MEETING NOTICE
AND AGENDA

TRANSPORTATION INDEPENDENT TAXPAYER
OVERSIGHT COMMITTEE (ITOC)
The ITOC may take action on any item appearing on this agenda.

Wednesday, December 7, 2005
9:30 a.m. to 3:30 p.m.

SANDAG, Conference Room 8A
401 B Street, Suite 800
San Diego, CA  92101-4231

Staff Contact:  Craig Scott
(619) 699-1926
csc@sandag.org

SANDAG offices are accessible by public transit.
Phone 1-800-COMMUTE or see www.sdcommute.com for route information.

In compliance with the Americans with Disabilities Act (ADA), SANDAG will
accommodate persons who require assistance in order to participate in
SANDAG meetings. If such assistance is required, please contact SANDAG at
(619) 699-1900 at least 72 hours in advance of the meeting.

To request this document or related reports in an alternative format, please
call (619) 699-1900, (619) 699-1904 (TTY), or fax (619) 699-1905.
Welcome to SANDAG. Members of the public may speak to the TransNet Independent Taxpayer Oversight Committee (ITOC) members on any item at the time the ITOC is considering the item. Also, members of the public are invited to address the ITOC on any issue under the agenda item entitled Public Comments/Communications/Member Comments. Speakers are limited to three minutes. The ITOC may take action on any item appearing on the agenda.

This agenda and related staff reports can be accessed at www.sandag.org under Meetings on SANDAG’s Web site. Public comments regarding the agenda can be forwarded to SANDAG via the e-mail comment form also available on the Web site. E-mail comments should be received no later than noon, two working days prior to the ITOC meeting.

In compliance with the Americans with Disabilities Act (ADA), SANDAG will accommodate persons who require assistance in order to participate in SANDAG meetings. If such assistance is required, please contact SANDAG at (619) 699-1900 at least 72 hours in advance of the meeting. To request this document or related reports in an alternative format, please call (619) 699-1900, (619) 699-1904 (TTY), or fax (619) 699-1905.

SANDAG offices are accessible by public transit. Phone 1-800-COMMUTE or see www.sdcommute.com for route information.
+1. SUMMARIES OF THE OCTOBER 19, 2005 INDEPENDENT TAXPAYER OVERSIGHT COMMITTEE MEETING AND THE NOVEMBER 2, 2005 SPECIAL MEETING

Meeting summaries for the October 19, 2005 meeting and the November 2nd Special Meeting were distributed to the ITOC prior to the last meeting. The item was carried over to this meeting for action.

+2. SUMMARY OF THE NOVEMBER 9, 2005 INDEPENDENT TAXPAYER OVERSIGHT COMMITTEE MEETING

The meeting summary for the November 9, 2005 meeting has been prepared for the ITOC’s consideration.

3. PUBLIC COMMENTS/COMMUNICATIONS/MEMBER COMMENTS

Members of the public will have the opportunity to address the ITOC on any issue within the jurisdiction of the ITOC. Speakers will be limited to three minutes each. Committee members also may provide information and announcements under this agenda item.

+4. DRAFT TransNet PLAN OF FINANCE FOR THE EARLY ACTION PROGRAM – ANALYSIS OF COST/BENEFIT OF BONDING (Elisa Arias)

At the last two meetings, the ITOC discussed the draft TransNet Plan of Finance and supported moving forward assuming the use of bonding to deliver the Early Action Program. The ITOC requested additional information on the methodology used in preparing the cost/benefit analysis included in the draft Plan of Finance. The attached memo provides additional detail on the methodology used in estimating the benefits associated with delivering the Early Action Program on the accelerated project schedules assumed in the bonding scenario.

+5. DRAFT RECOMMENDATIONS ON PROGRAM MANAGEMENT AND QUARTERLY REPORTING (Jack Boda/PBS&J)

PBS&J has completed its review of the SANDAG/Caltrans project/program management process and has developed recommendations to be presented for review and comment by the ITOC. These recommendations relate to the ITOC’s roles under Paragraphs 3 and 10 of the TransNet Extension Ordinance. The draft PBS&J report and related materials are provided for consideration by the ITOC.
<table>
<thead>
<tr>
<th>ITEM #</th>
<th>RECOMMENDATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.</td>
<td><strong>TransNet ENVIRONMENTAL MITIGATION PROGRAM</strong></td>
</tr>
<tr>
<td></td>
<td>(Janet Fairbanks)</td>
</tr>
<tr>
<td></td>
<td>INFORMATION</td>
</tr>
<tr>
<td></td>
<td>At an earlier meeting, ITOC members requested a</td>
</tr>
<tr>
<td></td>
<td>presentation on the new Environmental Mitigation</td>
</tr>
<tr>
<td></td>
<td>Program (EMP) that was included in the TransNet</td>
</tr>
<tr>
<td></td>
<td>Extension. SANDAG staff will provide an overview</td>
</tr>
<tr>
<td></td>
<td>of the EMP program and update the ITOC on the</td>
</tr>
<tr>
<td></td>
<td>status of key activities underway to implement</td>
</tr>
<tr>
<td></td>
<td>the provisions of the EMP.</td>
</tr>
<tr>
<td>7.</td>
<td>**2007 REGIONAL TRANSPORTATION PLAN (RTP)</td>
</tr>
<tr>
<td></td>
<td>PERFORMANCE MEASURES AND TRANSPORTATION PROJECT</td>
</tr>
<tr>
<td></td>
<td>EVALUATION CRITERIA** (Mike Hix and Rachel</td>
</tr>
<tr>
<td></td>
<td>Kennedy)</td>
</tr>
<tr>
<td></td>
<td>DISCUSSION/</td>
</tr>
<tr>
<td></td>
<td>POTENTIAL ACTION</td>
</tr>
<tr>
<td></td>
<td>As a follow-up to the discussion at the last</td>
</tr>
<tr>
<td></td>
<td>meeting, staff will provide an overview of the</td>
</tr>
<tr>
<td></td>
<td>process to be followed as part of the development</td>
</tr>
<tr>
<td></td>
<td>of the 2007 RTP in updating and refining</td>
</tr>
<tr>
<td></td>
<td>performance measures and project evaluation</td>
</tr>
<tr>
<td></td>
<td>criteria. This work relates to the ITOC’s</td>
</tr>
<tr>
<td></td>
<td>responsibilities under Paragraph #6 from the</td>
</tr>
<tr>
<td></td>
<td>TransNet Extension Ordinance. The ITOC should</td>
</tr>
<tr>
<td></td>
<td>discuss how it should participate as part of the</td>
</tr>
<tr>
<td></td>
<td>RTP development process and to what extent</td>
</tr>
<tr>
<td></td>
<td>additional effort and potential consultant</td>
</tr>
<tr>
<td></td>
<td>assistance may be required.</td>
</tr>
<tr>
<td>8.</td>
<td><strong>FUTURE MEETING SCHEDULE AND AGENDA TOPICS</strong></td>
</tr>
<tr>
<td></td>
<td>ACTION</td>
</tr>
<tr>
<td></td>
<td>The dates shown below have been suggested as</td>
</tr>
<tr>
<td></td>
<td>potential meeting dates from 9:30 a.m. to 3:30 p.m.</td>
</tr>
<tr>
<td></td>
<td>The next meeting date and time is to be</td>
</tr>
<tr>
<td></td>
<td>confirmed at the end of each meeting. The ITOC</td>
</tr>
<tr>
<td></td>
<td>may wish to suggest specific agenda topics for</td>
</tr>
<tr>
<td></td>
<td>the next meeting. Potential topics for the next</td>
</tr>
<tr>
<td></td>
<td>meeting include an overview of the $2,000 per</td>
</tr>
<tr>
<td></td>
<td>dwelling unit private funding contribution</td>
</tr>
<tr>
<td></td>
<td>required as part of the TransNet Extension</td>
</tr>
<tr>
<td></td>
<td>Ordinance, the ITOC’s role in the Regional</td>
</tr>
<tr>
<td></td>
<td>Transportation Improvement Program (RTIP) process,</td>
</tr>
<tr>
<td></td>
<td>and a presentation on the ASCE’s second annual</td>
</tr>
<tr>
<td></td>
<td>report card on infrastructure in San Diego County.</td>
</tr>
<tr>
<td></td>
<td>- January 18, 2006</td>
</tr>
<tr>
<td></td>
<td>- February 15, 2006</td>
</tr>
<tr>
<td></td>
<td>- March 15, 2006</td>
</tr>
<tr>
<td></td>
<td>- April 19, 2006</td>
</tr>
<tr>
<td></td>
<td>- <strong>May 17, 2006</strong></td>
</tr>
<tr>
<td></td>
<td>- June 21, 2006</td>
</tr>
<tr>
<td></td>
<td>- July 19, 2006</td>
</tr>
<tr>
<td></td>
<td>- August 16, 2006</td>
</tr>
<tr>
<td></td>
<td>- September 20, 2006</td>
</tr>
<tr>
<td></td>
<td>- October 18, 2006</td>
</tr>
<tr>
<td></td>
<td>- November 15, 2006</td>
</tr>
<tr>
<td></td>
<td>- December 20, 2006</td>
</tr>
<tr>
<td>9.</td>
<td><strong>ADJOURNMENT</strong></td>
</tr>
<tr>
<td></td>
<td>+ next to an agenda item indicates an attachment</td>
</tr>
</tbody>
</table>
SUMMARIES OF THE OCTOBER 19, 2005 INDEPENDENT TAXPAYER OVERSIGHT COMMITTEE MEETING AND THE NOVEMBER 2, 2005 SPECIAL MEETING

October 19, 2005 Meeting Summary:

Attendance-

Committee Members:  ▪ Maryam Babaki ▪ Jim Callaghan
▪ Michael Boyle ▪ John Meyer
▪ Jim Ryan

Ex-Officio Members: ▪ Gary Gallegos ▪ Tracy Sandoval

Others: ▪ Gail Brydges, City of Coronado ▪ Jack Boda, SANDAG
▪ Harvey Goodfriend, San Diego Taxpayers Association ▪ Richard Chavez, SANDAG
▪ Jim Ryan ▪ Craig Scott, SANDAG

The following summarizes the major actions and key discussion points under each agenda item from the October 19, 2005, meeting.

Item 1 - Meeting Summaries for the September 14, 2005, Meeting and the September 22, 2005, Special Meeting

The meeting summaries for the September 14, 2005, meeting and the September 22, 2005, special meeting were approved as written.

Item 2 - Public Comments/Communications/Member Comments

There were no public comments.
Item 3 – Workshop on Transportation System Performance Measurement and Overview of the Freeway Performance Measurement System (PeMS)

This item was structured as a special workshop for the ITOC on performance measurement conducted by Dr. Pravin Varaiya from U.C. Berkeley, Dr. Karl Petty from Berkeley Transportation Systems, Inc., and Tarek Hatata from System Metrics Group, Inc. The session began with an overview of system management and freeway performance measurement led by Tarek Hatata (see attached PowerPoint slides for greater detail on his presentation). Tarek described the role of system management as part of the overall transportation planning process and the evolution of Caltrans’ efforts in performance measurement leading up to the development of PeMS. He reviewed some of the efforts underway at SANDAG to expand PeMS in the San Diego region beyond the freeway system to include data for transit and local streets and roads.

Karl Petty then went into a more detailed description of PeMS in terms of how it was developed, the kind of data that is used, the types of reports and graphs that are available through PeMS, who uses the information, and what they do with it. He went through several examples of how to drill down through the available data to answer specific questions related to analyzing bottlenecks, level of service plots, average daily traffic (ADT) variations, route planning, and causes of congestion. He presented several dashboard-style reports that are available through PeMS. Dr. Petty led the ITOC through a “hands on” demonstration of several of the key features of PeMS. A copy of Dr. Petty’s PowerPoint slides is attached for further detail on his presentation.

Item 4 – Performance Measurement and the ITOC’s Roles and Responsibilities

Following the PeMS demonstration, Dr. Varaiya reviewed some key findings based on PeMS analysis work conducted on the statewide highway system. He highlighted traffic control measures such as ramp metering and improved traveler information systems as the most cost-effective ways of reducing congestion. He highlighted findings for San Diego’s freeway system as well. The ten worst bottlenecks were estimated to account for 61 percent of all bottleneck-related delay. It was pointed out that none of the ten areas were slated for improvement as part of the TransNet Extension. The proposed improvements on I-15 were mentioned as good candidates for evaluation through PeMS. The current data being collected for I-15 could be compared against the forecasted improvements expected from the implementation of the HOV/Managed Lane project. Then, after completion, the actual results could be compared against the forecasts to see if the project accomplished what it was expected to accomplish. A copy of Dr. Varaiya’s PowerPoint slides is attached for greater detail on his presentation.

The ITOC discussed ways in which it could take the information provided on performance measures and use it in carrying out the ITOC’s responsibilities. The possibility was discussed of using experts such as those present today to help the ITOC in conducting its work related to performance measurement. After discussion, it was decided to form an Ad Hoc Subcommittee consisting of Mike Boyle, Maryam Babaki, and Jim Ryan to work on a scope of work for the ITOC’s efforts in the performance measurement area. This work effort was to begin after the ITOC heard the results of the PBS&J recommendations related to program management.
Item 5 – Bylaws and Implementation Procedures

Maryam Babaki provided an overview of the Bylaw Subcommittee’s efforts in developing the draft bylaws being presented for the ITOC’s consideration. The Subcommittee reviewed the details of the TransNet Ordinance and bylaws developed for other oversight committees as background for preparation of the draft ITOC bylaws. She reviewed several issues that had been highlighted based on comments received to date for further discussion by the ITOC. A number of additional comments were raised by ITOC members. The bylaws were deferred to the next meeting for further discussion and action by the ITOC.

Item 6 – Future Meeting Schedule

The next ITOC meeting was scheduled for November 2, 2005, from 11:00 a.m. to 3:00 p.m. at SANDAG. Future meeting dates have been reserved for November 9, and December 7, 2005. The November 2, 2005, meeting was set as a special meeting to discuss the draft TransNet Plan of Finance, interest rate hedging strategies, and TransNet annual audit procedures. Action on the draft bylaws also was scheduled for that special meeting.

Item 7 – Adjournment

The meeting was adjourned at 3:45 p.m.

Attachments: System Management and Freeway Performance Measurement PowerPoint slides
PeMs PowerPoint slides
San Diego Freeway Congestion PowerPoint slides
Overview

October 19, 2005
Agenda

- What is System Management
- Freeway Performance Measurement
- Designing for Multi-modal Performance Measurement
What is System Management?
The corridor system management plan is an evolving effort that is consistent with a maturing transportation system.
Its foundation is detailed performance measurement and evaluation related to statewide and regional goals and other priorities

- Mobility Mission – Delay, speed, travel time
- Safety Goal – Accident Rates
- Reliability Goal – Variation of travel time
- Productivity Goal – Percent utilization during peak demand conditions
- Flexibility – Modal shares of demand (mode split and trend thereof)
- Preservation Needs
- Identification and analysis of bottlenecks
Maintenance now can save a lot later

- What are current pavement conditions?
- What and when are preservation projects needed?
- What are the repercussions of delaying these projects
Deferring pavement preservation investment can end up costing the State and region a lot more in the future.

- Where is each corridor (or segments thereof) on this graph? How much more will it cost if we wait?
Demand management relates to policies and strategies that help reduce demand during peak conditions.

- Land use strategies (long term)
- Parking costs, tolls
- HOT Lanes
- Carpooling incentives
- Other
Incidents (including collisions) cause a high percentage of overall congestion – reducing incidents and incident recovery times is critical

▸ How many collisions and incidents does the freeway system (or corridor) experience?

▸ What type of collisions and incidents can be averted and how?

▸ What can we do to reduce recovery from collisions and incidents?
We also need to evaluate traffic control effectiveness and potential

- What improvements to ramp metering and arterial signal management can directly address congestion?
- What are the resulting freeway improvements?
- What are the impacts on the arterials?
- What are the “Net” impacts?
Operational improvements are targeted investments in (smaller) physical projects that facilitate traffic flow and reduce congestion

- What operational improvements are targeted at the critical regional freeway bottlenecks?
- Which of these improvements are programmed and planned for?
Expansion projects are generally the most expensive and take a long time to implement

- Major expansion projects on freeways and other modes can reduce congestion on specific corridors
- The benefit cost ratios (or return on investment) of major expansion projects are generally lower than operational strategies
Freeway Performance Measurement
Transportation agencies have traditionally focused on delay caused by congestion for freeway performance (e.g., Caltrans’ Highway Congestion Monitoring Report).
... and total congested directional miles

![Graph showing total congested directional miles for various districts from 1987 to 2003.](chart)

- **District 3 - Marysville**
- **District 4 - Oakland**
- **District 5 - San Luis Obisbo**
- **District 6 - Fresno**
- **District 7 - Los Angeles**
- **District 8 - San Bernardino**
- **District 10 - Stockton**
- **District 11 - San Diego**
- **District 12 - Irvine**

Legend:
- Blue: District 3 - Marysville
- Red: District 4 - Oakland
- Orange: District 5 - San Luis Obisbo
- Blue: District 6 - Fresno
- Black: District 7 - Los Angeles
- Red: District 8 - San Bernardino
- Green: District 10 - Stockton
- Blue: District 11 - San Diego
- Green: District 12 - Irvine

*Note: The chart includes data points for years 1987 to 2003.*
The HICOMP also identified locations and associated durations of congestion
The HICOMP also identified locations and associated durations of congestion.
For system management purposes, we need additional performance measurement

- How productive is our system when we need it most (i.e., during peak demand conditions)?
- How variable are travel times on selected corridors, or between selected origin-destination pairs?
- Where are the major bottlenecks on our corridors?
- How much of the congestion is due to accidents and incidents?
In general, freeway productivity can be significantly lower during peak demand conditions than its design capacity.

Source: Performance Measurement System (PeMS) – October 2001

Vphpl: volume per lane per hour

Lost Productivity

As speeds drop, flow rates diminish significantly

I-405 SB
Postmile 31.93
Los Angeles
10/19/2001

System Metrics Group, Inc.
Aggregating productivity losses for a corridor or for a region provides for a sense of how much can be re-captured “theoretically” without expanding the system.

<table>
<thead>
<tr>
<th>Time Period</th>
<th>I-880 Northbound</th>
<th>I-880 Southbound</th>
</tr>
</thead>
<tbody>
<tr>
<td>AM</td>
<td>4.3</td>
<td>4.4</td>
</tr>
<tr>
<td>Midday</td>
<td>1.6</td>
<td>1.5</td>
</tr>
<tr>
<td>PM</td>
<td>5.8</td>
<td>4.7</td>
</tr>
<tr>
<td>Night</td>
<td>0.5</td>
<td>0.5</td>
</tr>
</tbody>
</table>
Travel times and variability of travel time (or reliability) can be computed for a corridor or an Origin Destination pair.
Bottlenecks can be identified using speed contour maps
Note that bottlenecks change in severity from day to day

Northbound AM

Aggregated Speed (mph) for I-880N
01/23/2003 06:00-10:59
Traffic Flows from Bottom to Top
Bottlenecks change in severity from day to day

Northbound AM

Aggregated Speed (mph) for I-880N
03/12/2003 06:00-10:59
Traffic Flows from Bottom to Top
Bottlenecks change in severity from day to day

Northbound AM

Aggregated Speed (mph) for I-880N
04/30/2003 06:00-10:59
Traffic Flows from Bottom to Top
Once bottlenecks are identified, transportation professionals can identify the reasons for the bottleneck via aerial photos and field observation.

