. Second, we format the station data in the **TMG format**, which is a fixed-width format (ie: not pretty to look at), needed for direct input into TSN. Third, we allow users to view collections of stations grouped by geographic location instead of just one-by-one. And fourth, we allow users to filter out data that has been imputed.

TMG Report

This tab takes the hourly flow in the geographical segment and places it into the TMG format. The HTML table of this data is truncated at 100 rows and is only meant to be used for debugging. To see the whole data set in the correct, fixed-width format export the data to text. In either case, these reports are not meant to view, per se. They are meant to be fed into TSN. Hence the formatting is not human-friendly.

Besides a date range, we have three main options:

- **Constrain to TSNs:** When this is checked we only include PeMS VDS stations that have been matched to a TSN (Census Station). If you unclick this box then you'll get all of the PeMS VDS in the geographical region included in the report. For the stations that don't have a TSN we fill in the last few columns to indicate where they are (having a TSN ID, but no location so we don't fill those in for TSN stations). It is important to note that if you are looking at a single VDS that wasn't matched to a census station, then if you click this box then you'll never get any data back.
- **Filter out bad lanes:** When this is checked, we filter out the report any lanes where the diagnostics have indicated that the detector is bad. When data is filtered out the hourly flow is set to blanks.
- **Detector % Observed Threshold:** This option is a way to filter out imputed data from the report. Users can select the percentage of observed data per hour that is required for the data to be included in the report. PeMS stores the percentage of data samples observed for the entire station, not for individual lanes. Hence the we apply this threshold to the percentage of samples for the whole station (across all lanes) and then if the threshold is violated we toss the data from all lanes and leave the hourly summary for all lanes blank. For example, lets say we're looking at a four lane location that for the hour should have 48 5-minute samples. If you set the % observed threshold to 50% then if more than 50% of the 5-minute samples are imputed then we'll fill in the cells for this hour for all lanes with blanks.

The TMG Report pages in PeMS assist Caltrans engineers in collecting and properly formatting PeMS data for input into the Caltrans TSN system. The report takes the hourly flow in the geographical segment and places it into the TMG format.

Chapter 1 Exercise Answers
Basic Navigation
Question 7 Answer

Answer 7

7. How many PeMS designated holidays were there in 2010?
 A. The PeMS Holidays page indicates that there are 11 designated holidays in PeMS.

From PeMS home page

- Under **Tools** click on the **Holidays** link
- Select 2010 from the pull down menu

The PeMS Holidays page indicates that there are 11 designated holidays in PeMS.

Date	Description	Day of Week
01/01/2010	New Year's Day	Friday
01/18/2010	Martin Luther King, Jr. Day	Monday
02/15/2010	Washington's Birthday	Monday
05/31/2010	Memorial Day	Monday
07/05/2010	Independence Day	Monday
09/06/2010	Labor Day	Monday
10/11/2010	Columbus Day	Monday
11/11/2010	Veterans Day	Thursday
11/25/2010	Thanksgiving Day	Thursday
11/26/2010	Day After Thanksgiving	Friday
12/24/2010	Christmas Day	Friday

The dates listed here are omitted from reports that exclude holidays.

Chapter 3 Exercise Answers

Data Quality Assessment

1. What is the mainline VDS ID number at District 12 northbound SR-57 (SR57-N) at Wagner Avenue in Anaheim?
 - A. *The District 12 SR57-N Field Elements list indicates that the VDS ID number at Wagner is 1213091.*
2. Look at the Detector Health (Samples or % Observed) for the two week period between 8/6/2012 and 8/19/2012 for Wagner Avenue VDS. Any bad detector quality days?
 - A. *The “bad” detector quality days between August 6 and 19 in 2012 include 8/13, 8/14, and 8/15, where % Observed data fell below 50%.*
3. If bad detector days, what is the imputation method used by PeMS to estimate for the data gap?
 - A. *Imputation Methods report shows that imputation for the bad detector days was largely by local neighbors, global neighbors, and temporal medians.*
4. Run the Performance > Aggregate > Time Series report of FLOW for that time period of bad detector days? What is the percent data observed for that aggregate data? What is the percent imputed data?
 - A. *The Flow report shows 82% observed data (and therefore 18% imputed data) for the two week period.*

Chapter 3 Exercise Answers
Data Quality Assessment
Question 1 Answer

Answer 1

- What is the mainline VDS ID number at District 12 northbound SR-57 (SR57-N) at Wagner Avenue in Anaheim?
- A. *The District 12 SR57-N Field Elements list indicates that the VDS ID number at Wagner is 1213091.*

The screenshot shows the PeMS 11.1 home page with a red circle around the PeMS logo in the top left. A red arrow points from the 'Jump to default page for district...' dropdown in the 'Quick Links' section to the 'District 12: Orange County' header in the second screenshot. Another red circle highlights the 'Jump to default page for district...' dropdown. A red box labeled 'From the PeMS home page' contains step 1. A red arrow points from the 'Facilities & Devices' dropdown in the second screenshot to the 'Freeways' tab in the third screenshot. A red circle highlights the 'Facilities & Devices' dropdown.

From the PeMS home page

- Jump to the District 12: Orange County home page from the **Quick Links** pull down menu
(click on **Jump to default page for district...** pull down arrow, select and click on **D12: Orange County**)

From District 12: Orange County home page

- Move mouse pointer to **Facilities & Devices** > **Freeways**
(click **Freeways**)

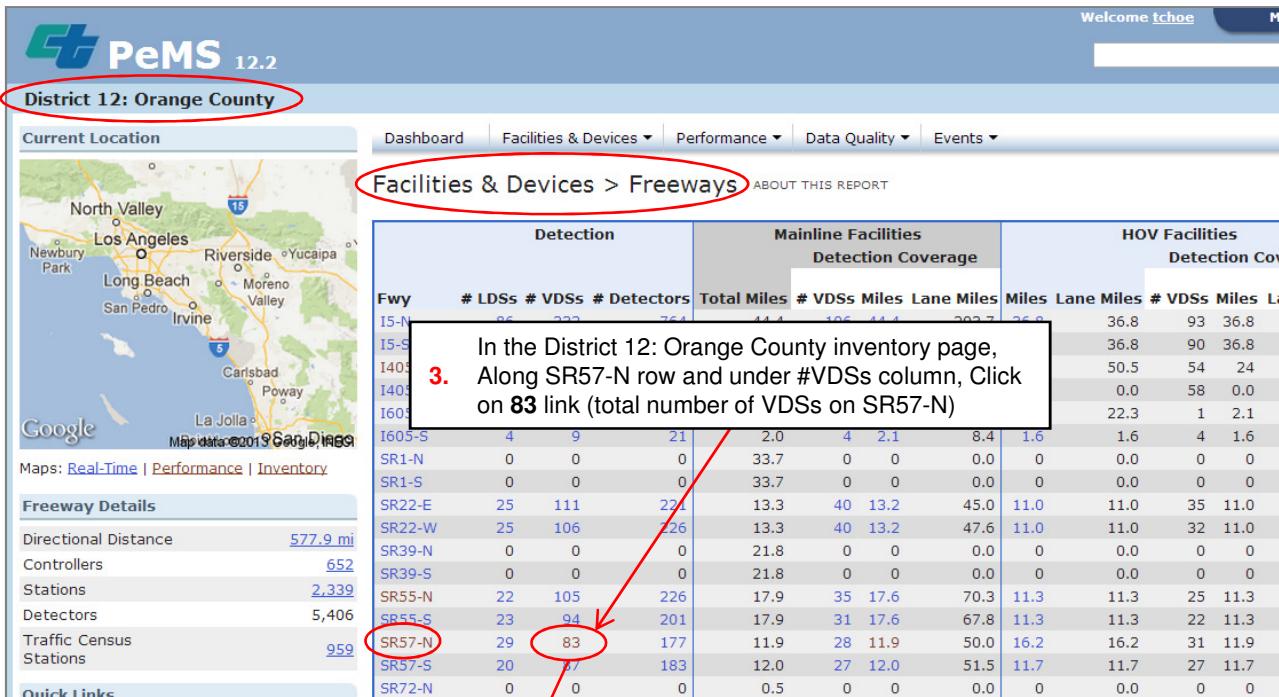
PeMS 11.1 Home Page

- Current Location:** State of California
- Status Check:** Delay by Day of Week
- Report Finder:** Freeways, Devices, My Routes
- Announcements:**
 - PeMS Server Maintenance: September 18, 2011
 - PeMS will be down for server maintenance on Monday, September 19th from 10:00 AM to 1:00 PM.
 - PeMS 11.1: August 31, 2011
 - This release includes new and improved navigational controls along with many bug fixes and performance enhancements. You may have noticed that the Tools drop down menu has been removed. Maps can now be accessed by clicking on one of the three links – Real-Time, Performance, or Inventory -- directly below the Current Location map in the upper left-hand corner of any page. A link to the Data Clearinghouse is under the Tools heading on the left side of every page. [Read more...](#)
 - Welcome to PeMS 11! May 24, 2011
 - Welcome to the new PeMS, version 11! PeMS 11 features an updated User Interface design and a number of other improvements. [Read more...](#)
 - Route Sharing: July 27, 2010

District 12: Orange County Home Page

- Current Location:** District 12: Orange County
- Dashboard:** Facilities & Devices (highlighted), Performance, Data Quality, Events
- Status Check:** Freeways, Routes, Corridors, Managed Facilities, Field Elements, Artarterials, Week
- Report Finder:** Freeways, Devices, My Routes
- Announcements:**
 - PeMS Server Maintenance: September 18, 2011
 - PeMS will be down for server maintenance on Monday, September 19th from 10:00 AM to 1:00 PM.

Chapter 3 Exercise Answers
Data Quality Assessment
Question 1 Answer

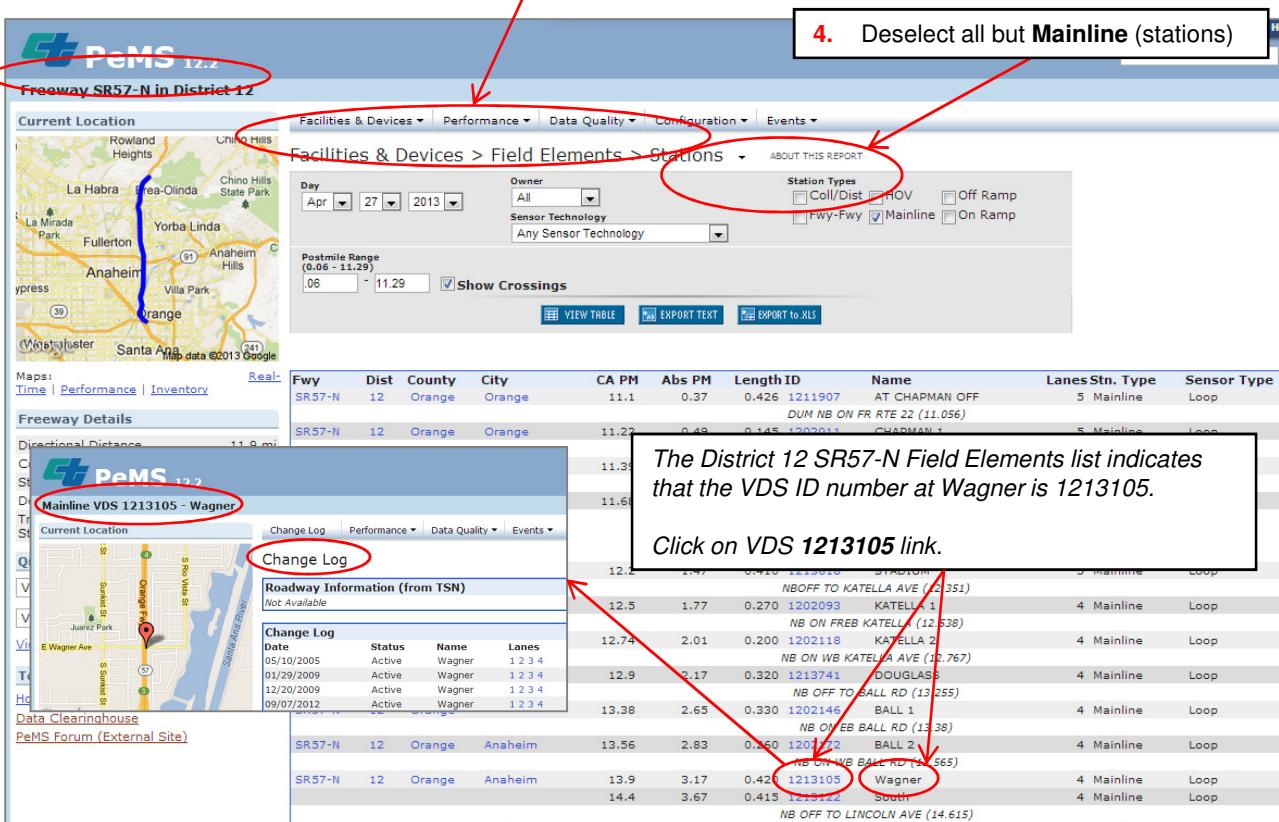


District 12: Orange County

Facilities & Devices > Freeways

3. In the District 12: Orange County inventory page, Along SR57-N row and under #VDSs column, Click on 83 link (total number of VDSs on SR57-N)