<table>
<thead>
<tr>
<th>LOCATION</th>
<th>SB AM</th>
<th>SB PM</th>
<th>NB AM</th>
<th>NB PM</th>
<th>POTENTIAL CAUSES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oak/Broadway</td>
<td>hidden</td>
<td></td>
<td></td>
<td></td>
<td>Roadway geometrics; on-ramp merging</td>
</tr>
<tr>
<td>23rd Avenue</td>
<td></td>
<td>YES</td>
<td></td>
<td></td>
<td>Roadway geometrics; poor pavement; low overpass</td>
</tr>
<tr>
<td>98th Avenue</td>
<td>YES</td>
<td></td>
<td></td>
<td>hidden</td>
<td>On-ramps merging</td>
</tr>
<tr>
<td>Davis/Marina</td>
<td>YES</td>
<td></td>
<td></td>
<td></td>
<td>Lane drop from 5 to 4 lanes; on-ramp merging</td>
</tr>
<tr>
<td>SR-238</td>
<td></td>
<td>YES</td>
<td></td>
<td></td>
<td>Off-ramp backup; lane drop 5 to 4 lanes @Washington off; Hesperian off backup</td>
</tr>
<tr>
<td>SR-92</td>
<td>YES</td>
<td></td>
<td></td>
<td></td>
<td>Off-ramp backup to mainline; lane drop from 5 to 4 lanes</td>
</tr>
<tr>
<td>Tennyson</td>
<td></td>
<td>YES</td>
<td>YES</td>
<td></td>
<td>Roadway geometrics; on-ramp merging</td>
</tr>
<tr>
<td>Whipple</td>
<td>hidden</td>
<td>YES</td>
<td>hidden</td>
<td>hidden</td>
<td>Vertical grade</td>
</tr>
<tr>
<td>Fremont</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Lane drop from 5 to 4 lanes</td>
</tr>
<tr>
<td>SR-84</td>
<td>YES</td>
<td></td>
<td></td>
<td></td>
<td>On-ramp merging</td>
</tr>
<tr>
<td>South of Mowry</td>
<td>YES</td>
<td></td>
<td></td>
<td></td>
<td>Roadway geometrics</td>
</tr>
<tr>
<td>Auto Mall Parkway</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>On-ramp merging (Construction)</td>
</tr>
<tr>
<td>Mission Blvd (Rte 262)</td>
<td>YES</td>
<td></td>
<td></td>
<td></td>
<td>Consecutive on-ramp merging (Construction)</td>
</tr>
</tbody>
</table>
Northbound Bottleneck at 23rd Street
Northbound Bottleneck at Tennyson
A preliminary UCB analysis also allows for estimating delay caused by accidents/collisions …
Designing Multi Modal Performance Measurement
SANDAG is developing new management systems that will collect arterial and transit data

- SMG and BTS are developing a design document to enable an interface between these systems and PeMS

- Although such interface is at least a couple of years away, once established, PeMS would be able to report on multi-modal measures that would:
  - Report transit ridership trends
  - Report arterial delays, speeds, volumes
  - Compare modal travel times (Bus Rapid Transit vs. Auto)

- The design document is currently in draft format and will be reviewed by SANDAG and revised as appropriate.
Questions/Discussion
PeMS
The Freeway Performance Measurement System

Improving Management of Freeways

Dr. Karl Petty
Berkeley Transportation Systems, Inc.
Agenda

- PeMS Overview
  - What is PeMS?
  - What data does it collect?
  - Who uses PeMS?
  - How is it used by Caltrans?
  - What can you see?
  - What’s coming?

- Hands On Demo
  - How do we navigate in PeMS?
  - What can we see?

- Note:
  - Normally this is a two-day class
  - I’ll skip a number of details
  - Please ask questions if something is fuzzy
Context: Systems Management

- Transportation network is a system
- At one level, vehicle hours are the input with vehicle miles as output
- There are many levels/types of inputs and outputs
- Proper collection and analysis of the outputs is necessary for efficient management and control

“If you cannot tell the VMT on your system yesterday, you cannot hope to manage your system today,”

attributed to Dolf May, 1961

Berkeley Transportation Systems, Inc.
Fact:
- Proper transportation management decisions require a huge amount of data

State of Affairs:
- Collected data is usually not stored
- Stored data is not retrievable or too hard to access
- Difficult to create correct views of data

Results:
- Very few engineers utilize data in control actions
- Long-term studies and management action rely on estimated values (if any)
- Because of this neglect, generating the correct view/plot of data is difficult
- Results in “Analytical Darkness”
- This is fostering exactly the wrong culture
PeMS Provides Feedback

Traveling Public

Input (VHT)

Freeway System

PeMS (rt-ADMS)

Maintenance Organization

Freeway Operations Organization

Planning Organization

Policy Making Organization

DOT

Travel Time, Reliability and Predictions

Detailed Sensor Health

Quantity and Quality of Travel

Long-Term Performance Measures

Long-Term System and Organizational Performance

Resource and Funding Decisions

Performance Reports

Travel Time, Reliability and Predictions

Sensor Maintenance Strategies

Capacity Preservation Strategies

Long-Term Capacity Improvements

Resource and Funding Decisions

Performance Reports

Long-Term System and Organizational Performance

Travel Time, Reliability and Predictions

Traveling Public

Input (VHT)

Freeway System

PeMS (rt-ADMS)
PeMS is an Archived Data Management System (ADMS)
Also has a role in supporting Traffic Management

Berkeley Transportation Systems, Inc.
What is PeMS?

- PeMS is a real-time Archive Data Management System (rt-ADMS)
- PeMS collects detailed freeway information
  - Fixed sensor: lane-by-lane, 20/30-second values
  - Incident: detailed reports
- Processes these values in real-time, performing:
  - Detector diagnostics
  - Imputation
  - Speed calculations
  - Aggregations
  - Performance measurement calculations
- Has a huge number of reports and tools
- Accessed via a browser
- In California:
  - Collects data from 6 districts (>23,000 sensors)
  - Holds 4.5TB of data
  - 55 Billion samples/year

Berkeley Transportation Systems, Inc.
PeMS Tools In a Nutshell

Real-time Archive Data Management System

- Focused on helping agencies plan for operations
- Allows for direct empirical measurements of freeway performance
- Moves users out of “Analytical Darkness”
- Links together
  - Traffic data archival systems
  - Real-time operational strategies
  - Freeway performance measurement
Fundamental Parts of PeMS

1. Raw Data Collection
2. Calculations in PeMS
   - Algorithms: Diagnostics, imputation and speed estimation
   - Calculations: Aggregation and performance measures
3. Reports
Raw Data Collection

- Organize detectors according to physical layout on the freeway
- For historical reasons we refer to a lane detector as a “loop”, but it could be radar, double loop, etc.
- Sensors report flow, occupancy, and, depending on type, speed every 30 seconds

Berkeley Transportation Systems, Inc.

Controller. In charge of multiple VDSs (LDS)

Grouping of detectors: Vehicle Detector Station (VDS)

On-ramp with demand, passage and queue detectors

Off-ramp (it's own VDS)

170/2070

To TMC

Organize detectors according to physical layout on the freeway

For historical reasons we refer to a lane detector as a “loop”, but it could be radar, double loop, etc.

Sensors report flow, occupancy, and, depending on type, speed every 30 seconds
Calculations in PeMS

- Performs detector diagnostics
  - Every lane-detector every day; stores results for analysis
- Imputes for data that is missing or bad
  - Bad is determined by detector diagnostics
  - Missing is due to communication failures
- Calculates performance measures
  - Rolls data up over space and time; stores results for queries
  - Performs calculations, including imputation, in real-time
- Presents many types of displays for different users
  - Maintenance, operations, planners, decision makers, public
- All calculations are done in real-time
The calculations section (grinding) is the link between the raw data and the reports.

There are many types of reports that leverage the work of the grinding.
PeMS Reports Caltrans is Using

There are many analytical tools and reports in PeMS.

- Today we’ll cover only a few of the tools
- Typical training course takes 2-3 days
- Sample drawn from four groups of users

1. Decision makers
   - High-level reports showing short and long term trends

2. Freeway Operations
   - Investigating quality and quantity of travel
   - Bottleneck identification and analysis
   - Safety analysis with incidents

3. Planners
   - High-level quality (LOS)
   - HOV lane analysis
   - Average Daily Traffic (ADT) analysis

4. Maintenance Personnel
   - Detector diagnostics
This ‘dashboard’ shows performance statistics for today.

- Shows VMT, VHT and detector health.
- Shows measured values up until “now”, prediction for rest of day.
- Each plot allows users to drill in further for analysis.
Example of drilling down
Can compare today with average
Green line is today until 9am
Red line is prediction for rest of today
Blue lines show min, mean, max of weekdays over past month
We are higher (more demand) today than normal
Decision Makers – Long Term

- Instantly get district-wide views of performance
- This view shows last 30 days
- Shows performance measures on top, detector health on bottom
- Can see daily trends
- Information always at fingertips

Berkeley Transportation Systems, Inc.
Freeway Ops – Data Plots

- Individual loop plots
- Plot of a particular quantity (flow, occupancy, speed, etc) over time
- Can roll up data over time to hour, day, week, month
- Can roll up data over space to freeway, city, county, district and state
- This plot is of flow versus time over two days
- Shows two lanes and the aggregate

Berkeley Transportation Systems, Inc.
Freeway Ops – Variation

- Plot quantities over time of day and day of week to see temporal trends.
- This is a plot of flow at a particular loop over the time of day.
- In this plot, we selected only weekdays and non-holidays.
- Plotting avg, min, max (can also plot median, 25th and 75th percentiles).

Berkeley Transportation Systems, Inc.
Example of spatial and temporal rollup

Plot of delay per month for a section of freeway in D11 (San Diego)

Covers almost six years

Shows a clear trend that delay is increasing on this freeway and the performance is decreasing

Provides clear, easy-to-obtain measurements of performance measures
Freeway Ops – Bottleneck Identification

The PeMS Bottleneck Identification Algorithm:

- Look for spatial, persistent drops in speed
- For each detector, compare speed to upstream detector
  - If difference is above a threshold mark it as a potential bottleneck
  - Walk upstream until speed difference
  - Record spatial extent
  - Compute performance measures (delay)
- Store for each detector for each shift (AM, Noon, PM)
- Roll up data over time to produce displays
For a given region, show the sorted list of bottlenecks

This shows in D11 (San Diego) all of the AM bottlenecks during the first two months of 2003

Shows number of days bottleneck is active, spatial and temporal extent, and delay generated

Links allow users to drill down to investigate characteristics and causes of bottlenecks
Freeway Ops – Bottlenecks

- Jumps to delay versus time of day for this location
- Can now see when the bottleneck starts and end
- Allows users to investigate the variability of the bottleneck on users
- Is it a one-time event?
- In this example we can see that the bottleneck is very predictable – every day we have similar delay patterns.
Freeway Ops – Bottlenecks

- Jumps to spatial contour plots
- This is showing speed versus space and time
- Allows users to investigate the spatial and temporal extent of the bottleneck on a single day
- We mark on the plot where we think the bottleneck was activated for this day

Berkeley Transportation Systems, Inc.
Freeway Ops – Bottlenecks

- Can jump to a map view of the location of the bottleneck
- We color and size the dots according to the delay caused and the number of days activated
- For Caltrans we tie map to other types of media
- They have a video record of every freeway in the state (PhotoLog)
- Users can see the bottleneck through these movies
- PeMS folds in all of the Caltrans and CHP incidents
- For this plot the geographic segment is all of District 7 (LA)
- Shows breakdown of incidents over freeways (top 15 only)
- Can specify incident type and location

Berkeley Transportation Systems, Inc.
Freeway Ops – Incidents

- Shows average frequency of incidents over a space-time grid over many days
- This plot is a section of 405N from PM 0 to PM 50 in D7
- Helps identify when and where incidents occur on a freeway
- Relates to questions about safety
Freeway Ops – Incidents

- Can show standard statistics of incidents versus freeway performance measures
- This shows # accidents/VMT for all of LA for each day
- Relatively stable value of 3.4 accidents/MVMT
- Can narrow down to a particular freeway
- Can show this over long periods of time
- Helps investigate unsafe freeway sections, or changes in the safety over time
Planners – Level of Service

- Ability to perform many types of common transportation planning analysis functions
- Shows breakdown of Level of Service (LOS) over entire District during weekdays
- LOS ranges from A-F and represents driving conditions
- “A” is completely clear; “F” is completely packed
- We can see that the worst conditions are during the afternoon rush hour
- Can see the percentage of drivers experiencing each level of service

Berkeley Transportation Systems, Inc.
Can monitor lane utilization across flow regimes.

This plot shows for a single detector station the ratio of vehicles in each lane as a function of flow.

We can clearly see that lane 2 holds approximately 50% of the traffic all the time.

Vehicles shift from lane 3 to lane 1 during heavy demand.
More interesting to look at effect of HOV

Both plots are for a location that has time-activated HOV lanes

Top plot covers mid-day from 10am-3pm (no-HOV)
- Lanes are evenly balanced over all flow regimes
- Lane 1 has approximately 25% of the flow

Bottom plot covers AM peak from 7am-9am (HOV on)
- Lane 1 has significantly less flow than the other lanes
- Approximately 14% of flow

Note slightly different x-axis scales

A starting point into investigating HOV effectiveness
Planners – ADT Variation

- Shows variation in ADT over day of week
- Shows standard box and whisker plot with outliers:
  - 25th, 50th (median), and 75th percentile
  - 1.5*IQR
  - Outliers
- See the same trends everywhere:
  - M,T,W,T are the same
  - F is high
  - Sa, Su different
- Can investigate any location, any time range

Berkeley Transportation Systems, Inc.
This plot shows the statistics for the monthly ADT.

See similar trends in many locations:
- Demand is high in the summer
- Drops in fall

Does this mean that the roads are “more congested” in August?
Planners – ADT Growth Factors

- Can view long time ranges
- This covers 1/2000 through 4/2005
- Excellent input for growth models
- Can see slight growth over time
- Can see all of the holidays as outliers
- Can also do linear regression to get simple projections (when looking at yearly values)
- Growing at 0.89% per year

Berkeley Transportation Systems, Inc.
PeMS performs diagnostics on every lane detector in the system every night.

Store these results and use as basis for detector health programs.

The display here is for the entire D7 (LA) region.

Shows summary status of every freeway on one day.

Gives % good and bad.

Allows user to drill in.
Maintenance – Diagnostics

- Section of freeway
- Shows diagnostic status of all loops on one day
- Quick view of entire stretch of freeway
- Can pick different days to see changes
- Allows user to drill in (718151)
PeMS Roadmap
Dashboards:
- State-wide
- District – realtime
- District – historical

This is the statewide

Shows summaries for entire state and details for each district
- This is the district real-time dashboard
- Top row are plots of performance measures predicted over rest of day
- Middle row shows bottlenecks and chp incidents
- Bottom row shows detector health status

Berkeley Transportation Systems, Inc.
Routes

- Creation wizard
- Configuration page
- Travel time graphing
- Travel time variation
Congestion Pie

- Identify causes of congestion
  - Accidents
  - Excess demand
  - Inefficient ramp metering
- Give breakdown per District and per freeway-direction
- Done per quarter
Hands On PeMS Demo
http://pems.eecs.berkeley.edu/
Segments and Plots

- Plots available are a function of geographical segment type
  - Geographical segments are simply nested areas

- Geographical/Spatial segments:
  - State, District, County, City, Freeway
  - Can plot values which make sense averaged over space
    - VMT, VHT, Delay, Q (VMT/VHT), TTI (1/Q)

- Point segments:
  - Individual detector location
  - Can plot values at a single point
    - All spatial ones as well as Speed, Flow, Occupancy
    - All diagnostics: number of samples, number of bad samples, number of imputed samples
Aggregation Levels

- PeMS aggregates over space and time
- Lowest level of data is raw (lane-by-lane 30-second data)

- Base levels (filled in):
  - Lane-by-lane, 5-minute values
  - Aggregate (over lanes), 5-minute values
  - Hourly station aggregate
  - Daily station aggregate
  - County-Hour aggregate
Segments and Plot Types

Different Segments

Major types of displays for this particular segment

Minor display types
Segments and Plot Types

Bread crumbs: shows segment and major display type. They are clickable!

As you drill in, the segments indent. Reflect what’s available below this segment.
Plot Types are a Function of Segment

Segment is individual detector (313111)

Indented all the way in to detector level

Added ‘Capacity Analysis’ and ‘Download 30-sec’ screens, but lost ‘HICOMP’ screen

Note: Incidents don’t show up at this level
Different views of data

- Can always see a plot, table, export to text or spreadsheet

Different ways to see the same data: plot, table, text, spreadsheet

Values displayed in first few columns

Data quality is available for some plots. Shows number of points, % observed, % mixed, % imputed
Navigation Paradigms

For Individual Detector Stations

1. Know the detector ID number
   - You can search for the detector with the search box
2. Know where the detector is located
   - You can navigate geographically via lists to the detector
3. Know what kind of detector you’re looking for
   - Like a detector by a city, or major intersection
   - Use the map to pan and zoom around to find a detector that’s appropriate

For Other Geographical Segments

1. Only navigate geographically
Know the Detector Location

- Detector: D11, 5-S, Encinitas, by Birmingham Drive (or CA PM R39.6)

- Start at top of site, and drill in by geography:
  1. Select the district
  2. Select the freeway in the district
  3. Select the list of detectors on the freeway
  4. Look for the detector in the list by either the number, or the freeway crossing, or the postmile

- Always drilling in starting with largest, or highest, segment
Know Detector Location

- Many ways to start to drill down

  Click on “Districts” on left hand side. Will jump to table of districts in the state.

  Click on the District on the map. This will jump to another map of just D11.
Know Detector Location

This is the District Splash Page. Click on “Freeways” on left hand side. Will jump to table of freeways in district.

Click on number in the “# Fwys” column (ie: 24). Will jump to table of freeways in district.
Know Detector Location

- This is a common place to start for any plots
- Many ways to start drilling down

Click on number under “Miles w/ML Loops” to jump to “spatial” plots down the freeway

Click on number under “# VDS” column. Will jump to a table of VDS detectors on that freeway
Know Detector Location

- Now you have a list of detectors on the selected freeway
- The green bands are freeway crossings
- Almost all of the information that we know about the detectors is here

Look for VDS in this list. Check for Cal PM, or freeway crossing. Click on VDS number to jump to configuration page for that detector.

<table>
<thead>
<tr>
<th>Detector Type</th>
<th>Location</th>
<th>Ramp</th>
<th>VDS</th>
<th>Description</th>
<th>Location</th>
<th>ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>SB OFF TO BIRMINGHAM DR (R39.987)</td>
<td>39.987</td>
<td>39.845</td>
<td>1 Off Ramp</td>
<td>100300 1108123</td>
<td>BIRMINGHAM DR</td>
<td>109</td>
</tr>
<tr>
<td>SB OFF TO BIRMINGHAM DR (R39.987)</td>
<td>39.606</td>
<td>39.640.9150</td>
<td>4 Mainline</td>
<td>1108475 1108123</td>
<td>BIRMINGHAM DRIVE</td>
<td>109</td>
</tr>
<tr>
<td>SB OFF TO BIRMINGHAM DR (R39.987)</td>
<td>39.840</td>
<td>39.464</td>
<td>2 On Ramp</td>
<td>1108476 1108123</td>
<td>BIRMINGHAM DRIVE</td>
<td>109</td>
</tr>
<tr>
<td>SB ON FRM BIRMINGHAM DR (R39.970)</td>
<td>38.788</td>
<td>38.646</td>
<td>1 Off Ramp</td>
<td>1100397 1108122</td>
<td>MANCHESTER AVE</td>
<td>108</td>
</tr>
</tbody>
</table>
Know Kind of Detector (Use map)

- Click on district map on splash page to jump to dynamic map
- Note: dynamic maps have no district (can pan anywhere)

Use different stats to paint circles

Tool tips when zoomed in, can click on detector to jump to plot

Label detectors with different ID schemes

Can jump directly to other districts

Berkeley Transportation Systems, Inc.
Special Features

- Jumps to top of web site
- Links to Papers and System-wide help area
- Edit user account info and logout
- Help for just this screen, changes for every page. Best place to look if you have questions about a particular plot or table.

Berkeley Transportation Systems, Inc.
Timeseries Plots

- Main plot types are under “Aggregates”
- Timeseries plots are the foundation of PeMS
- From configuration page (or any page), can jump there directly

Click on “Aggregates -> Timeseries” to jump to the default timeseries plot for a detector.
Timeseries Plots

- This is the default timeseries plot for a detector.
- Shows daily flow over last 7 days.
- You can modify the parameters to produce different types of plots.
- This is the starting point for investigating this detector.

Modify any parameters and then click “Draw Plot” to see different plots.
Hands On Examples

1. What percentage of detectors are working in D11? Is this going up or down?
2. What freeway in D11 has the lowest percentage of working detectors?
3. What's the median speed on I-5 Southbound by Encinitas on weekdays at 8am in October 2005? Jan 2005?
4. For the last two months, has the total delay in D11 been going up or down?
Navigation and Plotting Example

Let’s plot the delay on the freeway segment “SR 78 – Westbound” over the last four years.

- Need to use the “Freeway Segments -> Aggregates” report.
- Look at a granularity of a month.
- Two types of reports:
  - Timeseries Sum: add up the delay on every day.
  - Timeseries Avg: the average delay on every day.
Solution

- Use “Timeseries Avg”
- Look at “Delay (V_t = 60)”
- Granularity of a year

Only weekdays

Key shows 25th, 50th and 75th percentiles
San Diego freeway congestion
Statewide findings

1. Congestion occurs when traffic density increases beyond $\rho_{cr}$ causing switch from high-volume, high-speed free flow state to low-volume, low-speed congestion state. In 2004, congestion delay was 158 million VHT or 11.7 percent to total VHT.

2. 46% of congestion occurs at 595 recurrent bottlenecks, 74 of which account for 58% of the delay. Ramp metering at 595 bottlenecks can eliminate 25% of total congestion.

3. 28% of congestion is caused by collisions, 10% of which account for 90% of collision-induced delay. Quick detection and clearance of the worst collisions can significantly reduce this congestion.

4. All other causes account cause remaining 26% of congestion delay.
Findings (contd)

5. Congestion increases travel time mean and variance. Travel time prediction based on real-time data significantly reduces this variance.

6. HOV activation increases total congestion, does not measurably reduce number of vehicles. HOV lanes suffer capacity reduction. Although underused, ‘excess’ HOV capacity cannot support toll-paying or hybrid vehicles. Carpooling is insensitive to travel-time savings.

7. Traffic control offers the most cost-effective means to reduce congestion.
Causes of congestion

- Recurrent bottlenecks—mitigated by metering, traveler information
- Collisions—mitigated by quicker response
- Weather
- Special events—traveler information
- Lane closure—traveler information
- etc.

Challenge is to quantify these effects
San Diego bottlenecks

For San Diego Co, 270 miles of 7 freeways, 0500-2200, 64 workdays in April-June 2003, algorithm finds

- 1733 bottleneck activations at 160 locations

- causing 1.2 million VH of delay = 64% of all delay in county

- 10 worst bottlenecks account for 61% of all bottleneck delay
## San Diego’s top bottlenecks

<table>
<thead>
<tr>
<th>ID</th>
<th>Location (postmile)</th>
<th>Frequency</th>
<th>Delay (v-h/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>I-5 NB@Loma Santa Fe Dr. (37.51)</td>
<td>97%</td>
<td>1617</td>
</tr>
<tr>
<td>B</td>
<td>I-5 SB@Loma Santa Fe Dr. (37.26)</td>
<td>94%</td>
<td>1678</td>
</tr>
<tr>
<td>C</td>
<td>I-8 EB@College Ave. (8.34)</td>
<td>80%</td>
<td>447</td>
</tr>
<tr>
<td>D</td>
<td>I-15 NB@Pomerado Rd. (26.05)</td>
<td>92%</td>
<td>2692</td>
</tr>
<tr>
<td>E</td>
<td>I-15 SB@Miramar Rd. (14.4)</td>
<td>78%</td>
<td>542</td>
</tr>
<tr>
<td>F</td>
<td>I-15 SB@Pomerado Rd. (25.91)</td>
<td>97%</td>
<td>2137</td>
</tr>
<tr>
<td>G</td>
<td>I-805 NB@SR-52 (24.60)</td>
<td>78%</td>
<td>696</td>
</tr>
<tr>
<td>H</td>
<td>I-805 SB@47th Street (11.5)</td>
<td>88%</td>
<td>834</td>
</tr>
<tr>
<td>I</td>
<td>I-805 SB@SR-52 (24.33)</td>
<td>94%</td>
<td>464</td>
</tr>
</tbody>
</table>
Verification

- No ground truth

- But, results confirmed by
  - experts in Caltrans and research community (Fred Rooney, James Banks)
  - SANDAG’s prioritization of highway projects (Regional highway project evaluation website, Sept. 2000)
Collision-caused delay on I-15

Collisions create temporary bottlenecks, causing additional delay

Difficulty: To estimate collision-caused delay, must predict delay in absence of collision

Algorithm

- Step 1: Determine space-time region of impact of collision and total delay in region
- Step 2: Estimate delay in absence of collision, using nearest neighbor prediction of flow and speed on non-collision days
- Step 3: Collision-caused delay = delay (step 1) - delay (step 2)
I-15N San Diego, Sept 2-Oct 31, ‘02 collision + traffic data

Flow

Speed

Delay

Crash Rate

High congestion

High crash rate
10-90 rule: 10% of collisions account for 90% of collision-caused delay. Can one quickly predict these outliers?
Savings from ramp metering on I-15

- Algorithm identified the following two time and location of bottleneck activations
  - Location 5 at postmile 7.581, 6:45 AM - 8:25 AM
  - Location 19 at postmile 24.511, 5:40 PM - 6:00 PM
- Metering these locations leads to savings shown in next slide
Total delay = Collision delay + IMP savings + Ramp delay + other

Total exposure = Free flow state + Congestion state
Congestion and travel time

- Travelers experience congestion as increase in travel time mean and variation

- Real time travel time prediction has a very low variance, conditioned on current data, because of high temporal correlation
Predicting travel times along two alternative routes

- Scatter plot of $T_1(t)$, $T_2(t)$, departing at $t$ every 17 min, 0500-2200, weekdays, 1-31 August, 2002 shows two equally good routes.
Value of real-time prediction

- Left: Best $E\{T_i(t)|D(t)\}$, given real-time data up to $t$ vs. best $ET_i(t)$, based on historical data
- Right: Best $E\{T_i(t)|D(t)\}$, given real-time data up to $t$ vs. best $T_i(t)$, based on clairvoyance

![Travel times using prediction vs. historical](image1)

![Travel times using prediction vs. true minimum](image2)

savings
Real-time prediction reduces uncertainty

- Prediction is accurate to 2 minutes on 23 minute trip
- More than 50% reduction in uncertainty in peak hours
A possible use

Karl,

I'd like to use information on average speed throughout the day along the SD I-15 corridor to help us recommend and set shift change times for our plant in Rancho Bernardo ... Can you help?

Thanks,--Jon
## Other examples

<table>
<thead>
<tr>
<th>O-D trip</th>
<th>Peak hour average travel time (min)</th>
<th>Peak hour prediction error $\sigma$ (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Historical</td>
<td>Prediction</td>
</tr>
<tr>
<td>San Diego 1</td>
<td>13.0</td>
<td>12.9</td>
</tr>
<tr>
<td>San Diego 2</td>
<td>22.7</td>
<td>20.9</td>
</tr>
<tr>
<td>Orange Co. 1</td>
<td>32.4</td>
<td>32.3</td>
</tr>
<tr>
<td>Orange Co. 2</td>
<td>34.0</td>
<td>33.4</td>
</tr>
<tr>
<td>LA Co.</td>
<td>45.4</td>
<td>44.2</td>
</tr>
</tbody>
</table>

San Diego 1: from I-5 and I-805 to downtown (I-5 and I-163)  
San Diego 2: from SR-125 and I-8 to downtown  
Orange County 1: from I-5 and I-405 to I-5 and SR-91  
Orange Co 2: from I-5 and I-405 to I-405 and I-605  
LA County: from I-10 and I-210 to downtown
Effectiveness of high-occupancy vehicle (HOV) lanes

- San Francisco Bay Area HOV lanes are activated 5:00-9:00 AM, 3:00-7:00 PM; used as general-purpose lanes at other times

- Impact of HOV
  - HOV vehicles enjoy lower travel time than GP vehicles because of lower demand
  - HOV activation imposes capacity penalty on HOV lane, and congestion penalty on non-HOV lanes
  - HOV persons/hour flow not measurably larger than GP persons/hour flow
  - HOV activation increases total travel time
  - Carpooling insensitive to travel-time savings
November 2, 2005 Special Meeting Summary:

Attendance-

Committee Members:  
- Maryam Babaki  
- Hamid Bahadori  
- Michael Boyle  
- Jim Callaghan  
- John Meyer

Ex-Officio Members:  
- Gary Gallegos

Others:  
- Keith Curry, PFM  
- Christine Fay, PFM  
- Grace Barvin, Merrill Lynch  
- Ian Parker, Merrill Lynch  
- Tim Romer, Goldman Sachs  
- Allan Kosup, Caltrans District 11  
- Christine Valle, Caltrans District 11  
- Jack Boda, SANDAG  
- Richard Chavez, SANDAG  
- Marney Cox, SANDAG  
- Sookyung Kim, SANDAG  
- Jim Linthicum, SANDAG  
- Renee Wasmund, SANDAG  
- Craig Scott, SANDAG

Item 1 - Public Comments/Communications/Member Comments

There were no public comments.

Item 2 - ITOC Bylaws

The Bylaws had been deferred from the previous meeting. The discussion focused on the changes that had been made to the draft Bylaws based on the comments raised at the previous meeting.

**ACTION:** The ITOC approved the bylaws unanimously with one additional change, which was to add the following language to Section C(5) regarding the selection of Chair and Vice-Chair: “The selection shall be made at the first regular meeting following the commencement of the SANDAG fiscal year.”

Item 3 - Draft TransNet Plan of Finance for the Early Action Program (EAP)

Craig Scott provided a PowerPoint presentation (copies provided in the agenda package for the November 9th meeting) regarding the major findings and recommendations of the draft TransNet Plan of Finance. He reviewed the key assumptions that were made regarding the costs and revenues provided as input to the cash flow model used in developing the plan. He also summarized the financial scenarios developed for the plan and the results of the financial analysis. The staff recommendation was to proceed with the development of a final Plan of Finance based on one of the bonding scenarios (Scenario 3) with set asides of TransNet and state and federal matching funds for other non-EAP projects.

The discussion by the ITOC members focused on some of the key areas of risk related to the assumptions made for the Plan of Finance, including the risk that project costs could escalate at a higher rate than assumed and that state and federal funds could be impacted by actions such as future raids on Proposition 42 funds or the redirection of funding due to Hurricane Katrina relief efforts. There were questions related to other competing needs for the revenues assumed for the
EAP projects. Staff emphasized the importance of monitoring all of the key assumptions in the plan over time and, as issues arise in the future, the financial strategy may have to brought back to the ITOC, the Transportation Committee, and the Board of Directors for review and potential amendment.

It was suggested that an ITOC member attend the November 4, 2005, Transportation Committee meeting and indicate that the general sense of the ITOC was to support the use of bonding to accelerate project implementation and to support Scenario 3 as the most balanced, flexible approach to deliver the EAP program while maintaining funding for other high priority non-EAP uses. This item was to be discussed further at the next ITOC meeting.

**Item 4 - Interest Rate Hedging Proposal**

Keith Curry from Public Financial Management (PFM), SANDAG’s Financial Advisor, provided a PowerPoint presentation (copies distributed to ITOC members) regarding a proposal to lock in today's historically low interest rates for SANDAG’s planned long-term debt issuance in 2008. He outlined the proposed structure for $600 million in interest rate swaps, which, based on current rates, could achieve a total “all-in” cost of financing of 3.86 percent. The proposed structure would result in annual debt service savings of over $3.1 million per year, or nearly $95 million over 30 years. Mr. Curry reviewed the risks associated with the proposed strategy and strongly recommended moving forward with the proposal.

The ITOC raised several questions regarding the mechanics of the interest rate swaps and how the swaps would be affected by changing market conditions. The ITOC carried this item over to the next meeting for further discussion and potential action.

**Item 5 - TransNet Annual Audit and Related Requirements**

Renee Wasmund, Director of Finance, provided an overview of the annual audit requirements related to the TransNet program, how SANDAG is handling the audit process for the current TransNet program, and how the requirements will be changing as the audit process is turned over to the ITOC for Fiscal Year (FY) 2008-09 and beyond. She described the new policy regarding strengthening the requirements related to completing the audit process in a timely manner each year. The policy was recently approved by the Transportation Committee for consideration by the Board of Directors at the November meeting.

The ITOC’s discussion focused on the cost of the annual audit process and the amount of time required in reviewing the audits each year. Although the ITOC’s role in the audit process will not become effective until FY 2008-09, the staff offered to keep the ITOC informed regarding the audit process, including key activities such as the establishment of the new Maintenance of Effort (MOE) requirement based on the provisions of the new measure.

**Item 6 - Future Meeting Dates and Agenda Topics**

Several items were discussed as future agenda topics. John Meyer expressed interest in having ITOC meetings held in other parts of the county on a periodic basis. Members thought the idea had merit and should be investigated further.
Regarding potential future agenda items, the ITOC’s role in specific project issues, such as the proposed elimination of the SR 78/Rancho Del Oro interchange and the Nobel Drive Coaster Station, was discussed. Members questioned the ITOC’s involvement in projects that are not part of the TransNet program. It was decided that an item to discuss how and when the ITOC should get involved in these types of specific project issues would be considered for the December agenda.

Chairman Boyle distributed a draft scope of work for potential consultant services related to performance measurement. An Ad Hoc Subcommittee consisting of Mike Boyle, Maryam Babaki, and Jim Callaghan was appointed to meet prior to the next meeting to discuss the scope of work in more detail and refine the concept for further discussion at the next meeting.

The next meeting was set for November 9, 2005, from 9:30 a.m. to 3:30 p.m. at SANDAG. Agenda items were to include the draft Plan of Finance, interest rate hedging strategies, performance measurement on the local street and road system, and ITOC’s role in performance measurement.

**Item 7 - Adjournment**

The meeting was adjourned at approximately 3:20 p.m.
Action Requested: ACCEPT

SUMMARY OF THE NOVEMBER 9, 2005 File Number 1110200 INDEPENDENT TAXPAYER OVERSIGHT COMMITTEE MEETING

November 9, 2005 Meeting Summary:

Attendance:
Committee Members:
- Maryam Babaki
- Hamid Bahadori
- Michael Boyle
- John Meyer
Ex-Officio Members:
- Gary Gallegos
- Tracy Sandoval
Others:
- Keith Curry, Public Financial Mgmt.
- Harvey Goodfriend, San Diego Taxpayers Association
- Alex Al-Agha, City of Chula Vista
- Eddie Flores, City of San Diego
- Walt Huffman, City of San Diego
- Richard Chavez, SANDAG
- Marney Cox, SANDAG
- Jack Boda, SANDAG
- Janet Fairbanks, SANDAG
- Jeff Martin, SANDAG
- Craig Scott, SANDAG
- Renee Wasmund, SANDAG

The following summarizes the major actions and key discussion points under each agenda item from the November 9, 2005 meeting.

Item 1 - Meeting Summaries for the October 19, 2005, and November 2, 2005 ITOC Meetings

The meeting summary for the October 19, 2005 regular ITOC meeting and the meeting summary for the November 2, 2005 special meeting were presented for consideration by the ITOC. Because the meeting summaries were distributed after the agenda package was mailed, not all members had had the opportunity to review the material. The item was deferred to the next meeting.

Item 2 - Public Comments/Communications/Member Comments

Harvey Goodfriend informed the ITOC of the ongoing peer review regarding the region’s long-range transit plans and suggested that the ITOC may be interested in receiving a briefing on the status of the peer review process. He also suggested that the ITOC may be interested in hearing
from Alan Hoffman, a local transit consultant, who has done some independent work of his own on the issue. ITOC members were interested in such a discussion and suggested that the topic be scheduled for an ITOC meeting in the near future. There also was discussion of recent bus rapid transit (BRT) developments in the Los Angeles area and long-range transit planning issues in Orange County. Interest was expressed in having some of the ITOC members participate in a field trip to investigate the BRT services being provided. Staff was to investigate the logistics of coordinating such a field trip.

Item 3 - Draft TransNet Plan of Finance for the Early Action Program

As a continuation of the discussion on this topic from the November 2, 2005 special meeting, the ITOC received an update of the SANDAG Transportation Committee’s actions on the draft Plan of Finance. Maryam Babaki presented the general position of the ITOC in support of bonding based on Scenario 3 in the draft Plan of Finance to the Transportation Committee. The Transportation Committee took the same position, and a final Plan of Finance based on Scenario 3 will be developed for presentation to the SANDAG Board in December.

Gary Gallegos described the issue raised by the transit operators at the Transportation Committee meeting relating to the identification of a 10-year capital needs list. He outlined a process to be undertaken to define evaluation criteria for reviewing and prioritizing these transit capital projects. The result of this process may be a change to the Plan of Finance to redirect expenditures from one set of transit projects to another. He described the flexibility in the TransNet Ordinance and the Plan of Finance process to accommodate such tradeoffs and changes in priorities over time. Such proposed changes would be brought through the ITOC, Transportation Committee, and the Board of Directors as part of the review process.

ACTION: The ITOC (4-0) voted to support the use of bonding based on Scenario 3 in the draft TransNet Plan of Finance for implementing the Early Action Program.

Item 4 - Interest Rate Hedging Proposal

This item was carried over from the November 2, 2005 special meeting. Keith Curry from Public Financial Management (PFM), SANDAG’s Financial Advisor, was present to answer additional questions from the ITOC on the interest rate hedging proposal. Mr. Curry highlighted recent trends in the market impacting the resulting debt service savings that could be achieved under the proposal. The savings as compared to entering into non-callable fixed rate bonds today were estimated at about $3.1 million per year, or $93 million over the 30-year life of the transaction. The proposal is scheduled to be considered by the SANDAG Board at its November 18, 2005 meeting.

ACTION: The ITOC (4-0) voted to support moving forward with the interest rate hedging proposal as a cost-effective way to implement the accelerated implementation of the Early Action Program at a low cost of capital.
Item 5 - Transportation System Performance Measurement

A. Overview of Local Street and Road Performance Measurement

At the October meeting, the ITOC discussed techniques for measuring the performance of the freeway system. This item was focused on a discussion of what is being done at the local jurisdiction level to monitor the performance of the local street and road system. Alex Al-Agha, City Engineer for the City of Chula Vista, provided an in-depth review of the techniques used by the city as part of its Transportation Monitoring Program. He described the methodologies used to measure level of service at both major intersections and along major corridors and to measure travel times from one part of the city to another. These ongoing measurements are part of the city’s growth management process, which establishes a standard of no more than two hours a day at level of service “D” or worse. A proposed development, which would cause an arterial to fall below the established standard, would be required to mitigate for its impacts. He described how the city’s capital improvement program is used to target improvements on those corridors that are approaching the established standard. He also described a $5 to $10 million effort in the coming years to further expand the city’s monitoring program to provide live feedback from each of the city’s 210 intersections. The ITOC members asked specific questions regarding some of the techniques used and the specific types of data available for analysis purposes.