Fwy	# LDSs	# VDSs	# Detectors	Detection			Mainline Facilities			HOV Facilities		
				Total Miles	# VDSs	Miles	Lane Miles	Miles	Lane Miles	# VDSs	Miles	Lane Miles
SR57-N	26	222	764	44.4	105	44.4	202.7	26.0	36.8	93	36.8	
SR1-N	0	0	0	33.7	0	0	0.0	0	36.8	90	36.8	
SR1-S	0	0	0	33.7	0	0	0.0	0	50.5	54	24	
SR22-E	25	111	221	13.3	40	13.2	45.0	11.0	0.0	58	0.0	
SR22-W	25	106	226	13.3	40	13.2	47.6	11.0	11.0	35	11.0	
SR39-N	0	0	0	21.8	0	0	0.0	0	0.0	0	0.0	
SR39-S	0	0	0	21.8	0	0	0.0	0	0.0	0	0.0	
SR55-N	22	105	226	17.9	35	17.6	70.3	11.3	11.3	25	11.3	
SR55-S	23	94	201	17.9	31	17.6	67.8	11.3	11.3	22	11.3	
SR57-N	29	83	177	11.9	28	11.9	50.0	16.2	16.2	31	11.9	
SR57-S	20	0	183	12.0	27	12.0	51.5	11.7	11.7	27	11.7	
SR72-N	0	0	0	0.5	0	0	0.0	0	0.0	0	0.0	



4. Deselect all but Mainline (stations)

The District 12 SR57-N Field Elements list indicates that the VDS ID number at Wagner is 1213105.

Click on VDS 1213105 link.

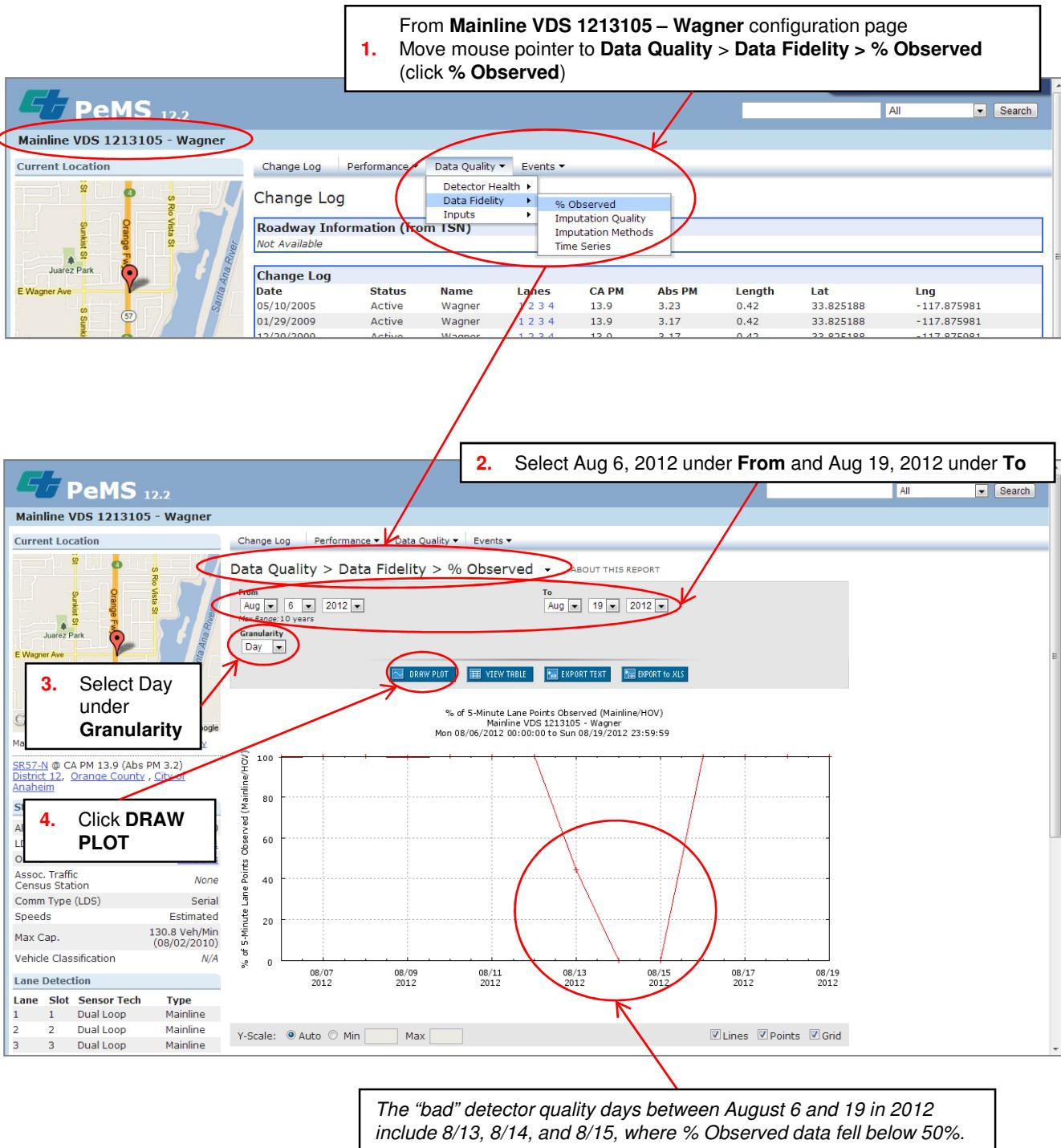
Fwy	Dist	County	City	CA PM	Abs PM	Length ID	Name	Lanes	Stn. Type	Sensor Type
SR57-N	12	Orange	Orange	11.1	0.37	0.426	AT CHAPMAN OFF	5	Mainline	Loop
							DUM NB ON FR RTE 22 (11.056)			
				11.2	0.49	0.445	CHAPMAN 1	5	Mainline	Loop
				11.3						
				11.4						
				11.5						
				11.6						
				11.7						
				11.8						
				11.9						
				12.0						
				12.1						
				12.2						
				12.3						
				12.4						
				12.5						
				12.6						
				12.7						
				12.8						
				12.9						
				13.0						
				13.1						
				13.2						
				13.3						
				13.4						
				13.5						
				13.6						
				13.7						
				13.8						
				13.9						
				14.0						
				14.1						
				14.2						
				14.3						
				14.4						

Chapter 3 Exercise Answers
Data Quality Assessment
Question 2 Answer

Answer 2

2. Look at the Detector Health (Samples or %Observed) for the two week period between 8/6/2012 and 8/19/2012. Any bad detector quality days for Wagner Avenue VDS?

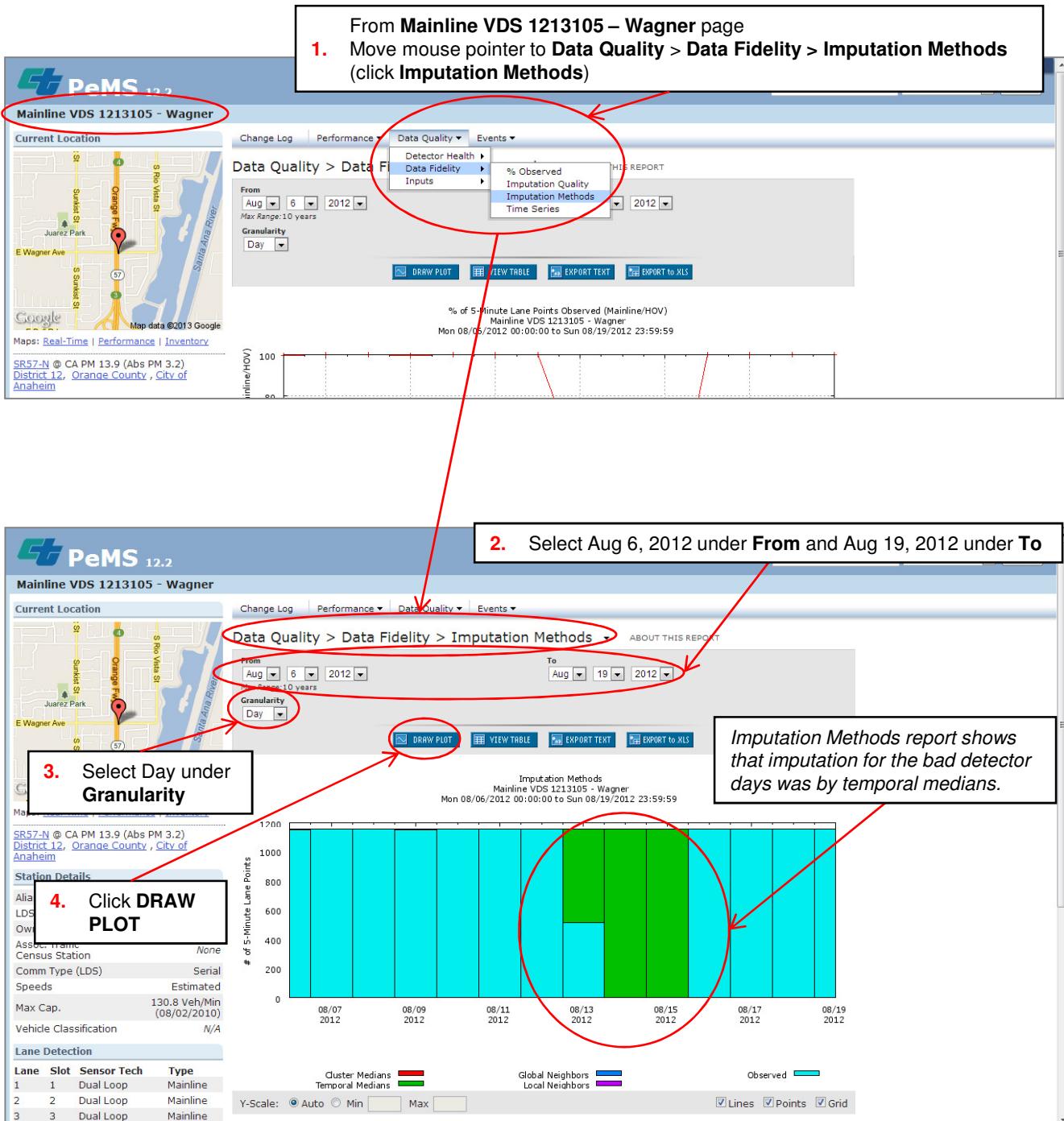
- A. The "bad" detector quality days between August 6 and 19 in 2012 include 8/13, 8/14, and 8/15, where % Observed data fell below 50%.