Eddie Flores and Walt Huffman from the Engineering and Capital Projects Department of the City of San Diego described the techniques used for performance measurement in the City of San Diego. The techniques used were similar to those used in Chula Vista; however, due to budget cutbacks in recent years, the data is not collected with the same frequency or comprehensiveness. Hamid Bahadori stated that, based on his experience in Orange County, the level of performance measurement being undertaken in San Diego is more representative of what is being done in most cities, while Chula Vista is more of the exception in terms of the extent of its data collection efforts.

The ITOC discussed at length the issue of financing cumulative impacts, which Alex Al-Agha suggested was a major issue not addressed by the current system. The limitations of the CEQA process and the development impact fee process to deal with the issue were discussed. New resources such as the future growth of Proposition 42 funds, as well as incremental future growth in TransNet funds and gas tax receipts, were offered as possible sources for funding these needs on the local street and road network.

Regarding future developments in the area of performance measurement on the local street and road system, Richard Chavez distributed copies of a final draft of a design document for expanding the PeMS system to provide for performance measurement on the local arterial network. He briefly described the report and offered to discuss it with the ITOC in more detail in the future if so desired.

B. ITOC’s Role in Performance Measurement

Mike Boyle introduced this topic as the beginning of a discussion regarding how the ITOC should approach its responsibilities described in Paragraphs 6 and 7 of the Ordinance. Paragraph 6 relates primarily to the ITOC’s participation in the ongoing refinement of SANDAG’s performance measures and project evaluation criteria used in the Regional Transportation Plan (RTP) process, while
Paragraph 7 relates to the ongoing review of SANDAG’s State of the Commute report regarding the evaluation of the performance of the existing system.

For the RTP-related work, Jack Boda described the process coming up in the next few months related to the development of the 2007 RTP. A working group is being formed to review and refine the performance measures and evaluation criteria used in the RTP. The ITOC’s active involvement in reviewing recommendations coming from the working group was suggested as a way for the ITOC to fulfill its responsibilities in this area. ITOC members thought this was a good opportunity and that the ITOC should be involved and perhaps participate in the working group effort. It was requested that a presentation on the RTP process and the efforts of this working group effort be put on the ITOC agenda in the near future so that the ITOC could discuss how it could best participate in the refinement of the RTP performance measures and project evaluation criteria.

Mike Boyle discussed the proposed scope of work for consulting services that he had distributed at the November 2, 2005 special meeting. His concern was that, in order to maintain its independence from SANDAG, the ITOC may need consulting assistance to carry out some its responsibilities. The proposed scope of work outlined some potential areas of consultant assistance related to the performance measurements responsibilities. There was substantial discussion of the pros and cons of taking advantage of data being provided by SANDAG staff or SANDAG consultants at no cost to the ITOC as compared to hiring consultants to provide an independent analysis of the data being provided. There also was a discussion of the issue of independence in terms of ITOC members providing independent views themselves based on the expertise upon which they were selected to serve on the ITOC, as opposed to the ITOC hiring independent consultants to provide the independent viewpoint.

Staff discussed the issue of the ITOC’s budget. Based on the provisions of the Ordinance, the separate budget for the ITOC begins in FY 2008-09 (July 1, 2008). The Ordinance discusses the transition period until that time during which the ITOC’s activities are to be phased to the extent possible within budget constraints of the existing TransNet program. ITOC members questioned whether or not the budget provisions should become applicable as soon as future revenues are bonded against for the Early Action Program. The ITOC members present discussed several possible options, including seeking a legal opinion regarding the availability of separate funding for the ITOC prior to FY 2008-09 and sending a letter to the SANDAG Board seeking a budget allocation now. Because several members were not present for this discussion, the issue was deferred to a future meeting.

**Item 6 - TransNet Environmental Mitigation Program**

This item was deferred to the next meeting.

**Item 7 - TransNet Local Street and Road Program Requirements**

Craig Scott provided a brief overview of some of the ITOC’s responsibilities related to the local street and road program as contained in the agenda report. The ITOC will be involved in reviewing the multi-year programs submitted for approval by the local jurisdictions. This review will provide an opportunity for the ITOC to raise issues regarding eligibility and priorities prior to the funds being expended in addition to the ITOC’s future role in conducting the annual fiscal audits to determine how the funds were actually expended. The ITOC’s future roles in reviewing local
jurisdiction compliance with the maintenance of effort requirements and the $2,000 per dwelling unit private funding contribution also were discussed. The staff intends to work with the ITOC and the Cities/County Transportation Advisory Committee (CTAC) in the development of definitions, policies, and procedures related to the implementation of these local street and road-related programs.

**Item 8 - Future Meeting Schedule**

The next ITOC meeting was scheduled for December 7, 2005, from 9:30 a.m. to 3:30 p.m. at SANDAG. Potential agenda items for the next meeting included an overview of the TransNet Environmental Mitigation Program, an update on the quarterly reporting process and the consultant’s recommendations on program management, and further discussion of the ITOC’s role in performance measurement as related to the 2007 RTP update.

**Item 9 - Adjournment**

The meeting was adjourned at 2:50 p.m.
INDEPENDENT TAXPAYER
OVERSIGHT COMMITTEE

December 7, 2005

AGENDA ITEM NO.: 4

Action Requested: DISCUSSION

DRAFT TransNet PLAN OF FINANCE FOR THE EARLY ACTION PROGRAM
- ANALYSIS OF COST/BENEFIT OF BONDING

File Number 1110200

Attachments related to this item include:
• November 30, 2005 memo to Craig Scott regarding TransNet Early Action Benefit Analysis.
TO: Craig Scott, TransNet Program Manager
FROM: Elisa Arias, Senior Planner
Rachel Kennedy, Associate Planner
SUBJECT: TransNet Early Action Plan Benefit Analysis

SANDAG staff has estimated the benefits of advancing projects in the TransNet Early Action Plan (EAP). The California Life-Cycle Benefit/Cost Analysis Model (Cal-B/C) was reviewed to determine the benefit categories to quantify. This model was developed for Caltrans as a tool for benefit-cost analysis of transportation projects. The Cal-B/C model considers the following benefit categories: Travel Time Savings, Accident Reduction Benefits, Reduced Vehicle Operating Costs, and Reduced Emissions.

To obtain the data for the estimation of benefits, two travel demand forecasts for 2015 were prepared. One included the EAP projects and the other excluded them. The findings for each benefit category are documented in this memo. The table below shows the summary of estimated benefits of advancing the EAP projects.

<table>
<thead>
<tr>
<th>Annual Cost Savings with EAP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Travel Time Savings</td>
</tr>
<tr>
<td>Accident Reduction Savings</td>
</tr>
<tr>
<td>Operating Cost Savings</td>
</tr>
<tr>
<td>Reduced Emissions Savings</td>
</tr>
<tr>
<td>Total Savings</td>
</tr>
</tbody>
</table>
Travel Time Savings

In order to account for the travel time saved on roadways that currently experience the highest levels of congestion, only vehicle hours reduced in facilities operating at Level Of Service (LOS) D or worse were calculated. Total annual vehicle miles traveled (VMT) for both the EAP and non-EAP scenarios were multiplied by the median hourly wage for San Diego ($15.23)\(^1\) to determine the travel time savings benefit.

<table>
<thead>
<tr>
<th>Hourly Wage Rate/Person Hour</th>
<th>Hours Traveled Without EAP</th>
<th>Value</th>
<th>Hours Traveled With EAP</th>
<th>Value</th>
<th>Travel Hours Saved</th>
<th>Travel Time Cost Savings with EAP</th>
</tr>
</thead>
<tbody>
<tr>
<td>$15.23</td>
<td>164,113,600</td>
<td>$2,499,450,128</td>
<td>133,735,840</td>
<td>$2,036,796,843</td>
<td>30,377,760</td>
<td>$462,653,285</td>
</tr>
</tbody>
</table>

Accident Reduction Savings

In order to estimate the number of accidents on the regional roadway network, accident rate data from the Caltrans Collision Accident Data Book (2002) was utilized to model accidents for new and existing road segments. The base year 2004 modeled accident data were compared to the California Highway Patrol’s Statewide Integrated Traffic Records System accident data to assure accuracy. Accidents were broken into three categories: fatal, injury, and property damage only. The Caltrans Cal-B/C model uses a “value for statistical life” of $3,104,738 for a fatal accident, a value of $81,572 for an injury accident and a value of $6,850 for a property damage only accident.\(^2\) These dollar amounts were applied to the estimated annual number of accidents for the transportation network with EAP projects and without the EAP projects. The total annual accident reduction benefits of implementing the EAP are $55,123,002.

<table>
<thead>
<tr>
<th>Type</th>
<th>Dollar Value per Accident</th>
<th># of Accidents Without EAP</th>
<th>Accident Costs Without EAP</th>
<th>Accident Costs With EAP</th>
<th>Difference</th>
<th>Accident Cost Savings with EAP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fatal</td>
<td>$3,104,738</td>
<td>311</td>
<td>$965,573,518</td>
<td>$943,840,352</td>
<td>7</td>
<td>$21,733,166</td>
</tr>
<tr>
<td>Injury</td>
<td>$81,572</td>
<td>18,756</td>
<td>$1,529,964,432</td>
<td>$1,498,314,496</td>
<td>388</td>
<td>$31,649,936</td>
</tr>
<tr>
<td>Property Value Only</td>
<td>$6,850</td>
<td>14,579</td>
<td>$99,866,150</td>
<td>$98,126,250</td>
<td>254</td>
<td>$1,739,900</td>
</tr>
</tbody>
</table>

$2,595,404,100\(^1\)$ $2,540,281,098\(^2\)$ $55,123,002\(^3\)$

(1) Total accident costs without EAP
(2) Total accident costs with EAP
(3) Total dollars saved

---

\(^1\) See http://www.calmis.ca.gov/file/occup$/oeswages/Sand$oes.xls

\(^2\) See www.dot.ca.gov/hq/tpp/offices/ote/Benefit_Cost/models/calbc.html
Reduced Vehicle Operating Costs

To calculate vehicle operating costs, a two step processed was used. First, fuel-related operating costs were calculated and then added to non-fuel costs for the two network scenarios.

To calculate fuel-related vehicle operating costs, Caltrans utilizes a fuel consumption rate based on vehicle speed.³ Vehicle Miles Traveled (VMT)⁴ for autos and trucks were separated into five mile-per-hour categories and fuel consumption rates were applied, and then multiplied by the cost of gas per gallon (minus state and federal taxes).

The American Automobile Association’s September 23, 2005 Fuel Gauge Report was utilized for the gas rate.⁵ The Fuel Gauge Report stated that the San Diego metro region’s average price for a gallon of regular unleaded gasoline was $2.976 for September 23, 2005. This price includes taxes. As per the California State Board of Equalization⁶, the per gallon taxes for a gallon of gas are as follows: Federal excise tax $0.184, State excise tax $0.18, underground storage tank (UST) charge $0.013, and sales taxes at the rate of $0.0775%. Subtracting the appropriate taxes and charges, a gallon of gas in the San Diego metro region costs $2.3975. This is the gas price utilized to calculate fuel-related vehicle operating cost.

Non-fuel costs are calculated for total auto and truck VMT at a rate of $0.165 and $0.285, respectively.

The total annual operating cost savings of the EAP are $25,007,372. Additional data and tables can be viewed in Appendix A.

<table>
<thead>
<tr>
<th>Annual Reduced Vehicle Operating Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuel Cost Without EAP</td>
</tr>
<tr>
<td>$3,790,697,450</td>
</tr>
</tbody>
</table>

Reduced Emissions

The 2000 Addendum to the 1997 Federal Highway Cost Allocation Study Final Report states that the “Average (pollution) costs for all motor vehicle travel are about 1.5 cents per mile.”⁷ Total VMT was multiplied by 1.5 cents to calculate the total air pollution benefit cost. The EAP scenario produced an annual air pollution emissions savings of $916,083.

³ See http://www.dot.ca.gov/hq/tpp/offices/ote/Benefit_Cost/benefits/vehicle_operating_cost/method.html
⁴ See www.fuelgaugereport.com/CAmetro.asp
⁵ See http://www.boe.ca.gov/sptaxprog/spftdrates.htm#9
⁶ See http://www.fhwa.dot.gov/policy/hcas/addendum.htm (Table 12)
Additional Information

Additional methodology documentation and tables are available in Appendix A.
### Appendix A - Travel Time Savings (Median Hourly Wage)


#### Occupational Employment Statistics (OES) Survey Results

<table>
<thead>
<tr>
<th>MSA Code</th>
<th>Geographic Area Name</th>
<th>SOC Code</th>
<th>Occupational Title</th>
<th>May 2004 Employment Estimates</th>
<th>Entry-Level Hourly Wage (1)</th>
<th>Mean Hourly Wage</th>
<th>Mean Annual Wage</th>
<th>Mean Relative Standard Error (5)</th>
<th>26th Percentile Hourly Wage</th>
<th>75th Percentile Hourly Wage</th>
<th>50th Percentile (Median) Hourly Wage</th>
<th>60th Percentile (Median) Hourly Wage</th>
<th>76th Percentile Hourly Wage</th>
</tr>
</thead>
<tbody>
<tr>
<td>07320</td>
<td>San Diego MSA, California</td>
<td>11-0000</td>
<td>Total all occupations</td>
<td>1,280,660</td>
<td>$8.74</td>
<td>$19.55</td>
<td>$40,667</td>
<td>1.36</td>
<td>$39.78</td>
<td>$59.40</td>
<td>$41.23</td>
<td>$24.23</td>
<td></td>
</tr>
<tr>
<td>07320</td>
<td>San Diego MSA, California</td>
<td>11-1011</td>
<td>Chief Executives</td>
<td>3,560</td>
<td>$22.70</td>
<td>$45.96</td>
<td>$95,550</td>
<td>1.53</td>
<td>$31.38</td>
<td>$61.16</td>
<td>$44.80</td>
<td>$27.86</td>
<td></td>
</tr>
<tr>
<td>07320</td>
<td>San Diego MSA, California</td>
<td>11-1021</td>
<td>General and Operations Managers</td>
<td>18,340</td>
<td>$28.44</td>
<td>$51.14</td>
<td>$106,384</td>
<td>1.45</td>
<td>$39.85</td>
<td>$62.57</td>
<td>$46.27</td>
<td>$29.95</td>
<td></td>
</tr>
<tr>
<td>07320</td>
<td>San Diego MSA, California</td>
<td>11-1031</td>
<td>Legislators</td>
<td>230</td>
<td>$13.64</td>
<td>$22.13</td>
<td>$46,030</td>
<td>9.73</td>
<td>$15.79</td>
<td>$24.30</td>
<td>$17.61</td>
<td>$10.71</td>
<td></td>
</tr>
<tr>
<td>07320</td>
<td>San Diego MSA, California</td>
<td>11-2011</td>
<td>Marketing Managers</td>
<td>2,610</td>
<td>$20.33</td>
<td>$32.88</td>
<td>$69,655</td>
<td>2.21</td>
<td>$35.07</td>
<td>$72.68</td>
<td>$56.25</td>
<td>$34.00</td>
<td></td>
</tr>
<tr>
<td>07320</td>
<td>San Diego MSA, California</td>
<td>11-2012</td>
<td>Sales Managers</td>
<td>3,700</td>
<td>$26.57</td>
<td>$49.68</td>
<td>$103,307</td>
<td>1.81</td>
<td>$35.15</td>
<td>$61.10</td>
<td>$45.25</td>
<td>$27.25</td>
<td></td>
</tr>
<tr>
<td>07320</td>
<td>San Diego MSA, California</td>
<td>11-2031</td>
<td>Public Relations Managers</td>
<td>450</td>
<td>$27.90</td>
<td>$48.20</td>
<td>$96,096</td>
<td>5.92</td>
<td>$31.22</td>
<td>$58.75</td>
<td>$43.55</td>
<td>$25.95</td>
<td></td>
</tr>
<tr>
<td>07320</td>
<td>San Diego MSA, California</td>
<td>11-3011</td>
<td>Administrative Service Managers</td>
<td>2,120</td>
<td>$22.12</td>
<td>$37.21</td>
<td>$77,397</td>
<td>2.1</td>
<td>$24.76</td>
<td>$53.23</td>
<td>$47.59</td>
<td>$29.73</td>
<td></td>
</tr>
<tr>
<td>07320</td>
<td>San Diego MSA, California</td>
<td>11-3021</td>
<td>Computer and Information Systems Managers</td>
<td>2,440</td>
<td>$35.04</td>
<td>$49.85</td>
<td>$103,876</td>
<td>1.19</td>
<td>$39.96</td>
<td>$74.40</td>
<td>$57.77</td>
<td>$35.96</td>
<td></td>
</tr>
<tr>
<td>07320</td>
<td>San Diego MSA, California</td>
<td>11-3031</td>
<td>Financial Managers</td>
<td>5,290</td>
<td>$28.51</td>
<td>$47.28</td>
<td>$96,338</td>
<td>3.02</td>
<td>$32.77</td>
<td>$62.02</td>
<td>$50.25</td>
<td>$35.25</td>
<td></td>
</tr>
<tr>
<td>07320</td>
<td>San Diego MSA, California</td>
<td>11-3041</td>
<td>Compensation and Benefits Managers</td>
<td>530</td>
<td>$22.95</td>
<td>$34.22</td>
<td>$71,179</td>
<td>1.76</td>
<td>$26.65</td>
<td>$40.65</td>
<td>$33.65</td>
<td>$22.65</td>
<td></td>
</tr>
<tr>
<td>07320</td>
<td>San Diego MSA, California</td>
<td>11-3042</td>
<td>Training and Development Managers</td>
<td>310</td>
<td>$17.79</td>
<td>$30.37</td>
<td>$63,155</td>
<td>4.75</td>
<td>$22.26</td>
<td>$38.41</td>
<td>$30.52</td>
<td>$19.84</td>
<td></td>
</tr>
<tr>
<td>07320</td>
<td>San Diego MSA, California</td>
<td>11-3049</td>
<td>Human Resources Managers, All Other</td>
<td>620</td>
<td>$30.15</td>
<td>$43.10</td>
<td>$89,857</td>
<td>1.42</td>
<td>$33.09</td>
<td>$66.97</td>
<td>$51.52</td>
<td>$33.09</td>
<td></td>
</tr>
<tr>
<td>07320</td>
<td>San Diego MSA, California</td>
<td>11-3051</td>
<td>Industrial Production Managers</td>
<td>1,650</td>
<td>$25.31</td>
<td>$43.52</td>
<td>$90,519</td>
<td>5.41</td>
<td>$28.36</td>
<td>$58.75</td>
<td>$53.53</td>
<td>$28.36</td>
<td></td>
</tr>
<tr>
<td>07320</td>
<td>San Diego MSA, California</td>
<td>11-3061</td>
<td>Purchasing Managers</td>
<td>930</td>
<td>$26.06</td>
<td>$41.22</td>
<td>$85,728</td>
<td>3.18</td>
<td>$29.76</td>
<td>$58.77</td>
<td>$48.67</td>
<td>$29.76</td>
<td></td>
</tr>
<tr>
<td>07320</td>
<td>San Diego MSA, California</td>
<td>11-3071</td>
<td>Transportation, Storage, and Distribution Managers</td>
<td>650</td>
<td>$21.52</td>
<td>$32.59</td>
<td>$67,778</td>
<td>2.4</td>
<td>$24.47</td>
<td>$41.67</td>
<td>$31.76</td>
<td>$24.47</td>
<td></td>
</tr>
<tr>
<td>07320</td>
<td>San Diego MSA, California</td>
<td>11-4021</td>
<td>Construction Managers</td>
<td>1,630</td>
<td>$28.93</td>
<td>$42.03</td>
<td>$87,423</td>
<td>4.46</td>
<td>$32.81</td>
<td>$52.04</td>
<td>$40.17</td>
<td>$32.81</td>
<td></td>
</tr>
<tr>
<td>07320</td>
<td>San Diego MSA, California</td>
<td>11-4031</td>
<td>Education Administrators, Preschool and Child Care Centers/Programs</td>
<td>700</td>
<td>$15.67</td>
<td>$34.16</td>
<td>$71,044</td>
<td>21.87</td>
<td>$17.68</td>
<td>$22.94</td>
<td>$14.11</td>
<td>$17.68</td>
<td></td>
</tr>
<tr>
<td>07320</td>
<td>San Diego MSA, California</td>
<td>11-4032</td>
<td>Education Administrators, Elementary and Secondary School</td>
<td>1,160</td>
<td>(2)</td>
<td>(2)</td>
<td>$39,058</td>
<td>2.78</td>
<td>(2)</td>
<td>(2)</td>
<td>(2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>07320</td>
<td>San Diego MSA, California</td>
<td>11-4033</td>
<td>Education Administrators, Postsecondary</td>
<td>570</td>
<td>$23.56</td>
<td>$40.47</td>
<td>$84,178</td>
<td>3.67</td>
<td>$27.24</td>
<td>$38.45</td>
<td>$27.24</td>
<td>$27.24</td>
<td></td>
</tr>
<tr>
<td>07320</td>
<td>San Diego MSA, California</td>
<td>11-4036</td>
<td>Education Administrators, All Other</td>
<td>220</td>
<td>$19.49</td>
<td>$32.48</td>
<td>$67,579</td>
<td>5.85</td>
<td>$23.36</td>
<td>$31.24</td>
<td>$21.36</td>
<td>$16.90</td>
<td></td>
</tr>
<tr>
<td>07320</td>
<td>San Diego MSA, California</td>
<td>11-4041</td>
<td>Engineering Managers</td>
<td>3,020</td>
<td>$38.80</td>
<td>$54.66</td>
<td>$113,720</td>
<td>1.82</td>
<td>$43.56</td>
<td>$65.10</td>
<td>$63.70</td>
<td>$43.56</td>
<td></td>
</tr>
<tr>
<td>07320</td>
<td>San Diego MSA, California</td>
<td>11-4051</td>
<td>Food Service Managers</td>
<td>2,550</td>
<td>$14.63</td>
<td>$20.58</td>
<td>$42,803</td>
<td>3.51</td>
<td>$15.67</td>
<td>$18.72</td>
<td>$15.67</td>
<td>$10.26</td>
<td></td>
</tr>
<tr>
<td>07320</td>
<td>San Diego MSA, California</td>
<td>11-4081</td>
<td>Funeral Directors</td>
<td>70</td>
<td>$20.18</td>
<td>$31.82</td>
<td>$66,183</td>
<td>11.95</td>
<td>$22.87</td>
<td>$29.39</td>
<td>$24.05</td>
<td>$22.87</td>
<td></td>
</tr>
<tr>
<td>07320</td>
<td>San Diego MSA, California</td>
<td>11-4087</td>
<td>Gaming Managers</td>
<td>40</td>
<td>$32.46</td>
<td>$46.04</td>
<td>$85,756</td>
<td>5.35</td>
<td>$36.11</td>
<td>$42.43</td>
<td>$53.49</td>
<td></td>
<td></td>
</tr>
<tr>
<td>07320</td>
<td>San Diego MSA, California</td>
<td>11-4088</td>
<td>Lodging Managers</td>
<td>490</td>
<td>$18.86</td>
<td>$29.16</td>
<td>$60,523</td>
<td>10.99</td>
<td>$21.02</td>
<td>$25.70</td>
<td>$14.46</td>
<td>$14.46</td>
<td></td>
</tr>
</tbody>
</table>