Chapter 3 Exercise Answers
Data Quality Assessment
Question 3 Answer

Answer 3

3. If bad detector days, what is the imputation method used by PeMS to estimate for the data gap?
- A. *Imputation Methods report shows that imputation for the bad detector days was largely by local neighbors, global neighbors, and temporal medians.*



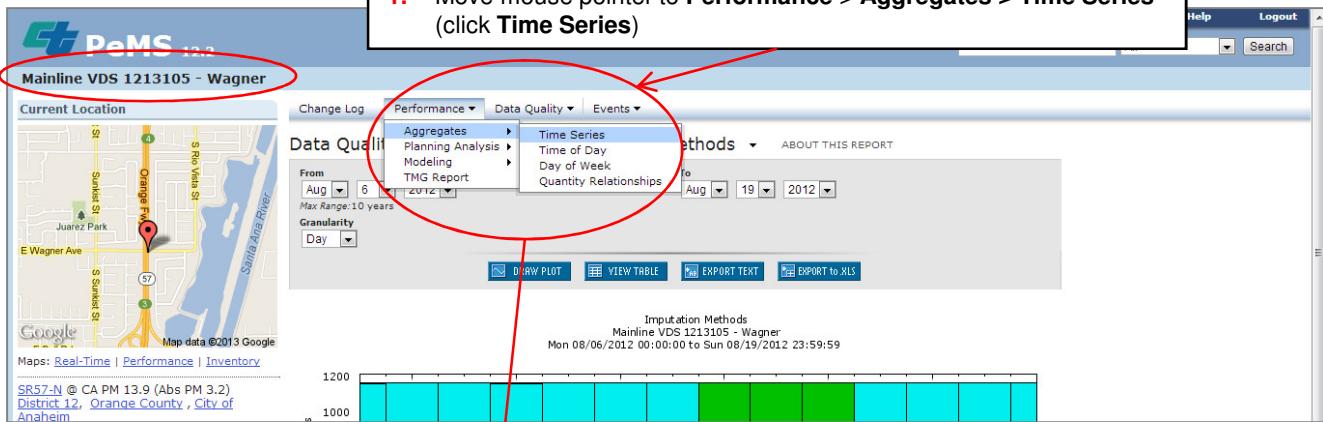
Chapter 3 Exercise Answers
Data Quality Assessment
Question 4 Answer

Answer 4

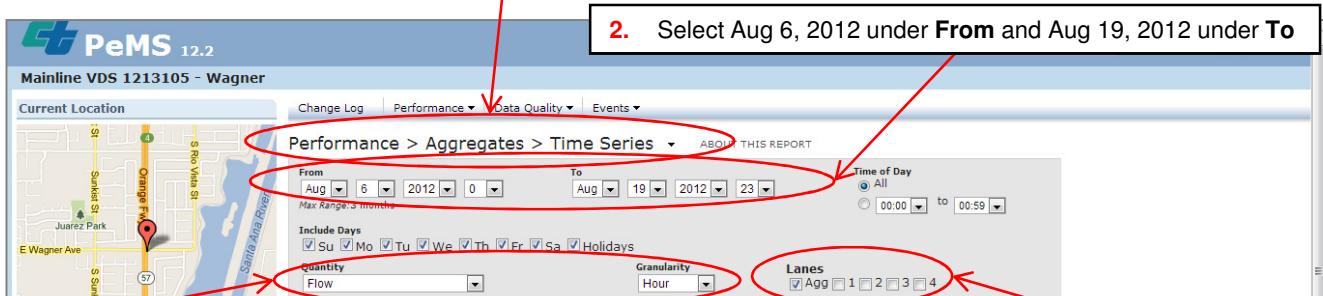
4. Run the Performance > Aggregate > Time Series report of FLOW for that time period of bad detector days? What is the percent data observed for that aggregate data? What is the percent imputed data?

A. *The Flow report shows 82% observed data (and therefore 18% imputed data) for the two week period..*

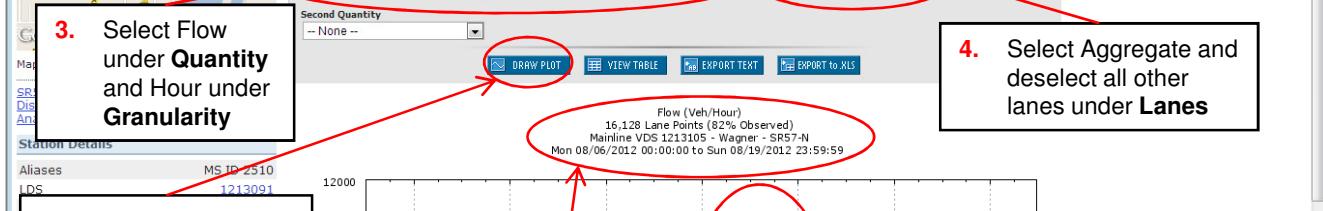
From Mainline VDS 1213105 – Wagner page
1. Move mouse pointer to Performance > Aggregates > Time Series (click Time Series)



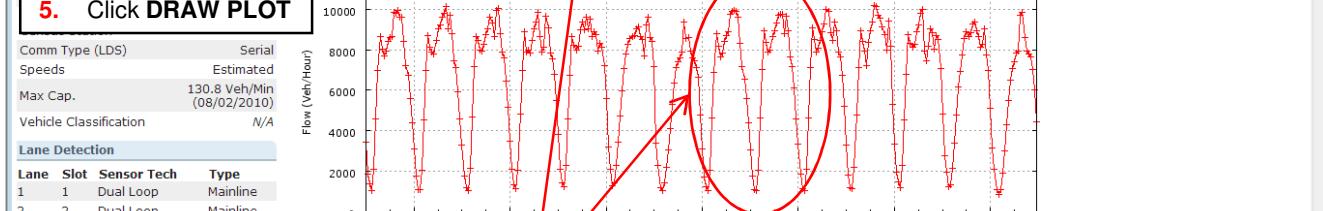
2. Select Aug 6, 2012 under From and Aug 19, 2012 under To



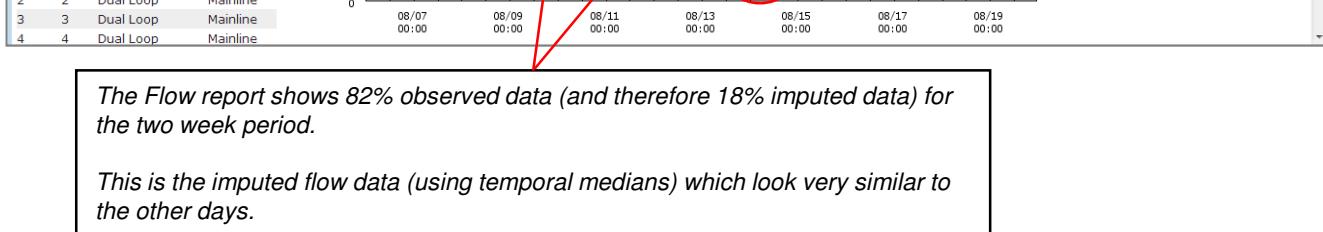
3. Select Flow under Quantity and Hour under Granularity



4. Select Aggregate and deselect all other lanes under Lanes



5. Click DRAW PLOT



Chapter 4 Exercise 1 Answers

Flow

1. What is the VDS ID number for District 3 – Eastbound I-80 at Richard Boulevard?
 - A. *The District 3 I80-E Stations list indicates that the mainline VDS ID number at Richards is 318113.*
2. At that station, what is the total number of lanes?
 - A. *The District 3 Mainline VDS 318113 – Richards Blvd configuration page indicates that there are 3 lanes on I80-E.*
3. What is the highest recorded one hour flow between 11/6/2011 and 11/19/2011? At what date and time? What is the percent data observed for that aggregate data?
 - A. *The District 3 Mainline VDS 318113 – Richards Blvd Aggregates > Time Series report indicates that the highest hour flow between 11/6/2011 and 11/19/2011 occurred on 11/10/2011 from 3pm to 4pm at a total of 4593 vehicles on I80-E, at 90% observed data*
4. Which lane typically has the lowest flow values among all lanes?
 - A. *The report indicates that lane 3 has the lowest flow values among all lanes (typically the outside lane has the lowest flow values among all lanes).*
5. What is the peak hour in terms of the highest (mean) flow rate during this two week period?
 - A. *The District 3 Mainline VDS 318113 – Richards Blvd Aggregates > Time of Day report indicates that the highest mean hour flow is from 4pm to 5pm at about 4000 vehicles.*
6. Which day of the week has the highest flows during this two week period?
 - A. *The District 3 Mainline VDS 318113 – Richards Blvd Aggregates > Day of Week report indicates that the day of the week with the highest flow occurred on Fridays during the two week period.*
7. What is the peak ADT during this two week period? At what date?
 - A. *The District 3 Mainline VDS 318113 – Richards Blvd Aggregates > Time Series report indicates that the peak ADT during this two week period is 59,064 on 11/11/2011.*
8. Which month had the highest MADT in 2011?
 - A. *The District 3 Mainline VDS 318113 – Richards Blvd Aggregates > Planning Analysis report indicates that the month with the highest Monthly Annual Daily Traffic (MADT) in 2011 is August 2011 with about 59,000.*

Speed

9. Among all the lanes, which lane is typically slowest during this two week period?
 - A. *The District 3 Mainline VDS 318113 – Richards Blvd Aggregates > Time Series report indicates that lane 3 is typically slowest (as was lowest flow – see question 4) during this two week period.*
10. If it typically has the lowest flow rates, why would the speeds also be the lowest among the lanes?
 - A. *With the lower speeds, likely from merging and weaving and higher truck traffic mix in the outer lane, flow is restricted.*

Density

11. Calculate the density at this station at 4pm on November 17, 2011. What is the density value per lane?
 - A. *Density = Flow/Speed = 4319/65.7 = 65.74 vehicles/mile. Per lane = 65.74 / 3 lanes = 21.91 vehicles/hour/lane.*
12. How might this PeMS value differ from the Highway Capacity Manual calculation value?
 - A. *The PeMS value is a density (flow and speed) measured at the VDS 318113 location, whereas the HCM value is calculated using various input quantities, equations, and empirical factors for a freeway segment.*

Chapter 4 Exercise 1 Answers
Freeway Station Level Analysis
Question 1 & 2 Answer

Answer 1 & 2

1. What is the VDS ID number for District 3 – Eastbound I-80 at Richard Boulevard?
 A. *The District 3 I80-E Stations list indicates that the mainline VDS ID number at Richards is 318113.*
2. At that station, what is the total number of lanes?
 A. *The District 3 Mainline VDS 318113 – Richards Blvd configuration page indicates that there are 3 lanes on I80-E.*

From the PeMS home page

1. Jump to the **District 3: North Central** home page from the **Quick Links** pull down menu

This screenshot shows the PeMS 12.2 home page. A red circle highlights the PeMS logo in the top left. Another red circle highlights the 'Quick Links' dropdown menu in the bottom left, which is open to show options like 'Jump to default page for district...' and 'D3: North Central' (which is selected). The main content area includes a map of California, a 'Status Check' section with a 'Delay by Day of Week' chart, a 'Report Finder' sidebar, and an 'Announcements' section.

From District 3: North Central home page

2. Move mouse pointer to **Facilities & Devices > Freeways** (click **Freeways**)

This screenshot shows the 'District 3: North Central' home page. A red circle highlights the 'District 3: North Central' title in the top left. Another red circle highlights the 'Facilities & Devices' dropdown menu in the top right, which is open to show 'Freeways' (selected), 'Routes', 'Corridors', etc. The main content area includes a map of Northern California, a 'Status Check' section with a 'Freeways' chart, a 'Report Finder' sidebar, and an 'Announcements' section.

Chapter 4 Exercise 1 Answers

Freeway Station Level Analysis

Question 1 & 2 Answer

District 3: North Central

Facilities & Devices > Freeways

Fwy	Detection			Mainline Facilities Detection Coverage			HOV Facilities Detection			
	# LDSs	# VDSs	# Detectors	Total Miles	# VDSs	Miles	Lane Miles	Miles	Lane Miles	# VDSs
I5-N	59	92	228	126.7	60	46.1	122.6	0	0.0	0
I5-S	57	91	225	126.7	61	46.1	122.6	0	0.0	0
I80-E	83	164	394	131.8	87	90.8	261.6	8.2	8.2	25
I80-W	76	170	389	132.0	90	95.5	265.8	8.2	8.2	24
I505-N	0	0	0	22.4	0	0	0.0	0	0.0	0

Freeway I80-E in District 3

Facilities & Devices > Field Elements > Stations

The District 3 I80-E Stations list indicates that the mainline VDS ID number at Richards is 318113.

Click on VDS 318113 link.

Fwy	Dist	County	City	CA PM	Abs PM	Length	ID	Name	Lanes	Stn. Type	Sensor Type	HOV MS ID	IRM
I80-E	3	Yolo	Richard Blvd	.274	72.46	0.000	318113	Richard Blvd	3	Off Ramp	No		
				.323	72.51	0.774	318113	Richard Blvd		Mainline	Loop	No	
				.405	72.59	0.000	318113	Richard Blvd		1	On Ramp	No	
<i>EB ON FR RICHARDS BLVD (.451)</i>													
I80-E	3	Yolo	Davis	1.25	3.44	0.838	316773	E. of Pole Line Rd.	3	Mainline	MVDS (Radar)	No	
				2	74.19	0.675	318017	West of Mace Blvd		Mainline	MVDS (Radar)	No	
				2.447	74.63	0.000	314015	SB Mace Blvd.	2	Off Ramp	Loop	No	R197
								EB OFF TO CHILES RD (2.492)					

Mainline VDS 318113 - Richard Blvd

Change Log

The District 3 Mainline VDS 318113 – Richards Blvd configuration page indicates that there are 3 lanes on I80-E.

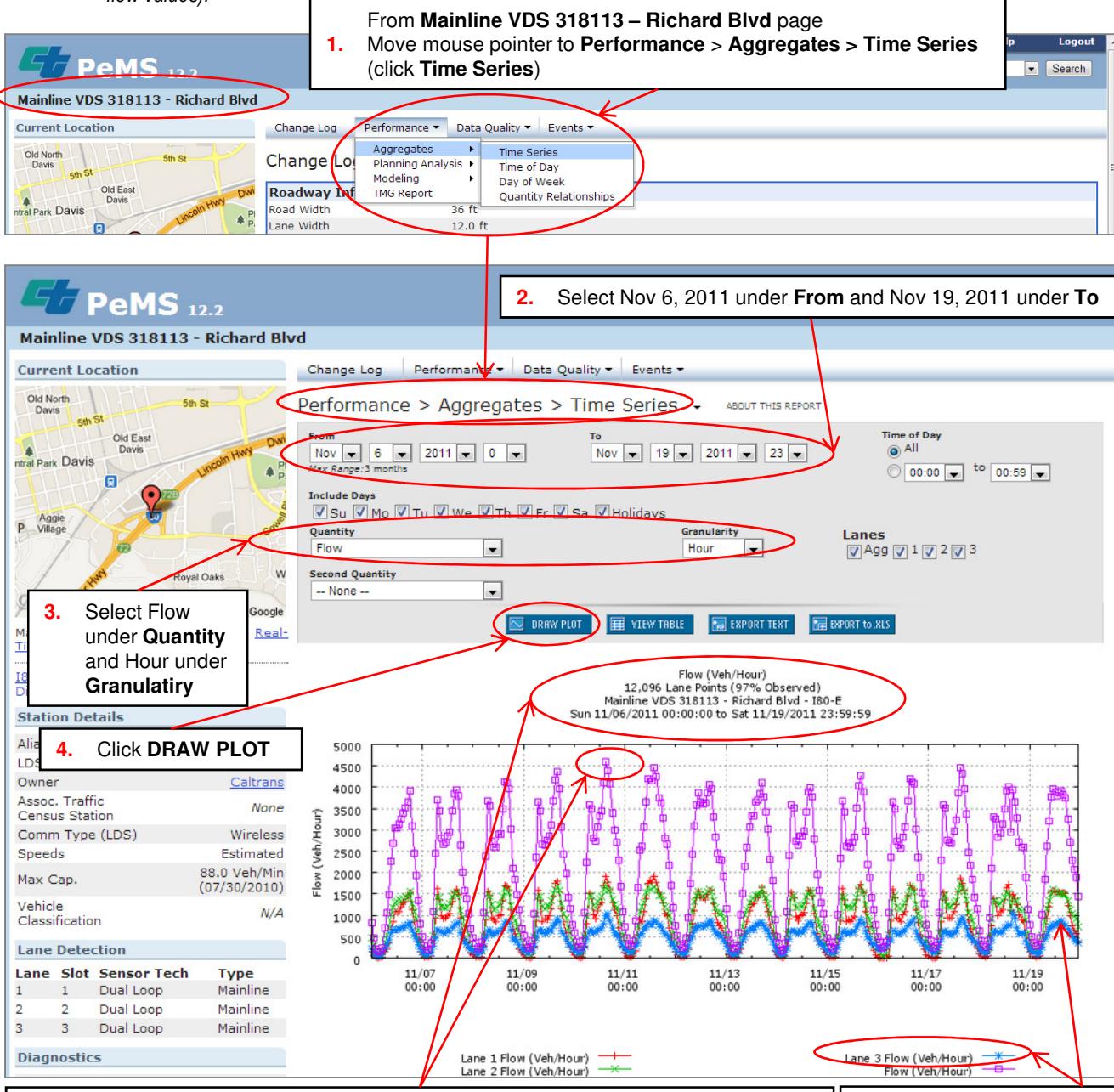
Roadway Information (from TSN)									
Road Width	36 ft								
Lane Width	12.0 ft								
Inner Shoulder Width	5 ft								
Outer Shoulder Width	5 ft								
Design Speed Limit	70 mph								
Functional Class	Principal Arterial W/ C/L Prin Arterial								
Inner Median Type	Unpaved								
Outer Shoulder Treated Width	5 ft								
Terrain	Flat								
Population	Urbanized								
Barrier	Three Beam Barrier								
Surface	Base & Surface >= 7" Thick								
Roadway Use	No Special Features								
Aliases	None								
LDS	318102								
Owner	Caltrans								
Assoc. Traffic Census	None								
Station	None								
Comments (Up/Down)									

Change Log

Date	Status	Name	Lanes	CA PM	Abs PM	Length	Lat	Lng
04/14/2010	Active	Richard Blvd	1 2 3	.323	72.51	0.77	38.541047	-121.73425
06/09/2011	Active	Richard Blvd	1 2 3	.323	72.51	0.77	38.541047	-121.73425

Answer 3 & 4

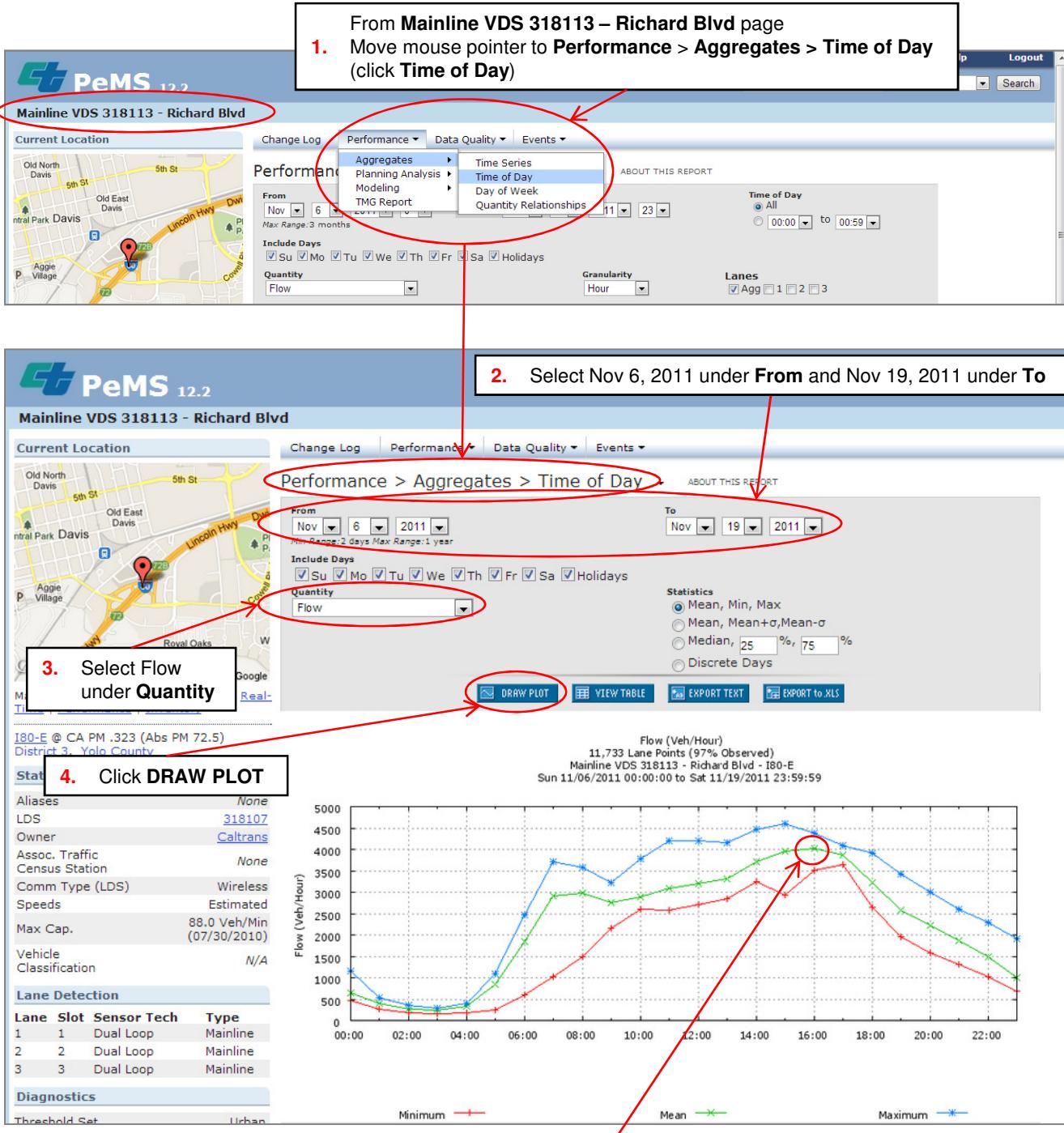
3. What is the highest recorded one hour flow between 11/6/2011 and 11/19/2011? At what date and time? What is the percent data observed for that aggregate data?
 - A. *The District 3 Mainline VDS 318113 – Richards Blvd Aggregates > Time Series report indicates that the highest hour flow between 11/6/2011 and 11/19/2011 occurred on 11/10/2011 from 3pm to 4pm at a total of 4593 vehicles at 90% observed data.*
4. Which lane typically has the lowest flow values among all lanes?
 - A. *The report indicates that lane 3 has the lowest flow values among all lanes (typically the outside lane has the lowest flow values).*



Answer 5

5. What is the peak hour in terms of the highest (mean) flow rate during this two week period?

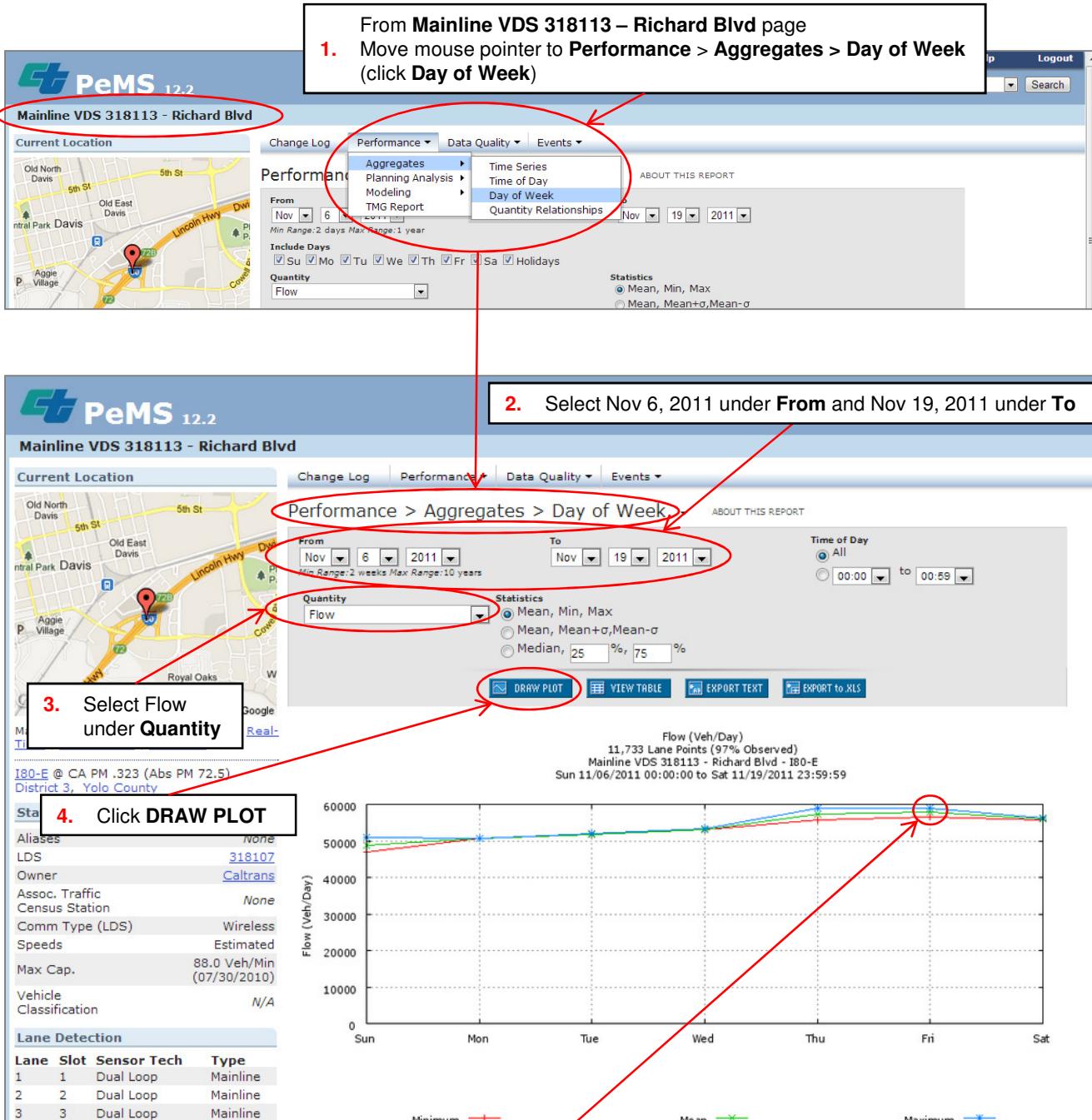
- A. The District 3 Mainline VDS 318113 – Richards Blvd Aggregates > Time of Day report indicates that the highest mean hour flow is from 4pm to 5pm at about 4000 vehicles.