Valuing Accidents

Most federal and state transportation agencies that perform benefit-cost analyses have well-established estimates for the dollar value of saving a human life. These figures are often called the "value of a statistical life" (VSL) to emphasize that the value refers not to any particular person's life, but to the reduction of statistically expected fatalities or injuries.

Researchers have estimated the VSL by evaluating both the willingness to pay for safety improvements and the willingness to accept compensation for increased risk. Some studies examine people's stated preferences, often by using contingent valuation. Others look at revealed preferences, such as the amount drivers will pay for a car with extra airbags or the amount that companies must pay workers to take unusually risky jobs. These methods are generally easier for the public to accept than methods that weigh human capital costs, which focus on a person's future earning power; doing so places a very low value on children and the elderly.

Most agencies also have well-established values for the prevention of property damage in a single accident. These values are less subjective than the VSL, because most property that is damaged in accidents already has an established value.

For highway accidents, the Cal-B/C model uses a VSL of $3,104,738 for a fatal accident, a value of $81,572 for an injury accident, and a value of $5,850 for a property damage only (PDO) accident. The model uses different values for other types of roads and modes of transit.

Other models and other state transportation agencies may use different values. For example, as of January 2004, the US Department of Transportation uses a VSL of $3 million for fatalities. The department adjusts this value periodically to reflect inflation.

Acknowledgements

Hosted by the Caltrans Office of Transportation Economics

Created by the California Center for Innovative Transportation at the Institute of Transportation Studies at the University of California at Berkeley and the Committee on Planning and Economics of the American Society of Civil Engineers

Access to Many documents on our web site are in PDF format and requires the Adobe Acrobat Reader. You can download this for free by clicking on the Adobe icon. If you have problems, the document may be obtained in a different format.

Last updated: August 6, 2004
Vehicle Operating Costs Methodology

Estimating a change in vehicle operating costs can be as simple as using a fixed cost-per-mile figure or as complicated as estimating the costs associated with each separate factor affecting vehicle operating costs. Vehicle type and speed are the two dominating factors in determining vehicle operating costs. Estimating the costs of such factors as road roughness requires investments in data collection that may not be justified by the potential increase in an estimate's accuracy. Considering fuel and non-fuel components can provide results within acceptable bounds of accuracy with a reasonable amount of data collection. Both the STEAM and Cal-B/C models use this approach, which is described in greater detail below.

Fuel-Related Costs

The relationship between fuel consumption rates and speed is the most widely understood of the operating cost factors. The Cal-B/C model uses the following fuel consumption rates (see table below), obtained from the California Air Resources Board's Motor Vehicle Emission Inventory (MVEI) models, and consumption-by-speed relationships modeled in HEEM.

<table>
<thead>
<tr>
<th>Speed</th>
<th>Auto</th>
<th>Truck</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>0.162</td>
<td>0.310</td>
</tr>
<tr>
<td>10</td>
<td>0.123</td>
<td>0.181</td>
</tr>
<tr>
<td>15</td>
<td>0.089</td>
<td>0.135</td>
</tr>
<tr>
<td>20</td>
<td>0.068</td>
<td>0.118</td>
</tr>
<tr>
<td>25</td>
<td>0.054</td>
<td>0.120</td>
</tr>
<tr>
<td>30</td>
<td>0.044</td>
<td>0.133</td>
</tr>
<tr>
<td>35</td>
<td>0.037</td>
<td>0.156</td>
</tr>
<tr>
<td>40</td>
<td>0.034</td>
<td>0.185</td>
</tr>
<tr>
<td>45</td>
<td>0.033</td>
<td>0.223</td>
</tr>
<tr>
<td>50</td>
<td>0.033</td>
<td>0.264</td>
</tr>
<tr>
<td>55</td>
<td>0.034</td>
<td>0.316</td>
</tr>
<tr>
<td>60</td>
<td>0.037</td>
<td>0.374</td>
</tr>
<tr>
<td>65</td>
<td>0.043</td>
<td>0.439</td>
</tr>
<tr>
<td>70</td>
<td>0.052</td>
<td>0.511</td>
</tr>
</tbody>
</table>

These fuel consumption rates can be multiplied by the number of vehicles, the length of the roadway, and the price of fuel to estimate the total fuel-related operating cost. Fuel costs are typically the largest portion of vehicle operating costs (VTPI 2003). The price of fuel should not include fuel taxes, which are considered transfer payments.

Current and historic fuel prices can be obtained through a variety of sources. A few are listed here:

http://www.dot.ca.gov/hq/tpp/offices/ote/Benefit_Cost/benefits/vehicle_operating_cost/method.html

Non-Fuel-Related Costs

Non-fuel-related costs include the costs of oil, tires, maintenance and repairs, and depreciation. The STEAM model estimates tire and maintenance costs using a fixed cost-per-mile for automobiles and trucks regardless of speed, ignoring depreciation or oil costs. The Cal-B/C model employs the same fixed cost-per-mile plus an additional estimate for depreciation. This depreciation estimate is based on a report by Jack Faucett Associates (1992) for the FHWA. The fixed cost-per-mile estimates for automobiles and trucks used in the Cal-B/C model are listed below.

**Non-Fuel Costs ($/mi.) in 2000 dollars**

<table>
<thead>
<tr>
<th>Vehicle Class</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Automobiles</td>
<td>$0.165</td>
</tr>
<tr>
<td>Trucks</td>
<td>$0.285</td>
</tr>
</tbody>
</table>

Once both components of vehicle operating costs have been determined, they can be summed to find the total vehicle operating costs.

The Cal-B/C and STEAM methodologies estimate vehicle operating costs using VMT and travel speeds. However, as stated earlier in this section, other factors such as speed cycling, roadway gradient, roadway curvature, and road surface can also affect vehicle operating costs. The HERST Technical Report Appendix D lists the vehicle operating cost equations that account for these factors in the HERS model (FHWA, 2002). Equations such as these will likely lead to better estimates, though the necessary data may not be available for such a detailed analysis. For many purposes the methodology used by Cal-B/C is appropriate. However, transportation improvements that significantly affect roadway geometry and/or road surface will alter vehicle operating costs and should be taken into account if possible.

**Sources**


<table>
<thead>
<tr>
<th>VMT Auto</th>
<th>VMT Truck</th>
<th>Speed</th>
<th>Fuel Consumption Rate Auto</th>
<th>Fuel Consumption Rate Truck</th>
<th>Sum Auto</th>
<th>Sum Truck</th>
<th>Total</th>
<th>Cost of Gas</th>
<th>Fuel Cost</th>
<th>Non-Fuel Costs Auto</th>
<th>Non-Fuel Costs Truck</th>
<th>Total Fuel and Non-Fuel Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>102,542,440</td>
<td>4,358,800</td>
<td>5</td>
<td>0.182</td>
<td>0.131</td>
<td>18,662,724</td>
<td>1,350,608</td>
<td>20,013,332</td>
<td>$2.3975</td>
<td>$47,981,964</td>
<td>$0.165</td>
<td>$0.285</td>
<td>$0.165</td>
</tr>
<tr>
<td>209,723,920</td>
<td>9,874,760</td>
<td>10</td>
<td>0.123</td>
<td>0.181</td>
<td>25,796,042</td>
<td>1,787,332</td>
<td>27,583,374</td>
<td>$2.3975</td>
<td>$66,131,138</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>440,622,640</td>
<td>21,386,400</td>
<td>15</td>
<td>0.089</td>
<td>0.135</td>
<td>39,215,433</td>
<td>2,687,164</td>
<td>42,102,597</td>
<td>$2.3975</td>
<td>$100,940,976</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1,397,788,000</td>
<td>75,005,840</td>
<td>20</td>
<td>0.068</td>
<td>0.116</td>
<td>95,049,584</td>
<td>8,650,689</td>
<td>103,900,273</td>
<td>$2.3975</td>
<td>$249,691,005</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2,370,053,280</td>
<td>125,492,640</td>
<td>25</td>
<td>0.054</td>
<td>0.120</td>
<td>127,982,677</td>
<td>15,059,117</td>
<td>143,041,994</td>
<td>$2.3975</td>
<td>$342,943,180</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3,903,214,840</td>
<td>206,687,600</td>
<td>30</td>
<td>0.044</td>
<td>0.153</td>
<td>171,741,453</td>
<td>27,489,451</td>
<td>199,230,904</td>
<td>$2.3975</td>
<td>$477,656,092</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2,188,023,320</td>
<td>117,861,240</td>
<td>35</td>
<td>0.037</td>
<td>0.156</td>
<td>80,956,863</td>
<td>18,386,353</td>
<td>99,343,216</td>
<td>$2.3975</td>
<td>$238,175,361</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1,577,248,400</td>
<td>90,193,320</td>
<td>40</td>
<td>0.034</td>
<td>0.185</td>
<td>53,626,446</td>
<td>16,685,764</td>
<td>70,312,210</td>
<td>$2.3975</td>
<td>$168,573,523</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1,081,414,040</td>
<td>65,241,400</td>
<td>45</td>
<td>0.033</td>
<td>0.223</td>
<td>35,686,663</td>
<td>14,548,832</td>
<td>50,235,496</td>
<td>$2.3975</td>
<td>$120,439,601</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1,260,474,040</td>
<td>80,618,720</td>
<td>50</td>
<td>0.033</td>
<td>0.284</td>
<td>41,955,843</td>
<td>21,283,342</td>
<td>62,239,185</td>
<td>$2.3975</td>
<td>$150,752,307</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1,028,555,360</td>
<td>78,182,120</td>
<td>55</td>
<td>0.034</td>
<td>0.316</td>
<td>34,970,882</td>
<td>24,073,530</td>
<td>59,044,412</td>
<td>$2.3975</td>
<td>$141,559,028</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1,584,017,680</td>
<td>127,477,560</td>
<td>60</td>
<td>0.037</td>
<td>0.374</td>
<td>58,806,654</td>
<td>47,676,607</td>
<td>106,483,262</td>
<td>$2.3975</td>
<td>$254,816,915</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7,880,058,400</td>
<td>593,974,920</td>
<td>65</td>
<td>0.043</td>
<td>0.439</td>
<td>330,242,511</td>
<td>290,754,990</td>
<td>621,007,501</td>
<td>$2.3975</td>
<td>$1,416,916,509</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>24,823,738,560</td>
<td>1,594,353,320</td>
<td>70</td>
<td>0.052</td>
<td>0.511</td>
<td>1,114,135,776</td>
<td>458,833,799</td>
<td>1,573,969,575</td>
<td>$3,775,989,556.54</td>
<td>4,095,916,532.40</td>
<td>454,390,696.20</td>
<td>8,326,299,785.14</td>
<td></td>
</tr>
</tbody>
</table>

* The Fuel Cost calculation requires multiple steps: first auto and truck VMT (in 5 mph categories) should be multiplied by their associated consumption rates, then totaled in separate auto and truck categories. These totals should then be multiplied by the cost of gas. Category specific VMT should be multiplied by non-fuel cost. The total of the fuel and non-fuel costs should be added together to get the total operating costs.

** The numbers listed are calculated for a 280 day Annual operating cost.
## Operating Costs

<table>
<thead>
<tr>
<th>VMT Auto</th>
<th>VMT Truck</th>
<th>Speed</th>
<th>Fuel Consumption Rate Auto</th>
<th>Fuel Consumption Rate Truck</th>
<th>Sum Auto</th>
<th>Sum Truck</th>
<th>Total</th>
<th>Cost per Gallon of Gas</th>
<th>Non-Fuel Costs Auto</th>
<th>Non-Fuel Costs Truck</th>
<th>Total Fuel and Non-Fuel Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>143,131,520</td>
<td>0,898,680</td>
<td>5</td>
<td>0.182</td>
<td>0.31</td>
<td>26,049,937</td>
<td>2,129,291</td>
<td>28,179,227</td>
<td>$2.3975</td>
<td>$67,559,698</td>
<td>$0.165</td>
<td>$0.285</td>
</tr>
<tr>
<td>256,924,080</td>
<td>12,594,680</td>
<td>10</td>
<td>0.123</td>
<td>0.181</td>
<td>31,601,862</td>
<td>2,279,637</td>
<td>33,881,299</td>
<td>$2.3975</td>
<td>$81,220,414</td>
<td></td>
<td></td>
</tr>
<tr>
<td>483,432,040</td>
<td>23,504,320</td>
<td>15</td>
<td>0.098</td>
<td>0.135</td>
<td>43,025,452</td>
<td>3,173,083</td>
<td>46,198,535</td>
<td>$2.3975</td>
<td>$110,760,957</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1,530,874,520</td>
<td>82,344,640</td>
<td>20</td>
<td>0.098</td>
<td>0.118</td>
<td>104,099,467</td>
<td>9,716,658</td>
<td>113,816,135</td>
<td>$2.3975</td>
<td>$272,874,183</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2,514,175,160</td>
<td>133,812,840</td>
<td>25</td>
<td>0.054</td>
<td>0.12</td>
<td>135,765,459</td>
<td>10,057,541</td>
<td>155,822,999</td>
<td>$2.3975</td>
<td>$363,995,641</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4,040,680,680</td>
<td>216,944,560</td>
<td>30</td>
<td>0.044</td>
<td>0.133</td>
<td>177,785,990</td>
<td>25,853,695</td>
<td>203,639,685</td>
<td>$2.3975</td>
<td>$495,418,480</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2,243,782,240</td>
<td>122,535,840</td>
<td>35</td>
<td>0.037</td>
<td>0.156</td>
<td>83,019,943</td>
<td>10,115,691</td>
<td>93,135,634</td>
<td>$2.3975</td>
<td>$244,869,943</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1,816,408,920</td>
<td>91,256,200</td>
<td>40</td>
<td>0.034</td>
<td>0.158</td>
<td>54,957,903</td>
<td>18,882,297</td>
<td>73,840,200</td>
<td>$2.3975</td>
<td>$172,237,120</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1,104,754,280</td>
<td>67,415,600</td>
<td>45</td>
<td>0.033</td>
<td>0.223</td>
<td>36,456,891</td>
<td>15,033,679</td>
<td>51,490,570</td>
<td>$2.3975</td>
<td>$123,448,642</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1,219,690,080</td>
<td>79,888,200</td>
<td>50</td>
<td>0.033</td>
<td>0.264</td>
<td>40,249,773</td>
<td>21,080,485</td>
<td>61,330,257</td>
<td>$2.3975</td>
<td>$147,063,267</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1,061,276,600</td>
<td>50,570,800</td>
<td>55</td>
<td>0.034</td>
<td>0.316</td>
<td>35,743,506</td>
<td>25,401,973</td>
<td>61,145,479</td>
<td>$2.3975</td>
<td>$146,812,051</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1,816,194,160</td>
<td>134,307,240</td>
<td>60</td>
<td>0.037</td>
<td>0.374</td>
<td>59,799,184</td>
<td>50,253,348</td>
<td>110,052,532</td>
<td>$2.3975</td>
<td>$263,850,945</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7,061,716,760</td>
<td>544,004,440</td>
<td>65</td>
<td>0.043</td>
<td>0.439</td>
<td>303,653,821</td>
<td>238,817,949</td>
<td>542,471,770</td>
<td>$2.3975</td>
<td>$1,300,576,065</td>
<td></td>
<td></td>
</tr>
<tr>
<td>24,682,954,040</td>
<td>1,596,206,040</td>
<td>70</td>
<td>0.052</td>
<td>0.511</td>
<td>1,132,208,967</td>
<td>448,896,267</td>
<td>1,581,104,234</td>
<td>$3,790,697,449.54</td>
<td>4,105,687,416.60</td>
<td>454,919,291.40</td>
<td>8,351,304,157.54</td>
</tr>
</tbody>
</table>

* The Fuel Cost calculation requires multiple steps- first auto and truck VMT (in 5 mph categories) should be multiplied by their associated consumption rates, then totaled in separate auto and truck categories. These totals should then be multiplied by the cost of gas. Category specific VMT should be multiplied by non-fuel cost. The total of the fuel and non-fuel costs should be added together to get the total operating costs.

** The numbers listed are calculated for a 280 day Annual operating cost.
## Air Pollution Costs Attributable to Different Vehicle Classes

Table 11 shows percentages of different types of emissions attributable to the vehicle classes included in EPA models. These vehicle classes do not correspond well with vehicle classes used by the Department for highway cost allocation and truck size and weight analyses. In particular, most of the trucks with three or more axles are all grouped in the EPA class of heavy duty diesel vehicles. Thus, it is difficult to directly use the EPA models to estimate air pollution costs attributable to the different highway cost allocation study vehicle classes.