Answer 6

6. Which day of the week has the highest flows during this two week period?

A. The District 3 Mainline VDS 318113 – Richards Blvd Aggregates > Day of Week report indicates that the day of the week with the highest flow occurred on Fridays during the two week period.



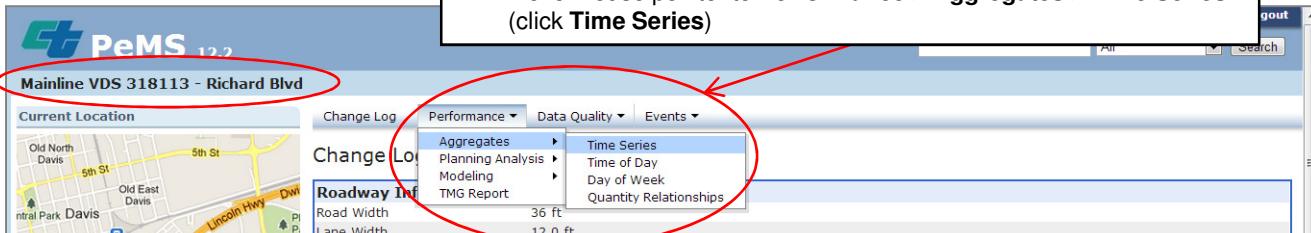
Answer 7

7. What is the peak ADT during this two week period? At what date?

- A. The District 3 Mainline VDS 318113 – Richards Blvd Aggregates > Time Series report indicates that the peak ADT during this two week period is 59,064 on 11/11/2011.

From **Mainline VDS 318113 – Richard Blvd** page

- 1.** Move mouse pointer to **Performance > Aggregates > Time Series** (click **Time Series**)



2. Select Nov 6, 2011 under **From** and Nov 19, 2011 under **To**

3. Select Flow under **Quantity**

4. Select Day under **Granularity**

5. Click **VIEW TABLE**

Day	Flow (Veh/Day)	# Lane Points	% Observed
11/06/2011	46,878	864	100.0
11/07/2011	50,574	864	100.0
11/08/2011	52,000	864	100.0
11/09/2011	53,289	864	100.0
11/10/2011	58,019	864	99.0
11/11/2011	59,064	864	100.0
11/12/2011	56,158	864	100.0
11/13/2011	50,912	864	100.0
11/14/2011	50,608	864	100.0
11/15/2011	51,701	864	100.0
11/16/2011	53,109	864	100.0
11/17/2011	55,690	864	99.0
11/18/2011	56,650	864	100.0
11/19/2011	55,817	864	60.0
Total	12,096		97.0

The District 3 Mainline VDS 318113 – Richards Blvd Aggregates > Time Series report indicates that the peak ADT during this two week period is 59,064 on 11/11/2011.

Chapter 4 Exercise 1 Answers
Freeway Station Level Analysis
Question 8 Answer

Answer 8

8. Which month had the highest MADT in 2011?

- A. The District 3 Mainline VDS 318113 – Richards Blvd Aggregates > Planning Analysis report indicates that the month with the highest Monthly Annual Daily Traffic (MADT) in 2011 is August 2011 with about 59,000.

From **Mainline VDS 318113 – Richard Blvd** page

1. Move mouse pointer to **Performance > Planning Analysis > MADT** (click **MADT**)

2. Select 2011 under **From** and **To**

3. Click **VIEW TABLE**

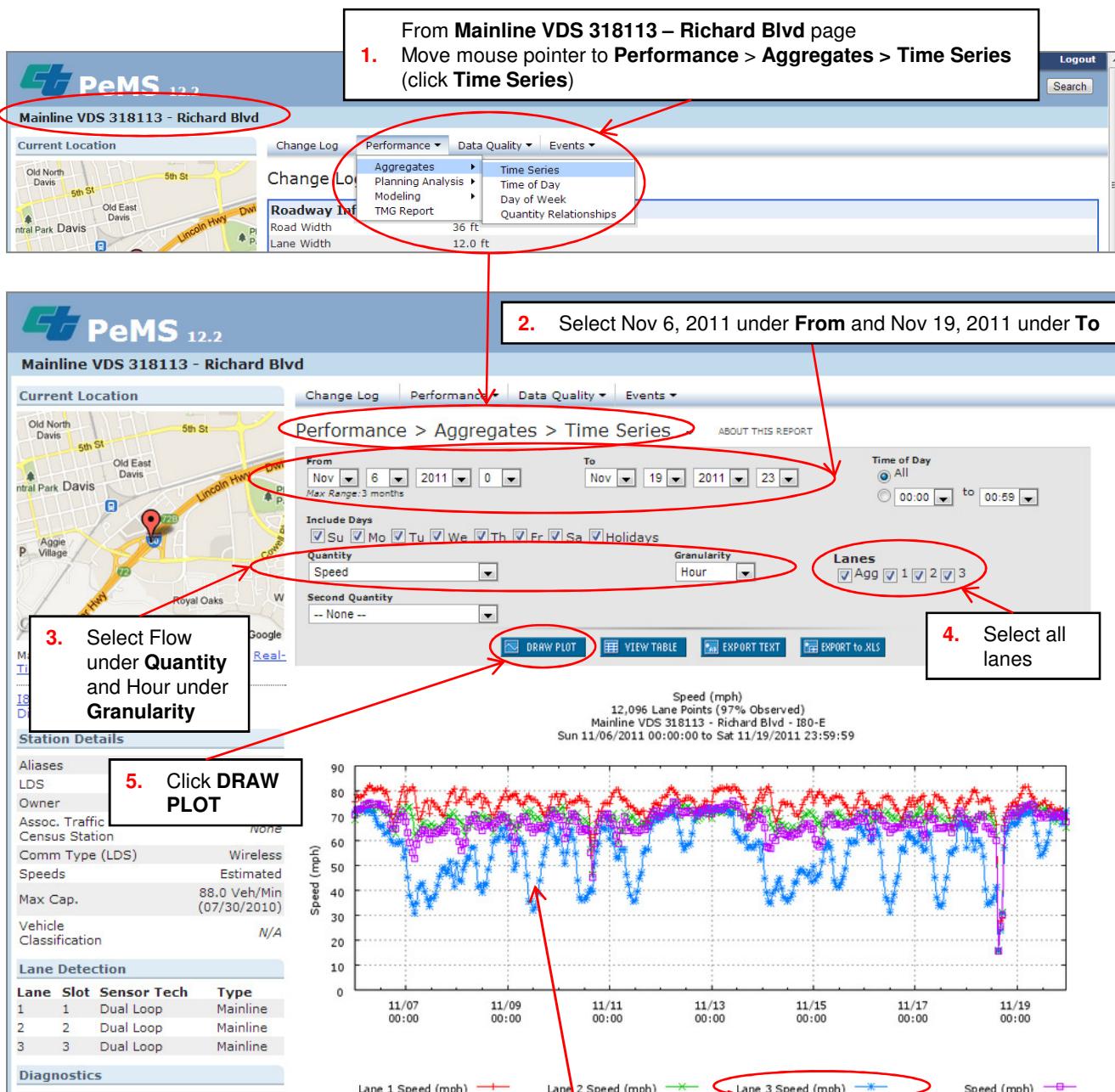
The screenshot shows the 'Performance > Planning Analysis > MADT' section highlighted. The 'From' and 'To' dropdowns are both set to '2011'. A red circle highlights the 'VIEW TABLE' button, which is also labeled '3. Click VIEW TABLE'. Below the table, a traffic diagram shows a four-lane highway with various traffic events and lane detection points.

Starting Month	2011
Jan	54,186
Feb	54,936
Mar	53,144
Apr	55,053
May	55,042
Jun	56,619
Jul	58,019
Aug	58,954
Sep	56,019
Oct	55,610
Nov	53,038
Dec	0

The District 3 Mainline VDS 318113 – Richards Blvd Aggregates > Planning Analysis report indicates that the month with the highest Monthly Annual Daily Traffic (MADT) in 2011 is August 2011 with about 59,000.

Answer 9 & 10

9. Among all the lanes, which lane is typically slowest during this two week period?
 - A. *The District 3 Mainline VDS 318113 – Richards Blvd Aggregates > Time Series report indicates that lane 3 is typically slowest (as was lowest flow – see question 4) during this two week period.*
10. If it typically has the lowest flow rates, why would the speeds also be the lowest among the lanes?
 - A. *With the lower speeds, likely from merging and weaving and higher truck traffic mix in the outer lane, flow is restricted.*



Answer 11 & 12

11. Calculate the density at this station at 4pm on November 17, 2011. What is the density value per lane (vehicles/hour/lane)?
 - A. The District 3 Mainline VDS 318113 – Richards Blvd Aggregates > Time Series report (see question 3 and 9) indicates that the flow on 11/17/2011 at 4pm was 4319 vehicles/hour and average speed across the lanes was 65.7 miles per hour. Density = Flow/Speed = $4319/65.7 = 65.71$ vehicles/mile. Per lane = $65.71 / 3$ lanes = 21.90 vehicles/hour/lane.
12. How might this PeMS value differ from the Highway Capacity Manual calculation value?
 - A. The PeMS value is a density (flow and speed) measured at the VDS 318113 location, where as the HCM value is calculated using various input quantities, equations, and empirical factors for a freeway segment.



Chapter 4 Exercise 2 Answers

Delay

1. What is a typical or average weekday daily delay ($V_t=60$) in the month of April 2012 for District 11 northbound I-805 (I805-N)? [hint: Aggregate plot]?
 - A. *The District 11 I805-N Aggregates > Time Series report indicates that the weekday daily delay is about 3,500 vehicle-hours at the $V_t=60$ threshold in the month of April 2012.*

Speeds & Bottlenecks

2. Plot the speed contour plot of District 11 I805-N mainline on April 12, 2012 from 6am to noon (6 to 12 hours). Where are the major bottlenecks (what absolute postmiles)? What are the congestion period and longest queue lengths?
 - A. *The Freeway I805-N in District 11 Spatial Analysis > Time Series Contours report indicates that on April 12, 2012 morning period, there were 4 bottlenecks at absolute post miles 12, 14, 16, and 23. The biggest bottleneck was at absolute post mile 23 with congestion period of 2 hours (from 7am to 9am) and queue length of 3 miles (from absolute post mile 20 to 23) with speeds below 30 miles per hour.*

Flow

3. What is the highest recorded hourly flow on District 11 I805-N on April 12, 2012? Where and what time of the day? What is the %Observed data quality for that station on that time and day?
 - A. *The Freeway I805-N in District 11 Spatial Analysis > Hourly Summary report indicates that on April 12, 2012 the highest hourly flow occurred at S/O MESA COLLEGE DR (VDS 1116119 with 100% observed data) at 10,726 vehicles/hour from 7am to 8am*

Chapter 4 Exercise 2 Answers
Freeway Spatial Level Analysis
Question 1 Answer

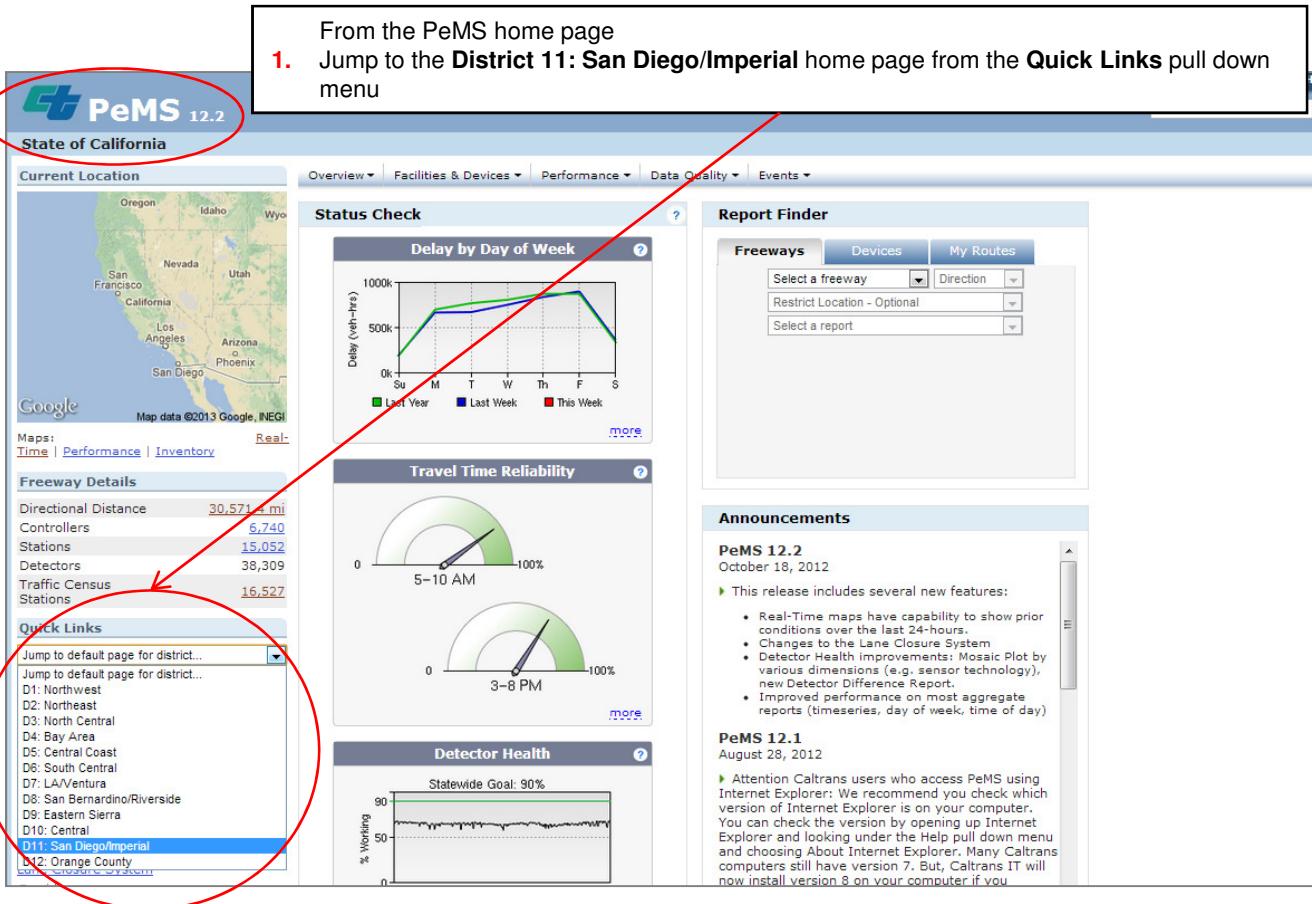
Answer 1

1. What is a typical or average weekday daily delay ($V_t=60$) in the month of April 2012 for District 11 northbound I-805 (I805-N)? [hint: Aggregate plot].

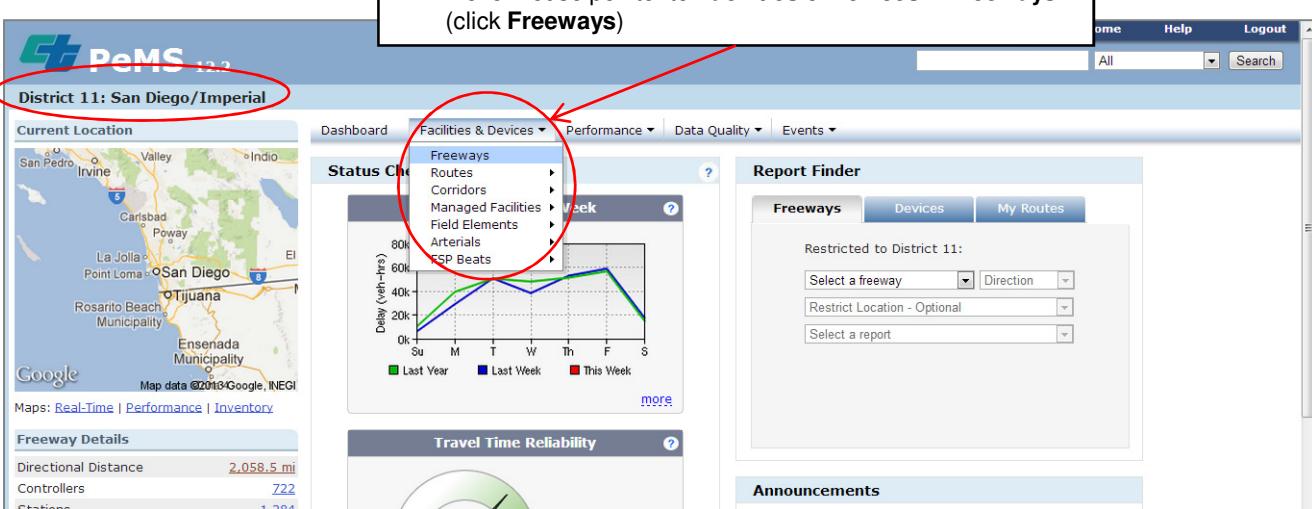
A. The District 11 I805-N Aggregates > Time Series report indicates that the weekday daily delay is about 3,500 vehicle-hours at the $V_t=60$ threshold in the month of April 2012.

From the PeMS home page

- Jump to the **District 11: San Diego/Imperial** home page from the **Quick Links** pull down menu



- From District 11: San Diego/Imperial home page
2. Move mouse pointer to **Facilities & Devices** > **Freeways** (click **Freeways**)



Chapter 4 Exercise 2 Answers

Freeway Spatial Level Analysis

Question 1 Answer

District 11: San Diego/Imperial

Facilities & Devices > Freeways

Fwy	Detection			Mainline Facilities			HOV Facilities			
	# LDSS	# VDSS	# Detectors	Total Miles	# VDSS	Miles	Lane Miles	# VDSS	Miles	
I5-N	120	168	568	72.3	107	71.4	306.5	7.8	8.0	9
I5-S	113	182	580	72.2	102	72.2	307.7	7.8	7.8	8
I8-E	38	62	196	171.9	43	28.2	105.4	0	0.0	0
I8-W	44	84	247	172.2	46	28.2	103.9	0	0.0	0
I15-N	58	112	346	54.5	51	53.5	237.9	15.6	15.6	3
I15-S	53	108	356	54.5	51	53.5	235.8	23.1	30.6	1
I805-N	51	89	278	28.7	46	28.7	122.4	0.5	0.5	0
I805-S	53	82	276	28.7	51	29.2	130.2	0	0.0	0