### Table 11. Distribution of Various Emissions by Vehicle Class

<table>
<thead>
<tr>
<th></th>
<th>LD Gas Vehicles</th>
<th>LD Gas Trucks 1</th>
<th>LD Gas Trucks 2</th>
<th>HD Gas Vehicles</th>
<th>LD Diesel Vehicles</th>
<th>LD Diesel Trucks</th>
<th>HD Diesel Vehicles</th>
<th>Motorcycles</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>SOA</td>
<td>51%</td>
<td>15%</td>
<td>10%</td>
<td>5%</td>
<td>0%</td>
<td>0%</td>
<td>17%</td>
<td>1%</td>
<td>99%</td>
</tr>
<tr>
<td>SOx</td>
<td>45%</td>
<td>15%</td>
<td>8%</td>
<td>3%</td>
<td>0%</td>
<td>0%</td>
<td>29%</td>
<td>0%</td>
<td>100%</td>
</tr>
<tr>
<td>NOx</td>
<td>42%</td>
<td>29%</td>
<td>0%</td>
<td>4%</td>
<td>0%</td>
<td>0%</td>
<td>25%</td>
<td>0%</td>
<td>100%</td>
</tr>
<tr>
<td>VOC</td>
<td>60%</td>
<td>30%</td>
<td>0%</td>
<td>5%</td>
<td>0%</td>
<td>0%</td>
<td>5%</td>
<td>0%</td>
<td>100%</td>
</tr>
<tr>
<td>PM10</td>
<td>26%</td>
<td>7%</td>
<td>4%</td>
<td>3%</td>
<td>0%</td>
<td>0%</td>
<td>59%</td>
<td>0%</td>
<td>99%</td>
</tr>
<tr>
<td>PM, coarse</td>
<td>47%</td>
<td>12%</td>
<td>7%</td>
<td>4%</td>
<td>0%</td>
<td>0%</td>
<td>29%</td>
<td>0%</td>
<td>99%</td>
</tr>
<tr>
<td>PM2.5</td>
<td>19%</td>
<td>6%</td>
<td>3%</td>
<td>3%</td>
<td>0%</td>
<td>0%</td>
<td>68%</td>
<td>0%</td>
<td>99%</td>
</tr>
<tr>
<td>Group 1</td>
<td>50%</td>
<td>29%</td>
<td>0%</td>
<td>4%</td>
<td>0%</td>
<td>0%</td>
<td>16%</td>
<td>0%</td>
<td>99%</td>
</tr>
<tr>
<td>Group 2</td>
<td>50%</td>
<td>28%</td>
<td>0%</td>
<td>4%</td>
<td>0%</td>
<td>0%</td>
<td>17%</td>
<td>0%</td>
<td>100%</td>
</tr>
<tr>
<td>Group 3</td>
<td>50%</td>
<td>28%</td>
<td>1%</td>
<td>4%</td>
<td>0%</td>
<td>0%</td>
<td>17%</td>
<td>0%</td>
<td>100%</td>
</tr>
</tbody>
</table>

- **LD Gas Vehicle** - gas-powered automobile
- **LD Gas Truck 1** - gas-powered trucks weighing 6,000 pounds or less (pickups, vans, etc.)
- **LD Gas Truck 2** - gas powered trucks weighing between 6,001 and 8,500 pounds
- **HD Gas Vehicles** - gas powered trucks and buses weighing more than 8,500 pounds
- **LD Diesel Vehicle** - Diesel-powered automobiles
- **LD Diesel Trucks** - diesel-powered trucks weighing 8,500 pounds or less
- **HD Diesel Vehicles** - diesel-powered vehicles weighing more than 8,500 pounds
- **SOA** - secondary organic aerosols
- **SOx** - sulfur dioxide
- **NOx** - nitrogen oxide
- **VOC** - Volatile organic compounds
- **PM10** - directly emitted particulate matter less than 10 microns
- **PM, coarse** - directly emitted particulate matter between 10 and 2.5 microns
- **PM2.5** - directly emitted particulate matter less than 2.5 microns
- **Group 1 - VOC and NOX, the primary precursor emissions for ozone**
- **Group 2 - Group 1 plus PM2.5, SOx, and SOA, precursors for both ozone and PM formation**
- **Group 3 - Group 2 plus ammonia, a precursor for both ozone and PM formation**

Except for PM\textsubscript{10} and PM\textsubscript{2.5}, automobiles account for the largest share of various motor vehicle emissions. Because of the complex chemical processes by which emissions are transformed into particulate matter, ozone, and other secondary pollutants, and variations in the transport of pollutants in different regions of the country, relative emissions attributable to different vehicle classes cannot be directly translated into relative air pollution costs without detailed air quality modeling that was beyond the scope of this project. For instance, while heavy trucks account for a large share of particulate emissions, they account for a smaller share of costs because significant portions of particulate matter are formed through chemical reactions involving other compounds emitted predominantly by light trucks and passenger vehicles.

Four vehicle classes are responsible for 99 percent of all emissions: automobiles; pickups, vans, and sport utility vehicles; heavy duty gas vehicles; and heavy duty diesel vehicles. Other vehicle classes have much less VMT, and thus their total emissions are lower, although emissions per mile of travel would be comparable. The emissions modeling approach used in this study did not differentiate emissions more finely than the eight vehicle classes shown in Table 11. While the relative emissions shown in Table 11 do not directly correspond to the relative contribution to pollution and pollution-related costs for different vehicle classes, they do indicate the relative order of magnitude of the contribution by different vehicle classes. Further work is underway to improve estimates of emissions by different vehicle classes under a variety of operating conditions. This work should improve the ability to estimate the relative contribution to air pollution costs by different vehicle classes.

Table 12 uses the percentages from Table 11 to estimate total costs attributable to the four EPA vehicle classes that account for the majority of costs along with the average costs per mile of travel for each vehicle class. Costs are estimated by taking proportions of total precursor emissions for each vehicle class, based upon the Group 3 set of emissions shown in Table 11, and multiplying by total air pollution costs. Costs per mile are estimated by dividing total costs for each vehicle class by the VMT for that class. Passenger vehicles (automobiles, pickups and vans) account for about three-quarters of total estimated costs. Costs per mile for pickups and vans are closer to those of trucks than they are to costs per mile for automobiles because pickups and vans are not subject to the same tailpipe emissions standards as automobiles and because they get poorer fuel economy than automobiles.

<table>
<thead>
<tr>
<th>Vehicle Class</th>
<th>Total Estimated Cost ($1990 millions)</th>
<th>Cents Per Mile of Travel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Automobiles</td>
<td>$20,343</td>
<td>1.1</td>
</tr>
<tr>
<td>Pickups, Vans</td>
<td>$11,324</td>
<td>2.6</td>
</tr>
<tr>
<td>Gasoline Vehicles &gt; 8,500 pounds</td>
<td>$1,699</td>
<td>3.0</td>
</tr>
<tr>
<td>Diesel Vehicles &gt; 8,500 pounds</td>
<td>$6,794</td>
<td>3.9</td>
</tr>
<tr>
<td>Overall</td>
<td>$40,443</td>
<td>1.5</td>
</tr>
</tbody>
</table>

www.fhwa.dot.gov/policy/hcas/addendum.htm
San Diego Association of Governments - TransNet Program

INDEPENDENT TAXPAYER OVERSIGHT COMMITTEE

December 7, 2005

AGENDA ITEM NO.: 5

Action Requested: DISCUSSION/POTENTIAL ACTION

DRAFT RECOMMENDATIONS ON PROGRAM MANAGEMENT AND QUARTERLY REPORTING

File Number 1110200

Attachments related to this item are:

2. Worksheet 1 – Continuing Improvement of TransNet Program Management Priorities
3. PBS&J Program Management Assessment – December 2006 (prepared for SANDAG and Caltrans District 11)
Highway and Transit Capital Project Development
2006 Priorities

• Maintain culture of continuous improvement
• Instill confidence with San Diego County voters by keeping promises
• Improve mobility by delivering projects on Early Action Corridors: I-5, I-15, I-805, Mid-Coast, SR 52, and SR 76
• Refine organizational structure to more clearly define roles and responsibilities and facilitate decision-making process
• Develop system that clearly and efficiently communicates and reports project progress
• Build highly performing teams consisting of both highway and transit professionals
### Worksheet 1 - Continuing Improvement of TransNet Program Management Priorities

<table>
<thead>
<tr>
<th>Measure</th>
<th>Description</th>
<th>Joint Priority</th>
<th>Efficiency</th>
<th>Effectiveness</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SCOPE AND COST ESTIMATE</strong></td>
<td><strong>HIGH</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Budget Control</td>
<td>Develop a process and implement tools to have a better control on budget.</td>
<td>Process improves operations and ease of conveying budget information</td>
<td>Improved process and tools results in improved ability to adjust budgets and make decisions</td>
<td></td>
</tr>
<tr>
<td>Cost Estimating</td>
<td>Discuss, evaluate current process, and develop and implement a modified process to frequently update cost estimates.</td>
<td>Process improves time to perform estimates and allows for focus on results</td>
<td>Improved process and tools results in improved accuracy for the work program</td>
<td></td>
</tr>
<tr>
<td>Project Risk</td>
<td>Establish risk factors and a process.</td>
<td>Identification of risks allows for efficient management by avoiding surprises</td>
<td>Identification and tracking of risks allows for early mitigation</td>
<td></td>
</tr>
<tr>
<td>Scope Tracking</td>
<td>Discuss current process and develop a modified process to monitor and approve scope changes and their impacts on costs and schedules.</td>
<td>Process improves ability to easily track changes and issues</td>
<td>Allows for analysis and decisions on changes throughout the Program</td>
<td></td>
</tr>
<tr>
<td><strong>ORGANIZATION STRUCTURE</strong></td>
<td><strong>HIGH</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Caltrans Corridor Managers</td>
<td>Appoint a corridor manager, a single focal point, to better integrate the highway and transit components, coordinate issues, and monitor scope, schedule, and cost to successfully deliver the final project.</td>
<td>Streamlined organization, clear point of responsibility</td>
<td>Point of accountability for effective management and coordination</td>
<td></td>
</tr>
<tr>
<td>Decision Making Process</td>
<td>A formal “Change Management” process that outlines steps as to what, how and who make decisions. In addition a multi-level process to make decisions and resolve issues at the lowest possible level, when possible. The process should follow mutually developed and acceptable criteria.</td>
<td>Efficient use of management time and resources</td>
<td>Allows for those with the most information to make the decisions, and for senior management to provide the proper monitoring and control</td>
<td></td>
</tr>
<tr>
<td>Roles and Responsibilities</td>
<td>These offices will be charged with responsibility to monitor program implementation, project control procedures, and produce progress reports.</td>
<td>Improved efficiency in carrying out the Program work efforts</td>
<td>Accountability for carrying out tasks improves effectiveness</td>
<td></td>
</tr>
<tr>
<td><strong>DASHBOARD</strong></td>
<td><strong>HIGH</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dashboard Concept</td>
<td>Develop reports that offer snapshots of projects, corridor, and the TransNet Program.</td>
<td>Less searching for and creation of “scattered” information</td>
<td>Provides managers information to make effective decisions</td>
<td></td>
</tr>
<tr>
<td>Economic Trends</td>
<td>Discuss ways to monitor economic trends and its impact on projects.</td>
<td>Provides information instead of requiring searches</td>
<td>Valuable information for effective use throughout the Program</td>
<td></td>
</tr>
<tr>
<td><strong>PROJECT EXPENDITURES</strong></td>
<td><strong>HIGH</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-------------------------</td>
<td>---------</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Project Expenditures</td>
<td>Produce reports to track expenditures and establish mechanism to implement required preventative and corrective steps.</td>
<td>Consistent informative reports require less fire drills and searches for information</td>
<td>Ability to review expenditures and make decisions for the future</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>SCHEDULE MANAGEMENT</strong></th>
<th><strong>MEDIUM</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Scheduling</td>
<td>SANDAG and Caltrans use different software for scheduling. Use a standardized scheduling system on a common scheduling platform that makes cross-project integration of logic and resources.</td>
</tr>
<tr>
<td>Resource Loading</td>
<td>Importance of resource loading schedules and monitoring status.</td>
</tr>
<tr>
<td>Measure</td>
<td>Description</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>QA/QC (INCLUDES VALUE ANALYSIS)</td>
<td>Process improves efficiency and ability to enhance quality</td>
</tr>
<tr>
<td>QA/QC (Includes Value Analysis)</td>
<td>enchmark improves efficiency and ability to enhance quality</td>
</tr>
<tr>
<td>EARNED VALUE</td>
<td>Implement earned value concept to integrate cost, schedule and performance to measure, monitor and control project resources.</td>
</tr>
<tr>
<td>Earned Value</td>
<td>Implement earned value concept to integrate cost, schedule and performance to measure, monitor and control project resources.</td>
</tr>
<tr>
<td>DOCUMENT CONTROL</td>
<td>Discuss a need for a document control on projects and the program; evaluate existing software such as Expedition, Share Point, and Edge Builder, and consider selecting one of them to enhance control of events, changes, and impacts.</td>
</tr>
<tr>
<td>Document Control</td>
<td>Discuss a need for a document control on projects and the program; evaluate existing software such as Expedition, Share Point, and Edge Builder, and consider selecting one of them to enhance control of events, changes, and impacts.</td>
</tr>
</tbody>
</table>
Program Management Assessment

Prepared for San Diego Association of Governments and Caltrans District 11

December 2005
# Contents

Acronyms and Abbreviations ........................................................................................................ iii

1. Introduction .............................................................................................................................. 1
   1.1. TransNet Program Overview ........................................................................................ 1
   1.2. Report Overview ............................................................................................................ 2

2. Purpose and Need .................................................................................................................. 3

3. Interviews ............................................................................................................................... 5

   4.1. Introduction .................................................................................................................... 9
   4.2. Risk Management .......................................................................................................... 9
   4.3. Schedule Control .......................................................................................................... 14
   4.4. Budget Control ........................................................................................................... 15
   4.5. Business Processes ...................................................................................................... 15
   4.6. Issues of Concern ......................................................................................................... 16
   4.7. Analytical Tools/Earned Value .................................................................................... 17
   4.8. Change Control ............................................................................................................ 18
   4.9. Communications Management .................................................................................... 20

5. Recommendations ................................................................................................................ 22
   5.1. Risk Management ......................................................................................................... 22
   5.2. Scope Management ...................................................................................................... 23
   5.3. Schedule Management .................................................................................................. 24
   5.4. Cost Management ........................................................................................................ 25
   5.5. Resource Management ............................................................................................... 26
   5.6. Quality Management ................................................................................................... 27
   5.7. Information Management ............................................................................................ 28
   5.8. Organizational Structure ............................................................................................. 32

6. Conclusion, Priorities, and Implementation Schedule ........................................................... 38

# Figures

1. Sample Probability Curve with Greater Risk ........................................................................ 11
2. Sample Probability Curve with Minimal Risk .................................................................... 11
3. Example Probability Curve ................................................................................................ 12
4. Sample Results of Risk and Probability Analysis ............................................................... 12
5. Sample Output 1 ................................................................................................................ 13
6. Sample Output 2 ................................................................................................................ 14
7. Sample P3e/c Scheduling Reports ...................................................................................... 15
8. Sample Cost Index Graph and Tabulation ......................................................................... 17
9. Sample Earned Value Plot ................................................................................................ 18
10. Sample Change Control Process ....................................................................................... 19
11. Sample Internal Web Site .................................................................................................. 20
12. Sample External Web Site .................................................................................................. 21
## Figures (continued)

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>13.</td>
<td>Project TRIP Report Concept</td>
<td>31</td>
</tr>
<tr>
<td>14.</td>
<td>Sample Organizational Structure for a Single TransNet Corridor</td>
<td>34</td>
</tr>
<tr>
<td>15.</td>
<td>TransNet Program Management Office Organizational Structure</td>
<td>36</td>
</tr>
<tr>
<td>16.</td>
<td>TransNet Program Management Priorities Implementation Schedule</td>
<td>41</td>
</tr>
</tbody>
</table>

## Appendices

<table>
<thead>
<tr>
<th>Appendix</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.</td>
<td>Interviews</td>
<td>A-1</td>
</tr>
<tr>
<td>B.</td>
<td>Benchmarking—Industry Best Practices</td>
<td>B-1</td>
</tr>
<tr>
<td>C.</td>
<td>Proposed Process to Develop Benchmark Cost, Schedules, and Scope</td>
<td>C-1</td>
</tr>
<tr>
<td>D.</td>
<td>Scope Statement for Inclusion in Future Consultant Task Orders, Schedule to Implement, and Risks and Estimates</td>
<td>D-1</td>
</tr>
<tr>
<td>E.</td>
<td>Proposed Trends, Risks, Issues, and Progress (TRIP) Process</td>
<td>E-1</td>
</tr>
<tr>
<td>F.</td>
<td>Program Management</td>
<td>F-1</td>
</tr>
</tbody>
</table>
## Acronyms and Abbreviations

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Caltrans</td>
<td>California Department of Transportation</td>
</tr>
<tr>
<td>CD</td>
<td>Compact Disk</td>
</tr>
<tr>
<td>EA</td>
<td>Expenditure Authorization</td>
</tr>
<tr>
<td>IFAS</td>
<td>Integrated Financial and Accounting System</td>
</tr>
<tr>
<td>ITOC</td>
<td>Independent Taxpayer Oversight Committee</td>
</tr>
<tr>
<td>OWP</td>
<td>Organizational Work Plan</td>
</tr>
<tr>
<td>PDF</td>
<td>Portable Data File</td>
</tr>
<tr>
<td>PIRS</td>
<td>Project Information Reporting System</td>
</tr>
<tr>
<td>PROMIS</td>
<td>Project Management Information System</td>
</tr>
<tr>
<td>QA/QC</td>
<td>Quality Assurance/Quality Control</td>
</tr>
<tr>
<td>RCMS</td>
<td>Regional Council Management System</td>
</tr>
<tr>
<td>SANDAG</td>
<td>San Diego Association of Governments</td>
</tr>
<tr>
<td>SB</td>
<td>Senate Bill</td>
</tr>
<tr>
<td>TRAMS</td>
<td>Transportation Accounting and Management System</td>
</tr>
<tr>
<td>TRIP</td>
<td>Trends, Risks, Issues, and Progress</td>
</tr>
<tr>
<td>WBS</td>
<td>Work Breakdown Structure</td>
</tr>
</tbody>
</table>
Chapter 1
Introduction

PBS&J, one of the nation’s largest engineering consulting firms, with more than 45 years of experience, has been providing full-service program management services to the Florida Turnpike, the Florida Department of Transportation, the North Texas Tollway Authority, expressway agencies, and several cities and counties across the United States.

As a general consultant, PBS&J has managed, and continues to successfully manage, programs worth billions of dollars. Our high-level activities include:

- Responsibilities and related tasks under bond resolution
- Planning (including 5- and 20-year plans)
- Production/design management
- Construction management
- Maintenance management
- Information management
- Program-/project-specific Web sites
- Right-of-way services management
- Surveying and mapping
- Environmental management
- Public information
- System integration and software development
- Toll operations, facilities, and equipment

For certain clients, our services also include preparing annual reports and overseeing up to seven prime consultants simultaneously. These consultants include URS, CH2M HILL, and Parsons Brinckerhoff. As a testament to our successful delivery of programs, PBS&J has been reselected by our clients for years.

This assignment involved reviewing program and project management processes and tools currently used by the San Diego Association of Governments (SANDAG) and the California Department of Transportation (Caltrans), determining strengths and weaknesses, and developing a list of recommendations to effectively manage and deliver the program.