From Freeway I805-N in District 11 page

4. Move mouse pointer to Performance > Aggregates > Time Series (click Time Series)

Freeway I805-N in District 11

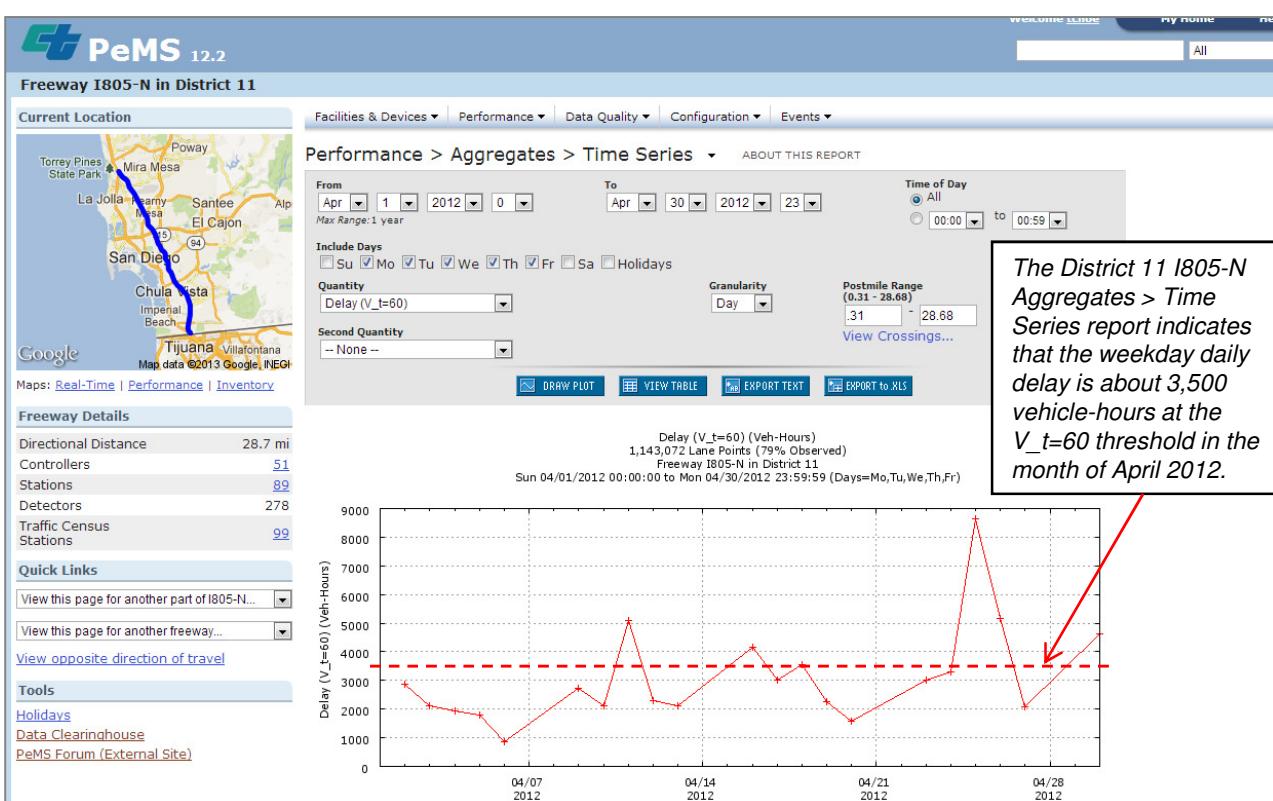
Performance > Aggregates > Time Series

Time Series

Day Apr 28 2012

Postmile Range (0.31 - 28.68) 31 28.68 Show Crossings

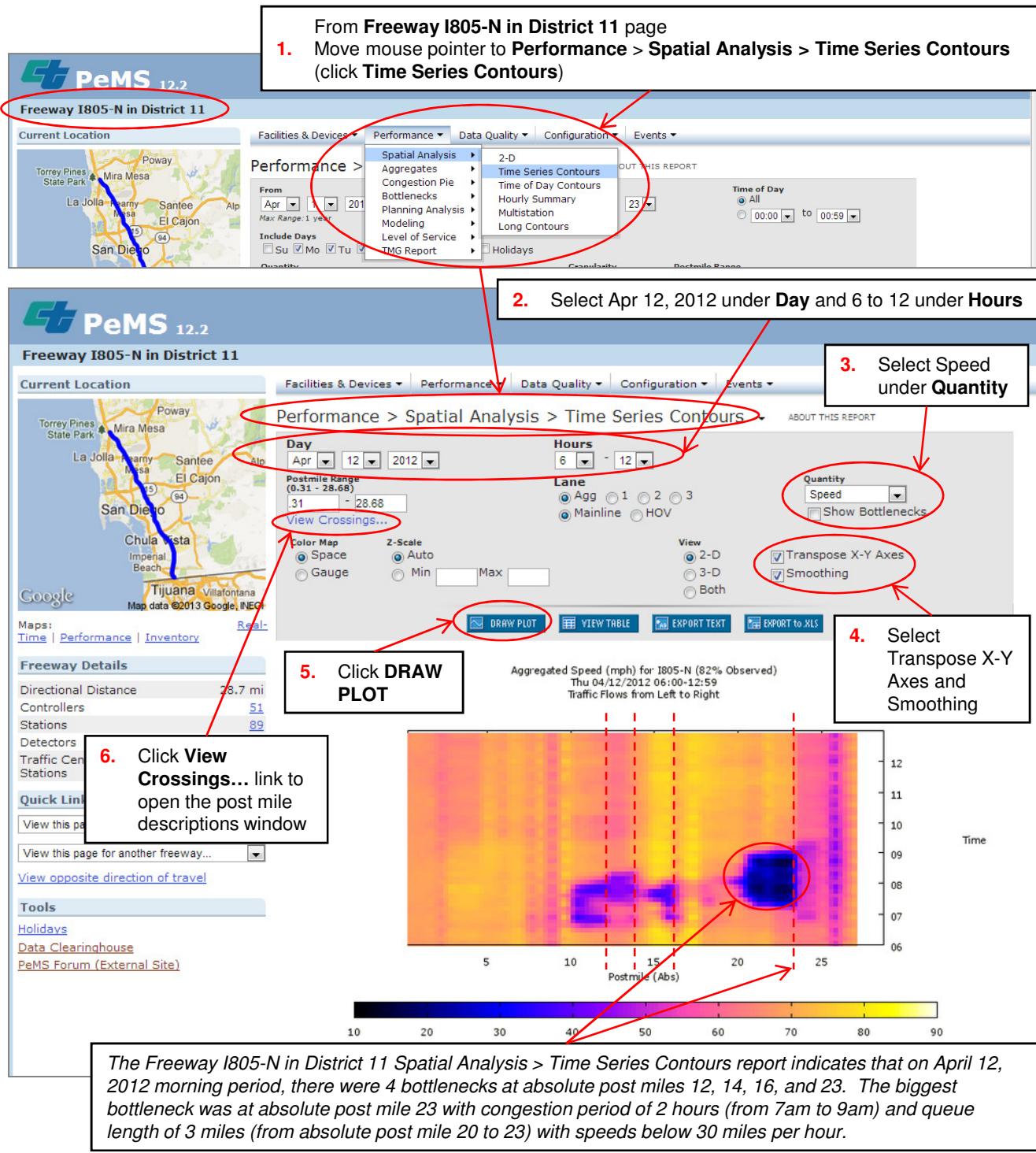
VIEW TABLE EXPORT TEXT EXPORT to XLS



Answer 2

2. Plot the speed contour plot of District 11 I805-N mainline on April 12, 2012 from 6am to noon (6 to 12 hours). Where are the major bottlenecks (what absolute postmiles)? What are the congestion period and longest queue lengths?

A. *The Freeway I805-N in District 11 Spatial Analysis > Time Series Contours report indicates that on April 12, 2012 morning period, there were 4 bottlenecks at absolute post miles 12, 14, 16, and 23. The biggest bottleneck was at absolute post mile 23 with congestion period of 2 hours (from 7am to 9am) and queue length of 3 miles (from absolute post mile 20 to 23) with speeds below 30 miles per hour.*



Chapter 4 Exercise 2 Answers
Freeway Spatial Level Analysis
Question 3 Answer

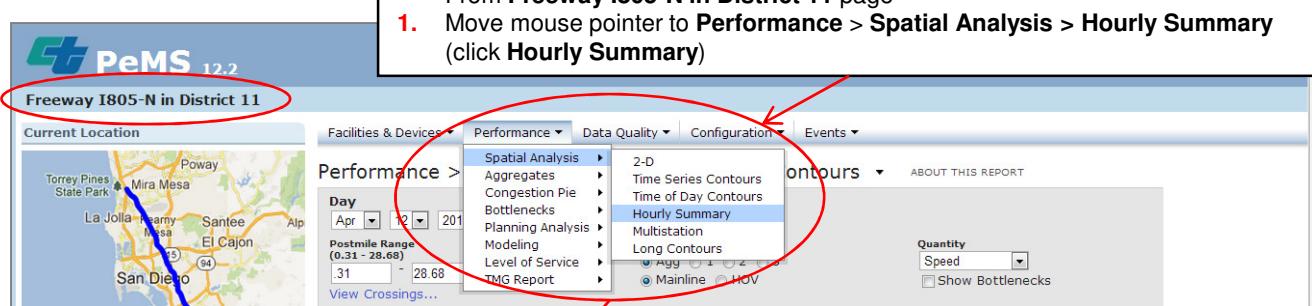
Answer 3

3. What is the highest recorded hourly flow on District 11 I805-N on April 12, 2012? Where and what time of the day? What is the %Observed data quality for that station on that time and day?

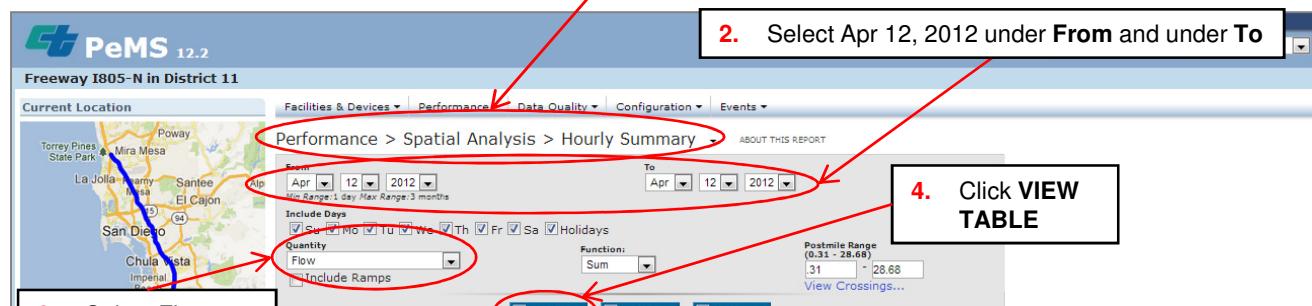
- A. The Freeway I805-N in District 11 Spatial Analysis > Hourly Summary report indicates that on April 12, 2012 the highest hourly flow occurred at S/O MESA COLLEGE DR (VDS 1116119 with 100% observed data) at 10,726 vehicles/hour from 7am to 8am.

From Freeway I805-N in District 11 page

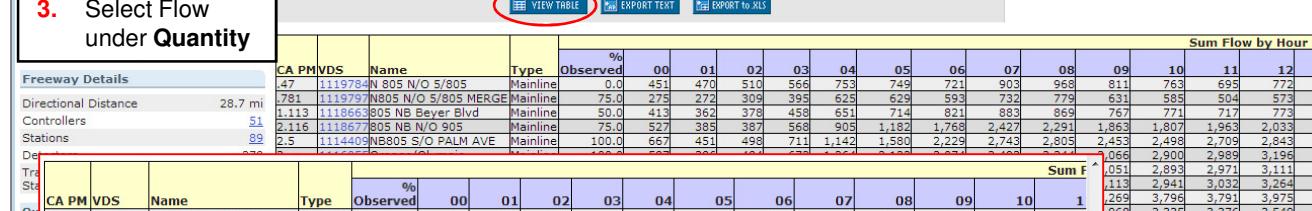
1. Move mouse pointer to Performance > Spatial Analysis > Hourly Summary (click Hourly Summary)



2. Select Apr 12, 2012 under From and under To



3. Select Flow under Quantity



4. Click VIEW TABLE



CA PM VDS	Name	Type	Sum Flow by Hour													
			% Observed	00	01	02	03	04	05	06	07	08	09	10	11	12
47	1119784 N 805 N/O 5/805	Mainline	0.0	451	470	510	566	753	749	721	903	968	811	763	695	772
.781	1119797 N805 N/O 5/805 MERGE	Mainline	75.0	275	272	309	395	625	629	593	732	779	631	585	504	573
1.113	1118663 N805 NB Beyer Blvd	Mainline	50.0	413	362	378	458	651	714	821	883	869	767	771	717	773
2.116	1118677 N805 NB N/O 905	Mainline	75.0	527	385	387	568	905	1,182	1,768	2,427	2,291	1,863	1,807	1,963	2,033
2.5	1114409 N805 S/O PALM AVE	Mainline	100.0	667	451	498	711	1,142	1,580	2,229	2,743	2,805	2,453	2,498	2,709	2,843
3	1116055 Orange/Olympic	Mainline	100.0	587	386	484	672	1,264	2,122	3,074	3,493	3,344	3,066	2,900	2,989	3,196
3.799	1116061 MAIN ST	Mainline	100.0	703	430	499	700	1,235	1,993	3,037	3,660	3,524	3,051	2,893	2,971	3,111
4.224	1115905 S/O ORANGE/OLYMPIC	Mainline	100.0	592	400	493	705	1,303	2,163	3,129	3,563	3,379	3,113	2,941	3,03	3,264
5.551	1120011 805 S/Telegraph	Mainline	100.0	687	406	539	738	1,588	3,074	4,585	5,276	4,831	4,269	3,796	3,549	3
6.21	1120272 S/Telegraph Cyn	Mainline	50.0	782	604	678	779	1,395	2,469	3,493	3,937	3,410	2,968	3,335	3,37	3,549
6.74	1120025 N805 NH SO H St	Mainline	100.0	702	468	558	896	1,761	3,712	6,408	5,890	5,488	4,833	4,156	4,474	4,559
7.08	1116413 West H St	Mainline	50.0	852	657	707	983	2,049	4,280	5,954	5,906	5,610	5,216	4,644	4,72	4,831
7.08	1116415 NB 805 off E st/bypass	Mainline	100.0	209	123	165	320	807	2,217	3,668	3,032	2,702	2,223	1,780	1,68	1,780
7.926	1120256 E St/Bonita Rd	Mainline	50.0	894	646	719	1,018	2,180	4,915	7,037	7,127	6,654	6,148	5,482	5,55	5,557
8.229	1120033 N805 NO 5/4	Mainline	100.0	587	380	440	618	1,504	3,629	5,954	5,705	5,267	4,731	4,052	3,99	4,474
9.976	1118131 NB805 S/O Plaza Blvd	Mainline	99.7	1,125	649											
10.456	1108448 PLAZA BLVD	Mainline	40.0	878	702											
11.092	1117980 NB 805 @ DIVISION	Mainline	99.7	683	449											
11.524	1108446 47TH ST	Mainline	50.0	776	558											
13.268	1108441 MARKET ST	Mainline	50.0	852	608											
14.035	1108408 HOME AVE	Mainline	99.7	535	334											
14.356	1119383 NB 805 S/O 15	Mainline	19.9	867	680											
15.32	1111572 NB 805 @ 15	Mainline	99.7	408	283											
16.08	1118908 N805 N/O University	Mainline	99.7	519	403											
16.549	1108403 EL CAJON BLVD	Mainline	99.7	419	348											
16.826	1118915 N 805 N/O El Cajon	Mainline	74.7	542	459	516	779	1,743	1,671	7,685	7,740	6,69	5,266	4,344	3,89	
17.364	1118924 NB 805 S/O 8	Mainline	99.7	366	288	236	605	1,541	4,315	7,359	7,540	7,216	4,626	3,648	3,32	
18.39	1116112 N/O 8	Mainline	80.0	630	551	546	850	2,021	5,754	10,283	10,614	8,219	7,130	5,843	5,26	
18.555	1119345 S/O MURRAY RIDGE RD	Mainline	80.0	543	425	474	783	1,880	5,348	9,820	10,376	8,595	6,523	5,300	4,57	
19	1108572 MURRAY RIDGE RD	Mainline	100.0	492	367	422	742	1,856	5,409	9,913	10,430	8,729	6,557	5,314	4,62	
19.54	1116119 S/O MESA COLLEGE DR	Mainline	100.0	513	376	427	752	1,885	5,452	10,096	10,726	9,024	6,772	5,515	4,83	
19.97	1116120 S/O MESA COLLEGE	Mainline	100.0	364	272	303	552	1,379	3,991	7,041	7,231	5,949	4,498	3,644	3,22	
20.29	1116133 N/O MESA COLLEGE	Mainline	100.0	451	336	384	707	1,760	5,044	8,928	9,107	7,568	5,630	4,627	4,06	
20.55	1116121 N/O MESA COLLEGE	Mainline	100.0	460	367	321	610	1,503	4,140	7,301	7,541	5,661	4,741	3,612	3,20	

The Freeway I805-N in District 11 Spatial Analysis > Hourly Summary report indicates that on April 12, 2012 the highest hourly flow occurred at S/O MESA COLLEGE DR (VDS 1116119 with 100% observed data) at 10,726 vehicles/hour from 7am to 8am.