1.1 TransNet Program Overview

In 1987 San Diego County residents approved the 20-year TransNet program, a one-half cent sales tax to fund a variety of transportation projects throughout San Diego County. This program, which was scheduled to expire in 2008, is one of the largest transportation improvement programs in California.

Beginning in 2003, Senate Bill 1703 (SB 1703) consolidated the roles and responsibilities of SANDAG with many transit functions of the Metropolitan Transit Development Board and the North San Diego County Transit District. SANDAG is now responsible for transit planning, funding allocation, project development, and construction in San Diego County; these responsibilities are in addition to its ongoing transportation role and other activities.
In November 2004, voters approved an extension ordinance and expenditure plan (Proposition A) that extends the TransNet program to 2048. This extension is expected to generate approximately $14 billion to be distributed among highway, transit, and local road projects to reduce traffic congestion in San Diego County.

Proposition A mandated the formation of an Independent Taxpayer Oversight Committee (ITOC) for TransNet. This committee will oversee the expenditure of TransNet funds and ensure that voter mandates are carried out. The ITOC may also make recommendations to improve the program’s financial integrity and performance.

To meet the overall program objectives, SANDAG identified Early Action Projects on Routes 5, 15, 52, 76, 805, and the Mid-Coast Light Rail Project; these projects have a 10-year completion timeline. To accomplish this objective, SANDAG, in coordination with other stakeholders, selected five consultant teams for 5-year, $10 million design and construction management on-call contracts. Tasks to be performed under these on-call contracts may include program management and the development of roadway, structure, and transit projects. Caltrans is a full partner with SANDAG in the development of roadway and structure projects, which would include widening existing facilities and providing new infrastructure, managed high-occupancy vehicle toll lanes, reversible lanes, and entry-exit points for bus rapid transit systems.

1.2 Report Overview

This report provides an overall assessment of the TransNet program and project management processes. During the preparation of this report, PBS&J conducted extensive research, review, and evaluation of the existing processes and tools used by SANDAG and Caltrans. As a result of these activities, recommendations were formulated on how to improve systems related to scope, schedule, and budget. Implementation of these recommendations will ensure continued program success and will ultimately facilitate communication, accountability, and efficiency. Concurrently, an enhanced level of responsibility and credibility will be provided to the primary stakeholders: the taxpayers of San Diego County.

The chapters in this report identify many of the challenges and issues that were reviewed and assessed early in this assignment. The report describes the detailed comments received during numerous interviews with SANDAG and Caltrans staff members. It contains detailed information gathered during the benchmarking process to assess industry standards. And it describes specific tasks, findings, and recommendations for consideration and implementation by the stakeholders.

This report is organized as follows:

- Purpose and Need
- Interviews
- Benchmarking—Industry Best Practices
- Recommendations
- Conclusion, Priorities, and Implementation Schedule
Chapter 2
Purpose and Need

The TransNet extension provides an exciting opportunity to see transportation improvements become a reality sooner than ever expected. With this opportunity come additional challenges and a public mandate for more open communication and accountability.

The 40-year extension to the TransNet program, which is anticipated to generate an additional $14 billion in sales tax revenues, has presented SANDAG with major expectations from the public in addition to enormous challenges and opportunities. The continuation of sales tax funding indicates that the public understands and supports investments in needed transportation improvements. The major change with this tax extension is the creation of the ITOC. The significance of the inclusion of an oversight committee to the program demonstrates that public and elected officials are increasingly aware of their accountability to the public sector with respect to transportation spending.

With the creation of the ITOC, SANDAG is further required to report program progress to the public and institute controls to comply with requests for increased accountability for expenditures, project priorities, possible benefits of accelerating projects, and programming of TransNet revenues. Further, it is essential to assure the public that SANDAG and its partners have taken additional steps to improve the TransNet program management with respect to project delivery, cost control, schedules, innovative contracting, construction, enhanced efficiency, and the proper use of revenues.

Until SB 1703 was enacted in 2003, SANDAG was a planning and oversight agency. This bill changed SANDAG to an implementing agency responsible for transportation improvements in the region. With this legislation, SANDAG absorbed all of the Metropolitan Transit Development Board engineering staff, and SANDAG’s role changed to encompass technical and financial responsibilities.

Since its inception, TransNet provided funding for highways, transit, and local roads, where Caltrans, the Metropolitan Transit Development Board, North San Diego County Transit District, and local agencies each worked independently to deliver their portion of the program; SANDAG continued to rely upon these agencies to complete the TransNet program. The current SANDAG program management organization has been effective in carrying out the oversight function on the original TransNet program, a much smaller program in size and cost of projects when compared to the TransNet extension.

It is important to recognize the cooperation, commitment, and enthusiasm shown by SANDAG, Caltrans, and the ITOC to successfully deliver the TransNet program. Outcomes from numerous meetings demonstrate that the current program is well-run by competent professionals who more than fulfill their obligations. It is apparent that both SANDAG and Caltrans have internal mechanisms to track scope, schedule, and budget of their respective programs. Consequently, the recommendations in, and the focus of, this report speak to the integration of existing processes tailored specifically to the collective needs of the TransNet program.
It is apparent that SANDAG and Caltrans management and staff are capable and committed, and that they understand the importance of successful delivery of the TransNet extension Transportation Improvement Projects, especially the Early Action Projects. Both agencies understand that there are differences between the original TransNet program and the TransNet extension; they are also aware that significant changes occurred before approval of the TransNet extension, and that these changes lead to increased responsibility and accountability. They recognize that to accomplish their objective, best industry practices, including program management and organization, must be in place.

While both agencies have their own independent processes, tools, and systems, they were generally designed and intended for internal use. Lack of proper processes, tools, and systems that can communicate with one other have made it difficult for SANDAG and Caltrans to effectively transfer and incorporate pertinent project information and cost effectively manage the TransNet extension program. In fact, at both agencies, a variety of systems are in use, ranging from legacy systems to state-of-the-art Web applications; however, these systems cannot accommodate the electronic sharing of data and information between the agencies.

Revenues are expended on TransNet extension projects by staff of both agencies and their consultants, but lack of a standardized work breakdown structure (WBS) and project numbering system compels each agency to perform numerous manual computations to prepare project- and/or summary-level reports. This situation has understandably generated inconsistencies.

As discussed in Chapter 3, Interviews, each agency is using different project scheduling systems that do not effectively communicate with one other. Additionally, data quality is somewhat compromised because budgets and schedules are not updated regularly and consistently. These factors have caused some budget and schedule surprises. These are just some examples of the challenges that both agencies face in adequately managing this large endeavor. Challenges, however, come with opportunities for betterment.

The TransNet extension is one of the largest and most complex transportation improvement programs in California. It is important to recognize that successful fulfillment of commitments noted in the TransNet extension ordinance may help future transportation sales tax propositions, boost the region’s economy, and enhance the credibility of SANDAG and their partner, Caltrans.

To meet the high expectations of the constituents, to improve worsening traffic conditions in the region, and to maintain the TransNet program as the region’s highest priority, despite competing interests, definite improvements to the process must be implemented to significantly enhance the management structure. These changes will also improve efficiency and effectively manage and deliver TransNet extension program commitments.

PBS&J’s review of the existing program and project management processes used by SANDAG and Caltrans was in direct response to the SANDAG Board of Director’s previous adoption of the TransNet Early Action Projects for immediate development. The Program Management Assessment specified activities to be evaluated as part of this preliminary study. This report describes the results of PBS&J’s analysis, suggests recommendations for improvement, and specifies timelines for implementation.
Chapter 3

Interviews

A significant part of this effort was to interview SANDAG and Caltrans staff to better understand their current challenges and to identify available tools to implement their respective programs. As part of this process, we also established the agencies’ expectations of the TransNet program and of each other.

During a 3-week discovery process, we identified how best to optimize and integrate different, yet effective, processes currently in place by both agencies.

The interview findings summarized in this chapter are organized as follows:

- General Comments
- Program Management
- Project Management
- Risk Management
- Scope Management
- Schedule Management
- Cost Management
- Resource Management
- Information Management

The sections below summarize our interview findings; detailed results are in Appendix A.

**General Comments.** SANDAG and Caltrans District 11 (San Diego) staff commented that theirs is the best relationship of any district and local Metropolitan Planning Organization or agency in the state; both are understandably proud of this. It was also evident that employees of both agencies understand the importance of successful delivery of the TransNet extension program, and they are committed to meeting this objective. However, they would like to see a clear communication process among all stakeholders.

**Program Management.** SANDAG relies heavily on Caltrans for TransNet program management. SANDAG noted that Caltrans has much data; however, due to the lack of proper linking tools or precise requests, they have been unable to fully develop a useful, easily understood project monitoring technique. SANDAG staff indicated that Caltrans has many talented staff members who can deliver quality projects. It was repeatedly mentioned that project managers have numerous assignments, and it is difficult to maintain the same manager with a dedicated team on each project.

Management of both SANDAG and Caltrans felt that assigning managers for corridors is essential to better coordinate, resolve issues, and make decisions in a timely manner. Implementation of this innovative concept is a high priority goal of both agencies. This concept will bring responsibility and authority to the corridor manager. In addition to the corridor manager concept, it was strongly felt that a well-defined dispute resolution process must be established to streamline decision making.
Project Management. SANDAG noted challenges in working with Caltrans on multimodal highway and transit projects, primarily due to the difficulties in coordinating among the cross-functional and cross-organizational teams.

Some Caltrans project managers feel they should have consultants perform functional work (such as environmental) because of their heavy workloads and staff shortages. TransNet extension projects are just one of several types of projects that Caltrans project managers are responsible for delivering.

Typically, Caltrans project managers have as many as 20 projects, sometimes totaling nearly $1 billion in construction. This heavy workload impedes their ability to actually manage projects. It was reported that project managers spend most of their time responding to day-to-day crises, and relief in this area would be greatly appreciated.

Risk Management. SANDAG project managers favor the concept of risk management as a way to prepare by having contingency plans in place. Staff would like to see a conflict resolution process (between SANDAG and Caltrans) in place. They recognize that such a process would be challenging and possibly adversarial if not developed jointly.

SANDAG foresees the ITOC requiring reports and updates on TransNet progress during monthly or quarterly meetings. A definite need exists to determine the types of reports the ITOC will want.

SANDAG would like to see a Web-based reporting system with the following features:

- Concise information
- Ability to see earned value for each project
- Ability to see planned versus actual expenditures for each project
- Baseline versus current schedule
- Risk management reporting with recommended actions
- Tracking of project scope changes

Scope Management. A formal process is not currently in place for communicating scope changes from Caltrans to SANDAG. However, if a proposed change is valid (that is, it is in the public’s interest or it improves the project), then the change is made. There is, however, no evaluation of budget or schedule implications resulting from the change. Scope changes occur routinely. It was noted that it is not uncommon to see the scope increase by as much as 50 percent by direction of management. For TransNet projects, scope changes are perceived to be typically through the direction of SANDAG.

Schedule Management. Caltrans currently uses Primavera P3 scheduling software; SANDAG uses Microsoft Project. SANDAG specifically wants to know if these two applications can be linked and integrated for reporting purposes. If necessary, SANDAG indicated a willingness to move away from Microsoft Project for the TransNet extension corridors, provided new software would allow for a resource-loaded schedule across the entire program. SANDAG project managers want monthly meetings where a 90-day forecast is developed and key issues with critical path items are discussed.
Because of workload constraints, project managers want to see dedicated scheduling staff in the TransNet project management office. Currently, SANDAG has six project managers, three of whom use Microsoft Project to track their projects; the other three are making varying degrees of effort to use Microsoft Project. In both cases, the schedules are standalone, with no attempt to link them to a master schedule.

Caltrans District 11 has 16 server-based copies of Primavera P3, with automated e-mail messages sent monthly to Caltrans task managers who request updates. Caltrans reportedly receives a 60 to 70 percent response rate. When key reports are due, Caltrans task managers indicated they must catch up quickly. It was also mentioned that there is no clear understanding of who is responsible (project managers or task managers) for tracking budget, scope, and schedule. Because of their heavy workloads, it is often difficult for project managers to input data into the schedules. This situation is further complicated because it is rare for a project manager to remain with a job for its duration.

Cost Management. SANDAG staff wants to know how the financial system could be reconfigured to receive updated Caltrans expenditures during the TransNet program. They want to see monthly reports for Caltrans and SANDAG WBS expenditures.

Established budget numbers in the TransNet ordinance are considered baselines and include some escalation, although there is no upper cap for expenditure authorizations. In the past, costs have not been established with a firm baseline. Caltrans wants to develop a database that maintains the original estimate while tracking changes such as increases in unit costs. They are willing to consider a new tool or system that is tied to managing risk and one that would track changes automatically. Because of the requirements set forth in the ordinance, all expenditures must be balanced and accounted for. Unfortunately, many projects have support costs over budget, partly because so much time elapses from when an estimate is performed to when work is completed.

In response to questions about how they manage money from different funding sources, Caltrans project managers noted that they merely track what has been spent. They stated that their main target is to deliver projects on time, primarily because the public is given a commitment of a project opening date and it is difficult to miss those dates without considerable criticism.

Resource Management. Caltrans is a proponent of the dashboard form of reporting; some SANDAG staff, however, claimed they have not seen it, and they are not convinced that the data are meaningful or accurate. The system may require modifications, but it was noted that this is a good start and a needed tool.

A problem was noted with scheduling, when durations can range from 5 days for one activity to 500 days for another. One Caltrans staff member said that “…you can’t manage a 500-day task. In effect, it just becomes a bar on the timeline that you just keep dragging out until the activity is complete. You just hope you come close.”

Information Management. Data sharing between SANDAG and Caltrans is a key issue to be addressed for TransNet program management. SANDAG has been open in sharing their data and
Interviews

providing access to interested stakeholders. SANDAG provides systems access to Caltrans; however, access to Caltrans systems is not provided to SANDAG because of Headquarters Information Technology staff security concerns. Security protocol at Caltrans is dictated by Headquarters (Sacramento). District 11 staff is open to data sharing.

SANDAG wants to see a Web-based reporting system containing concise information and the ability to see earned value and expenditure rates for each project. The report should also reveal planned versus actual expenditures, baseline versus current schedule, scope creep, and reporting of potential risks to schedule and budget.

Lack of a consistent project numbering system is a challenge in integrating datasets from Caltrans and SANDAG. No consistent project numbering scheme is shared by Caltrans and SANDAG. Currently, a project number comes from the SANDAG overall work program (OWP), which does not have a direct correlation with the Caltrans expenditure authorization (EA) and WBS number. A concept was discussed and developed to correlate the two numbering systems.

In conjunction with the TransNet program, a process must be established for Caltrans to coordinate their EA/WBS numbering system to the SANDAG OWP/Integrated Financial and Accounting System (IFAS) numbering system.

Caltrans has been unable to create a dynamic connection between the Caltrans intranet and SANDAG systems. Caltrans feels strongly that one agency must be responsible for managing and maintaining the database schedule. This need is based on the complex coordination required for the large corridor projects.

This summary of the agency interviews identifies some of the more important common interests and goals to be incorporated into the TransNet program. The ability to measure, control, and report on program scope, budget, and schedule is key to a successful program. Functional business processes and systems that allow these key elements to be achieved appear to be a primary objective.
Chapter 4  
Benchmarking—Industry Best Practices

4.1 Introduction

With the intent to effectively and efficiently deliver the TransNet extension program, SANDAG and Caltrans were interested in identifying the specific program management tools and processes that other transportation agencies with large capital improvement programs were using to manage their programs. Our team interviewed and obtained information from the following agencies:

- Florida Turnpike Enterprise
- North Texas Tollway Authority
- New York State Thruway Authority
- Maricopa Association of Governments, Phoenix, Arizona
- Sound Transit, Seattle, Washington
- Washington State Department of Transportation
- Florida Department of Transportation
- Colorado Department of Transportation
- Denver Regional Transit Authority–Fastracks Program
- Federal Highway Administration
- U.S. Department of Energy
- U.S. Office of Management and Budget

Agencies interviewed included toll agencies, associations of government, and transit agencies. Other non-transportation agencies, including major school boards, were interviewed based on their known program implementations.

The sections below summarize the responses obtained during our investigation. Details of the interviews are in Appendix B.

4.2 Risk Management

Risk management, in use at Caltrans since 2003, has been implemented by other agencies nationwide. Identification and quantification of risk items are effective tools to contain risk and avoid surprises. Many agencies—such as the Washington State Department of Transportation, the Federal Highway Administration’s Major Projects Unit, and the Denver Regional Transit Authority Fastracks Program—are putting significant focus on a formalized risk management process. Risk identification is typically performed in a workshop setting at the project development stage and is then updated at each phase including construction; it is most often performed concurrent with development of the cost estimate/budget. This process allows project managers and program-level decision makers to adequately understand the identified risks and work to avoid and/or mitigate risks as projects develop and are constructed. The implementation of a risk management process would be valuable on the TransNet program. Software used for risk and probability analysis at the agencies interviewed included Decisioneering’s “Crystal Ball” and Palisade’s “At-Risk.”
Agency Benefits
The benefits can be broad because the management of risk touches every part of an entity’s efforts. Benefits of risk management, as noted by the agencies, are shown below.

- Assists in identifying contingency amount for estimates.
- Affords a strong communication tool with the public.
- Provides an understanding/awareness on why estimates change.
- Provides an understanding/awareness of probability ranges for estimates.
- Produces useful information when going to the legislature or governing body.
- Offers good information to analyze alternatives.

Examples of Risk Management
At the project concept stage, a risk management team is assembled. This team is typically comprised of engineers most familiar with the project concept, design, and estimated cost. The team also includes risk assessment facilitators and cost estimators external to the project team who lead the risk assessment. Specific project line items identified as part of the project cost estimate become the basis for the risk management. The major cost line items are analyzed for associated risks, and contingencies are set for each line item to develop a composite project contingency.

The example below identifies primary risks for a major water crossing and the method of using the risks to identify line item contingencies to result in a composite contingency factor. This demonstrates a method of quantifying risk and ensuring budgets are determined with adequate contingencies to be adjusted throughout the project or to consider alternative design options.

Risk Management Example

<table>
<thead>
<tr>
<th>Category</th>
<th>(a) Percentage of Construction Cost</th>
<th>(b) Risk/Contingency (%)</th>
<th>(c) = a x b; Composite Risk Factor (%)</th>
<th>Major Risk Factors Summarized</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deck</td>
<td>35.0</td>
<td>20.0</td>
<td>7.0</td>
<td>Pre-cast versus cast-in-place</td>
</tr>
<tr>
<td>Cables</td>
<td>10.0</td>
<td>15.0</td>
<td>1.5</td>
<td>Overseas supplier, steel prices</td>
</tr>
<tr>
<td>Pylons/Piers</td>
<td>15.0</td>
<td>100.0</td>
<td>15.0</td>
<td>Complexity of construction</td>
</tr>
<tr>
<td>Foundations</td>
<td>35.0</td>
<td>25.0</td>
<td>8.8</td>
<td>Accessibility, mobilization</td>
</tr>
<tr>
<td>Other/Miscellaneous</td>
<td>5.0</td>
<td>20.0</td>
<td>1.0</td>
<td>Traveling inspection system, aesthetics</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100.0</strong></td>
<td><strong>20.0</strong></td>
<td><strong>33.3</strong></td>
<td></td>
</tr>
</tbody>
</table>

Probability curves are also identified based on the risks for each item. Examples of probability curves are shown in Figures 1 and 2.
The probability curve shown in Figure 1 has the estimate value at the top of the curve. The risk assessment team determined that the risks are greater that the cost of this item could overrun, thus the area under the curve is greater at higher values than the peak. The team also determined there is a lower chance a bid for this item would be below the estimate, and, if so, not a great amount below.

The probability curve shown in Figure 2 also has the estimate value at the top of the curve. The risk assessment team determined that there is minimal risk with this item, thus the narrow curve. The team also determined that a bid would not be significantly higher or lower than the estimate.