Answers to Exercises

A-28

Appendix

Chapter 4 Exercise 3 Answers

Travel Time

1. What is the District 7 I605-N Routes? What is the distance of that Route?
 - A. *The District 7 I605-N Route is the Route 571: D07 605N – 405 to 210. There are 25.5 miles in the Route.*

2. Plot the mainline weekday travel time by time of day for month of April, 2012. What is the free flow travel time? What is the am and pm peak hour mean travel time.
 - A. *The free flow travel time for the 25.5 mile Route I605-N is approximately 21 minutes (red line). The am peak hour mean travel time is approximately 28 minutes and the pm peak hour mean travel time is approximately 29 minutes.*

3. Plot the HOV weekday travel time. What is the am and pm peak hour mean travel time?
 - A. *The 20.5 mile Route I605-N HOVL has am peak hour mean travel time of approximately 25 minutes and pm peak hour mean travel time of approximately 27 minutes.*

Chapter 4 Exercise 3 Answers
Freeway Spatial (Module) Level Analysis
Question 1 Answer

Answer 1

1. What is the District 7 I605-N Routes? What is the distance of that Route?

A. The District 7 I605-N Route is the Route 571: D07 605N – 405 to 210. There are 25.5 miles in the Route.

From the PeMS home page

1. Jump to the **District 7: VA/Ventura** home page from the **Quick Links** pull down menu

The screenshot shows the PeMS 12.2 home page for the State of California. A red circle highlights the 'PeMS 12.2' logo in the top left. Another red circle highlights the 'Quick Links' dropdown menu in the bottom left, which contains options like 'Jump to default page for district...', 'D1: Northwest', 'D2: Northeast', etc., with 'D7: LA/Ventura' selected. A third red circle highlights the 'Status Check' section, specifically the 'Delay by Day of Week' chart showing data for Last Year, Last Week, and This Week. A fourth red circle highlights the 'Travel Time Reliability' section with two gauge charts for 5-10 AM and 3-8 PM. A fifth red circle highlights the 'Detector Health' section showing a line graph of '% Working' over time.

From District 7: LA/Ventura home page

2. Move mouse pointer to **Facilities & Devices** > **Routes** (click **Routes**)

The screenshot shows the District 7: LA/Ventura home page. A red circle highlights the 'District 7: LA/Ventura' logo in the top left. A second red circle highlights the 'Facilities & Devices' dropdown menu in the top right, with 'Routes' selected. A third red circle highlights the 'Status Check' section, specifically the 'Routes' chart showing delay over the last year, week, and day. A fourth red circle highlights the 'Report Finder' section with the 'Restricted to District 7' checkbox checked.

Chapter 4 Exercise 3 Answers
Freeway Spatial (Module) Level Analysis
Question 1 Answer

In the District 7: LA/Ventura Routes > Listing page,

3. Click on the page 2 link

Dist	Name	Start	End	Roadway	Length (Miles)	HOV (Miles)	# Stations
D7	105_110_91_57_Imperial	105-E/Atwood Way	57-N/State Hwy 90	Freeway	35.5	28.1	139
D7	105_605_91_57_Imperial	105-E/Atwood Way	57-N/State Hwy 90	Freeway	34.0	28.0	147
D7	10w 17th - Bundy	10-W/17th St	10-W/Bundy Dr	Freeway	10.5		29
D7	210W-FruitToLake	210-W/Fruit St	210-W/Lake/Maple St	Freeway	21.3		88
D7	210WVernon-Maple	210-W/Vernon/Hollyvale St	210-W/Maple St	Freeway	13.5		56
D7	405 Santa Monica Blvd (near) to 710 South	405-S/Beloit/State Hwy 2	405-S/Wardlow Rd	Freeway	22.3	18.0	106
D7	405N from 710 to Santa Monica Blvd	405-N/Wardlow Rd	405-N/State Hwy 2	Freeway	24.3	20.0	106
D7	405_22_55_91_57_Imperial	405-S/El Segundo Blvd	57-N/State Hwy 90	Freeway	45.2	36.3	219
D7	405_22_57_Imperial	405-S/El Segundo Blvd	57-N/State Hwy 90	Freeway	41.0	33.0	219
D7	beat 39	105-E/State Hwy 1	105-E/Central Ave	Freeway	8.0	6.3	34
D7	CMIA D7 210E from I-5 TO I-710	210-E/Yarnell St	210-E/Corson St	Freeway	24.8	1.0	36
D7	CMIA D7 405N from I-10 TO I-5	405-N/Sepulveda Blvd	405-N/Orion Ave	Freeway	19.0	8.3	43
D7	CMIA D7 from I-10W to SR-118	405-N/Cummings/4th St	5-N/Chatsworth Dr	Freeway	22.0	0.4	36
D7	CMIA D7 from Ora/LA Co line to I-10	5-N/Firestone Blvd	5-N/Ditman/Dennison St	Freeway	13.3		31
D7	CMIA D7 I-405 from I-110 to US-101	405-N/Avalon Blvd	405-N/Burbank Blvd	Freeway	28.8	16.6	96
D7	Corridor: 1A: Los Angeles I-5 - Primary	7	7	Freeway	13.8		33
D7	Corridor: 1A: Los Angeles I-5 - Secondary	7	7	Freeway	13.8		34
D7	Corridor: 1B: Los Angeles I-5 - Primary	7	7	Freeway	20.9		34
D7	Corridor: 1B: Los Angeles I-5 - Secondary	7	7	Freeway	20.9		39
D7	Corridor: 26: Santa Barbara US-101 - Primary	7	7	Freeway	0.0		0

4. Click on D07 607N Route link

Dist	Name	Start	End	Roadway	Length (Miles)	HOV (Miles)	# Stations
D7	Corridor: 26: Santa Barbara US-101 - Secondary	7	7	Freeway	0.0		0
D7	Corridor: 2: Los Angeles I-405 - Primary	7	7	Freeway	26.5	14.3	88
D7	Corridor: 2: Los Angeles I-405 - Secondary	7	7	Freeway	26.5	22.2	103
D7	D07 605N - 405 to 210	605-N/Spring St	605-N/Mount Olive/Huntington Dr S.E./San Fernando Mission	Freeway	25.5	20.5	94

Route 571: D07 605N - 405 to 210

The District 7 I605-N Route is the Route 571: D07 605N – 405 to 210. There are 25.5 miles in that Route. Route was created on 1/1/2006.

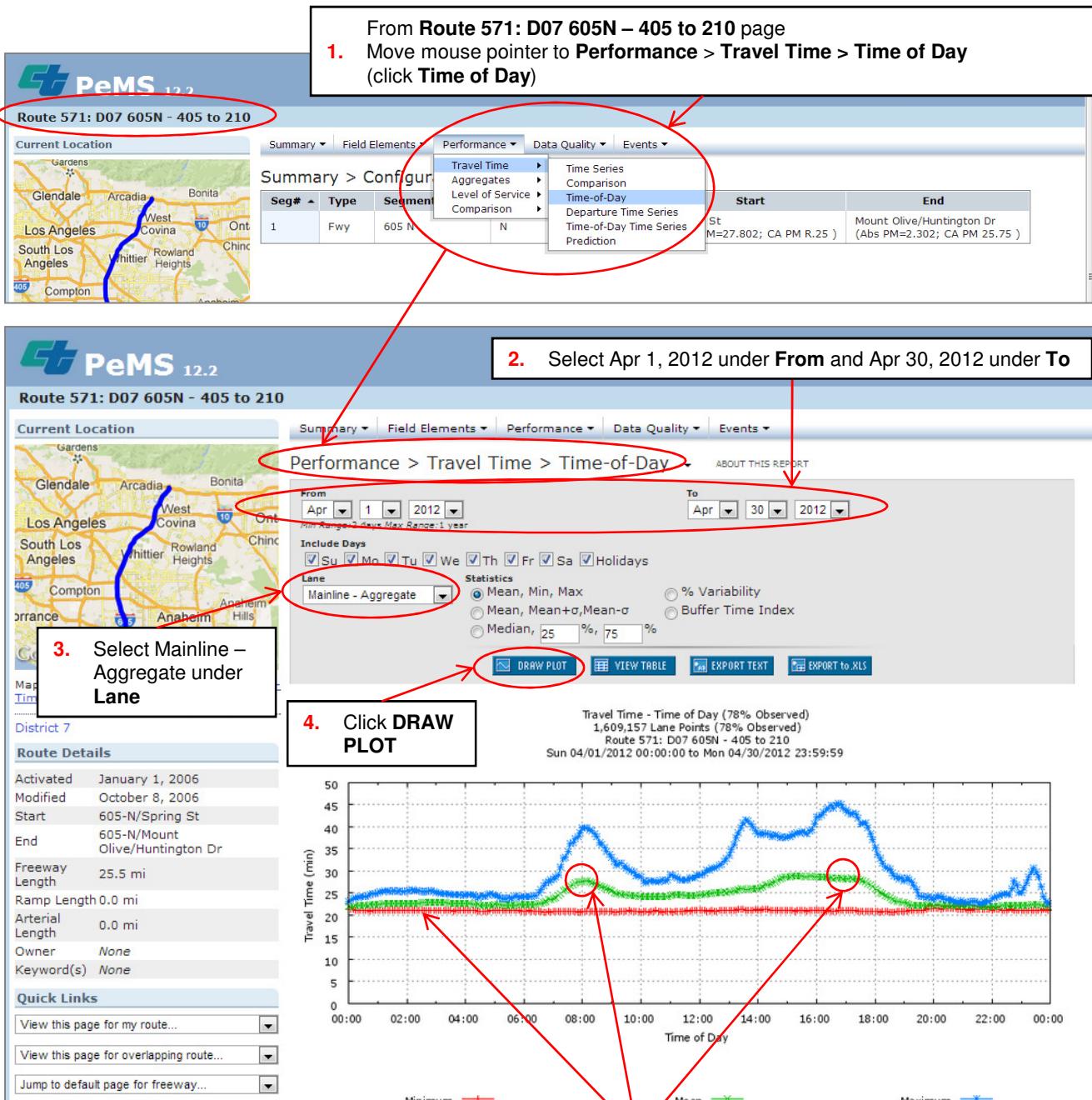
Seg#	Type	Segment Name	Direction	Length(mi)	Start	End
1	Fwy	605 N	N	25.5	Spring St (Abs PM=27.802; CA PM R.25)	Mount Olive/Huntington Dr (Abs PM=2.302; CA PM 25.75)

Chapter 4 Exercise 3 Answers
Freeway Spatial (Module) Level Analysis
Question 2 Answer

Answer 2

2. Plot the mainline weekday travel time by time of day for month of April, 2012. What is the free flow travel time? What is the am and pm peak hour mean travel time?

A. *The free flow travel time for the 25.5 mile Route I605-N is approximately 21 minutes (red line). The am peak hour mean travel time is approximately 28 minutes and the pm peak hour mean travel time is approximately 29 minutes.*



Chapter 4 Exercise 3 Answers
Freeway Spatial (Module) Level Analysis
Question 3 Answer

Answer 3

3. Plot the HOV weekday travel time. What is the am and pm peak hour mean travel time?
- A. The 20.5 mile Route I605-N HOVL has am peak hour mean travel time of approximately 25 minutes and pm peak hour mean travel time of approximately 27 minutes.