Based on specific curves being selected for each of the major estimate items, a software program generates random numbers for each probability curve, and sums are calculated for each set of random numbers. The results are “forecast” curves, which define the results of the team’s evaluation of the risks associated with the project. The forecast curve demonstrates the estimated range of values that could result from project bids, with probability ranges for the curves. For example, the forecast curve shown in Figure 3 depicts a project with a current base estimate of $105 million and a contingency at the concept stage taking the estimate to $135 million. The resulting curve demonstrates that, based on the risk assessment team’s analysis, there is a 60 percent chance the bids could fall between $100 million and $120 million. The curve also shows that the value with contingency is at the upper end of the forecast curve, showing that the review team has confidence the bids will fall below the $135 million.
Risk and probability analysis can also be used to evaluate alternatives. Figure 4 demonstrates the combined results of risk and probability analysis on alternatives for a major bridge project. The design alternatives for the bridge are concrete segmental and steel box girder at the early project stage. The range of the curves reflects the risk assessment team’s confidence in the budgets, considering the project risks. The overlap of the curves shows that the alternatives are somewhat comparable. For this specific project, senior agency management is deciding whether to proceed with the design of one or both of the alternatives. With the agency just receiving bids showing that the price of steel has decreased and the price of concrete has increased, the curves could be even closer, thus pointing to dual designs and allowing contractors to bid both steel and concrete. The final results could be a significant savings to the agency with one of the alternatives.
Just as risk management can be applied to issues of cost, the same principles apply to schedule. Early prediction of schedule overruns or underruns affords an owner opportunities for mitigation, cash flow, and public relations management that are otherwise not possible. Risk is managed in relation to schedule at several agencies through the use of Monte Carlo statistical analysis, whereby probabilities of completion at any given time are determined. By applying Monte Carlo techniques to detailed and accurate critical path method schedules, reliable predictions of project completion are obtained in time to allow for plan adjustments. Several software programs are in use by agencies. For those with Primavera P3 version 3.1 as their scheduling platform, Primavera’s Monte Carlo is the program of choice. For those that have migrated to Primavera P3e/c, Pertmaster Project Risk is the leading tool. PBS&J has applied these tools for agencies such as the Texas Department of Transportation. Figures 5 and 6 illustrate the resulting sample output.

Figure 5. Sample Output 1

Reports and charts similar to those shown in Figures 5 and 6 might indicate a 32 percent chance of completing this Texas Department of Transportation project on time in February 2007. This project is more likely to complete in April 2007, with a worst case completion date of October 2007. Considering extenuating circumstances that might surround this project, are these possibilities acceptable? The answers will be different for each specific project, but having the data to make an informed decision for critical projects is invaluable.
4.3 Schedule Control

Most agencies used scheduling software to track their projects from production through construction, typically on a monthly basis. One agency tracks progress with written monthly reports. All respondents who use scheduling software are currently using Primavera P3, with two noting they are planning to transition to P3e/c, a newer Web-based Primavera scheduling system. The use of P3e/c by these agencies is with the intent of having better controls and reporting on a program with multiple projects that interface and have common resources. Owners, engineers, and contractors across the construction industry are migrating to P3e/c. All Florida Department of Transportation Districts are migrating from P3 to P3e/c. In the review of SANDAG and Caltrans scheduling systems, migrating to P3e/c as an industry standard would be a viable approach for the TransNet program.

Agency Benefits

Agencies that have migrated from the use of personal computer scheduling to server-based systems have realized multiple advantages. Project schedules are still tracked and maintained in a similar fashion, with the true advantages being seen in the tracking and reporting at a program level. Some major advantages are shown below.

- Ease of schedule reporting over an entire program.
- Cash flow and resources management over an entire program.
- Ability to easily report on specific groups of multiple projects within a program (such as a corridor or a group under one project manager’s responsibility).
- Roll-up of any groups of projects or activities for specialized reporting.
- Flexibility to interrelate activities and projects throughout the program.
Examples of Schedule Control
The sample reports shown in Figure 7 demonstrate schedule reporting at the program, corridor, and project level, out of one P3e/c program report. Curves below these schedules represent resource person-hour commitments for each reporting level, but can also be configured to report cash flow information.

Figure 7. Sample P3e/c Scheduling Reports

4.4 Budget Control

Agencies appear to vary greatly in the types of software they use to manage and control their budgets. Many use systems (including products from J.D. Edwards, Oracle, CapitalSoft, Deltek, and others) that control much of their financial data. Most agencies require project managers to track budgets and manage changes using these software programs. In review of the existing SANDAG and Caltrans process, both agencies noted what they felt were deficiencies in their budget controls, varying from having separate systems to having decisions made without project manager input. The apparent solution is to integrate the SANDAG and Caltrans budget systems and enforce a consistent process of budget and change control.

Agency Benefits
Budget control is imperative to agencies, particularly with large programs. The benefits include:

- Baselining or setting an initial budget that remains the initial budget.
- Compiling and tracking approved changes for the revised budget.
- Forecasting budget cash flows.
- Tracking actual against budget cash flows.

4.5 Business Processes

Agencies interviewed described their business processes as a means of managing each project’s scope, expenditures, and documentation. The agencies mentioned various methods used to enhance these processes including use of technology, use of management dashboards for information, encouraging input from stakeholders and public oversight groups, and having independent audits to report on the proper use of the processes. In review of the TransNet program, both SANDAG and Caltrans have demonstrated a clear need for efficient business systems. The integration of information from both agencies into consistent, clear reporting using
dashboard reports and other needed reports will help keep all entities informed, from project managers to the ITOC.

Agency Benefits
Effective business processes offer numerous benefits, including:

- Consistency in how the agency does business.
- Ability to measure business activities and progress.
- Clear steps in the process to achieve business results.
- Ability to analyze when issues arise and make revisions as necessary.

4.6 Issues of Concern

Cost escalation in the construction industry was the most common concern among the agencies. Scope creep and funding were related issues to project budgets. The integration and functionality of business systems were also of concern to some agencies. These issues appear to be consistent with items noted by SANDAG and Caltrans, with integration being even more critical as the two agencies work on a common goal. The need for an improved method of estimating and controlling costs is consistent among nearly all agencies. An increased emphasis on the TransNet program to monitor industry cost trends, perform risk analysis, and provide more frequent estimate updates is important to meet these concerns. In addition to implementing risk analysis, many agencies—such as the Colorado Department of Transportation—are evaluating trends and publishing trend reports.

Agency Benefits
Improved methods to estimate and control costs offer numerous benefits, including:

- Provides cost information and trends in addition to typical historical costs.
- Allows analysis of trends to explain the “why?” of cost variability.
- Allows a look outside of the agency to provide information for the future.
- Identifies factors and variables that have a significant influence on agency project costs.
- Allows an educated view of cost escalation.

Example of Cost Trend Analysis

Figure 8 is an excerpt of the Colorado Department of Transportation’s construction cost index. This index measures and tracks key cost indicators on projects to provide data and graphs that can be used when performing cost estimates. In a market with high cost volatility, more agencies are continuing to develop and analyze information to better predict and estimate costs.

Publications such as Engineering News-Record are also good sources for national cost information and trends impacting the industry.
4.7 Analytical Tools/Earned Value

Most agencies interviewed do not specifically use earned value as a measurement tool; however, they do depend on monthly progress reports and business system information to measure progress. Earned value is an approach that integrates cost, schedule, and performance to measure, monitor, and control project resources. Project schedules and cash flow reporting are often used as a substitute for earned value, which can lead to difficult interpretations of variances and possibly not identifying all issues on a project that earned value could identify. Only one agency (Sound Transit) measures earned value and uses the information to report to multiple participating communities. However, earned value management is now a federal requirement for all major acquisitions by the Office of Management and Budget, which has recently implemented this and has included performance measures in their contracts. The U.S. Department of Energy also uses earned value management. Software to meet the federal requirements includes “Xpdient.” The implementation of an earned value system could assist TransNet project and corridor managers in assessing project performance and determining whether to take action.

Agency Benefits
Using analytical tools such as earned value could have the following advantages:

- Allows a method to accurately assess project status.
- Allows for a synopsis of both cost and schedule variances with one tool.
- Provides early warning signal(s) for potential issues.
- Allows for action to be taken to mitigate issues.
Example of Earned Value Implementation

Figure 9 demonstrates the planned value to be earned plotted against the actual earned value and actual expenditures. The figure shows a project that is ahead of schedule and has expended less than budgeted at the cutoff dates. Typically identifying these variances early allows for improved project management and control.

Figure 9. Sample Earned Value Plot

However, as a project management technique from which all government entities (federal, state, county, municipal, and tribal) can benefit, the disciplined approach integrates cost, schedule, and technical performance measures to monitor and control project resources and compile results into one set of metrics so that effective comparisons can be made. Earned value management also helps evaluate and control project risk by measuring project progress in monetary terms.

Examples of the federal government earned value approach are on the following Web sites:


4.8 Change Control

All of the agencies had a concern and an interest to control project changes. Many have a process that requires agency team consensus before a change is approved. Most agencies are working to track changes and fully report on the reasons for them. Many agencies create a change control board to review changes and make final decisions on whether to implement them. Most agencies use the change control process in their budget and tracking systems. Most agencies use industry programs developed by firms such as J.D. Edwards, Oracle, CapitalSoft, or Deltek to track projects and their changes as part of their financial systems. The emphasis on change control during the interviews, and during discussions with SANDAG and Caltrans, demonstrates that the
TransNet program has the need for a solid process for joint change control between SANDAG and Caltrans.

**Agency Benefits**
With change control being a topic of concern to nearly all agencies, an effective change control process can provide great benefits, such as:

- Identifying potential changes early in the process.
- Publicizing changes for notification purposes.
- Quantifying and evaluating changes before they impact a project.
- Allowing for consensus and change approvals before implementation.
- Tracking potential change in cost and schedule to avoid surprises.
- Documenting proposed and implemented changes for projects.

**Example of Change Control Process**
Figure 10 is the flow chart established by the Florida Department of Transportation for their change control process.

**Figure 10. Sample Change Control Process**

It is important to create and adhere to the process and work flow for change management. Implementation of the quality assurance process is often critical.
4.9 Communication Management

The agencies reported various forms of communication management. Monthly reports, public meetings, executive summaries, dashboard reports, and Web sites were all mentioned as methods used by the agencies to communicate information to senior management, stakeholders, and the general public. SANDAG and Caltrans project managers expressed some frustration with being unable to efficiently obtain the information they need to communicate in their reports, and they mentioned the need for advanced electronic systems to control information for improved communications. Dashboard reports and other types of consistent communication were noted as needs for the TransNet program. A variety of systems are being used by agencies to manage information and properly communicate. Information from these systems can be directly uploaded into internal or external Web sites that contain information on all projects. Most agencies have Web sites for public information and viewing. Some agencies also use software such as Microsoft SharePoint.

Agency Benefits

Strong communication management has obvious benefits for any agency or organization. These benefits can:

- Impart program knowledge to stakeholders.
- Inform public and program personnel of progress and events.
- Publicize success.
- Provide notification of issues.

Examples of Communication Management Tools

Figures 11 and 12 are sample internal and external Web pages using EdgeBuilder.

Figure 11. Sample Internal Web Site
This summary of the agency interviews identifies that most transportation agencies have interests and goals similar to those of the TransNet program. The ability to measure, control, and report on program scope, budget, and schedule is the key element to a successful program. Functional business processes and systems that allow these key elements to be achieved appear to be the objective of every agency, including SANDAG and Caltrans. From the review of what others in the transportation industry use to enhance their programs, it appears that the goals of SANDAG and Caltrans are consistent, and with some key integration tools being implemented, the TransNet program could be “state of the industry.”
Chapter 5
Recommendations

This chapter describes recommendations for improvements to the management tools that are critical for providing a successful program and how to implement these tools within the proposed organization structure of the TransNet program. The existing situations, reasons for change, proposed improvements, expected outcomes, and time frames for implementation are described for risk management, scope management, schedule management, cost management, resource management, quality management, information management, and organizational structure.

Additional information for benchmarking and scope strategy as it relates to the processes described is in Appendix C, Proposed Process to Develop Benchmarks Cost, Schedules, and Scope; and Appendix D, Scope Statement for Inclusion in Future Consultant Task Orders, Schedule to Implement, and Risks and Estimates.

5.1 Risk Management

The objectives of risk management are to increase the probability and impact of positive events and decrease the probability and impact of events adverse to the project; in other words, to prevent management by crisis. The use of all the other tools and the corresponding recommendations as outlined in this chapter all play a key role in the project’s risk management. These tools interact with each other and can involve effort from one or more of these processes at each project phase. The processes for conducting risk management include planning, identifying, analyzing, responding, and monitoring control for each process.

Existing Situation
Since September 2002, Caltrans District 11 Directive No. 0201 has been in effect. In accordance with the directive, the project manager is responsible for risk management planning, completion, maintenance, monitoring, and control of the risk management plan. Functional managers are responsible for identifying, qualifying, and quantifying risk and impact.

Reasons for Change
Under typical circumstances, enough risk factors exist to challenge the most capable project management team. In today’s environment, more difficult factors are working against the successful execution of the design and construction program. These factors include environmental and right-of-way issues, cost of materials, increases in energy costs, and potential increases in labor costs to meet demand. With so many variables, it is imperative that management understand and address those costs that can be controlled.

Proposed Improvements
Risk management measures should be incorporated into crucial aspects of the program execution: scope, cost, and schedule. Current SANDAG and Caltrans practices to control risks must be collected and integrated. Risk analyses must be performed regularly to identify potential problems, ascertain their source and extent, and develop mitigation measures. Risk analyses will be subjective for most work aspects; cost risks will likely require sophisticated techniques such as Crystal Ball and/or Monte Carlo simulations discussed in this report and used by some
agencies. The resulting knowledge should be used to deploy a coordinated system of mitigation measures and conservative contingency packages to address impending program risks.

**Expected Outcome**
Using risk analysis to identify and prioritize challenges with the SANDAG design and construction program, coupled with effective management and control, will contribute to successful project completion.

**Time Frame to Implement**
The time frame to implement such a recommendation could vary from the short to mid term (6 to 12 months). This continuing program would benefit by lessons learned as the program matures.

5.2 **Scope Management**

Defining and controlling what is and is not included in the project is the primary purpose of scope management. Scope management includes processes to ensure that the project consists of all the work required, and only the work required, to complete the project successfully.

**Existing Situation**
The Project Study Report is used to define scope, cost, and schedule. Caltrans project managers have reported difficulties in controlling scope because management at times changes scope in response to public demand or to incorporate specific local needs into individual projects.

**Reasons for Change**
With the exception of smaller capital improvement projects, gradual and at times significant changes in scope (scope creep) have been prevalent. New or revised regulations, elected officials, and public comments requiring changes in scope often result in project delays to accommodate design additions and possibly delay the onset of construction. Such changes make it difficult to provide the full range of projects originally planned for the program because of the necessity to borrow funds from future projects to pay for short-term project modifications.

**Proposed Improvements**
A process should be developed to benchmark the scope for each project. This activity is closely related to the need to develop a method for controlling changes to the benchmark cost for each project. This benchmark should be specific and should be determined through a consensus process before being advanced for final design and construction. This benchmark would not be modified as the project unfolds. As changes to the project scope are approved, a comprehensive record would be kept noting changes that were made, who approved the changes, and what the impact of the changes would be. At the end of the project delivery effort, the finished project would be compared to the original benchmark; questions would already be answered about why differences occurred, whether they were justified, and what part of the project experience should be incorporated in the next round of projects.

**Expected Outcome**
Developing a benchmark scope would provide a tool to measure project success. Investing in collaboration and creativity in the process of controlling scope and keeping them at a benchmark
level would increase the probability that projects promised for delivery would be delivered to the taxpayers funding the program. It is also likely that the project delivery team would experience a greater sense of accomplishment in delivering projects on time, within scope, and within budget with design consistency across each corridor and within the entire TransNet program.

It is recognized that changes are sometimes justified. In these instances, it is critical to properly document the changes and the approval history.

**Time Frame to Implement**
The time frame to implement such a recommendation could vary from the short to mid term (6 to 12 months). The sooner these measures are in place and implemented by staff, the greater the chance for overall program success.

**5.3 Schedule Management**

Proper schedule management will help many of the process tools of program management. It works directly with cost and resource management and, if done properly, will help identify potential risks associated with a project.

**Existing Situation**
Caltrans District 11 uses Primavera P3 version 3.1 for internal scheduling. At the state level, eXpert Project Management is used; however, Headquarters is currently selecting a replacement application.

SANDAG uses Microsoft Project to develop capital project schedules. Approximately 50 Microsoft Project licenses have been purchased. Investments have also been made in staff training. Most SANDAG employees have now begun using Microsoft Project for scheduling.

**Reasons for Change**
To provide consistent schedule development, updating, monitoring, and reporting on a program-wide basis, we recommend a scheduling system that can integrate schedule information at the project, corridor, and program level. Having all program schedule information in a single database allows for program-level cash flow and resource planning and analysis of common elements (such as structure design or right-of-way acquisition) at the corridor or program level. The current systems provide good scheduling analysis at the project level; however, they are limited in reporting at the summary levels.

Keeping the current Caltrans P3 system, with its potential shortcomings (such as the default configuration of establishing each project as an independent file) will not allow for easy information reporting across projects. With the current project schedules being independent, cross-project logic is not possible. The P3 software is also limited in its capacity to accommodate numerous tasks. Caltrans currently manages more than 400 projects and 23,000 tasks. This volume of activity approaches the limitations of the software, and Caltrans has done an exceptional job in using the software to the limit of its capabilities.
Proposed Improvements
For the TransNet program only, we recommend scheduling standardization on a common platform that can seamlessly integrate cross-project logic and resources. Primavera’s P3e/c provides a robust, cost-effective method to achieve this integration. Implementation of this recommendation can be limited to TransNet projects while maintaining current Caltrans and SANDAG systems and reports by linking P3e/c databases to existing and proposed TransNet Trends, Risks, Issues, and Progress (TRIP) reporting tools. We further recommended that SANDAG’s program management office could manage the TransNet P3e/c system for both SANDAG and Caltrans.

Using Caltrans’ current Primavera P3 software arranged in a master/project configuration could allow for intra-corridor management but not coordination between corridors. Indirect integration of Microsoft Project could be achieved by manual inclusion and maintenance of interface tasks and links; however, this approach is impractical for several reasons: it creates significant maintenance issues (that is, it is labor intensive) and it creates the potential for errors and omissions.

Regularly scheduled updates (generally not less than monthly) should be performed to identify issues that may affect performance. These updates should be performed early enough to make informed decisions and take corrective actions.

Expected Outcome
The implementation of an integrated program scheduling tool such as Primavera P3e/c would provide centralized scheduling that offers enhanced efficiency, monitoring, and reporting. This fully integrated tool would allow seamless reporting and resource sharing. It would also provide logical relationships between any combination of projects and corridors within the program. It would incur minimal up-front costs or software changes to SANDAG or Caltrans because the software would be housed in the program management office. Finally, it would lessen work for task/project managers because dedicated schedulers would update the schedules based on information provided by the task/project managers.

Time Frame to Implement
The time frame to implement such a recommendation could vary from the short to mid term (6 to 12 months), depending on the complexities encountered. The quality of the information in the existing schedules would also factor into the final timeline.

5.4 Cost Management
The three main areas of cost management include: cost estimating (developing an approximation of costs for the needed resources), cost budgeting (establishing a cost baseline of individual activities or work packages), and cost control (influencing factors that create cost variances and controlling changes to the project budget).

Existing Situation
Caltrans estimates are developed for the project at the planning and design stages. Annual capital updates are developed for each project. Project change requests are used to manage capital cost
change control. Support budgets required for each project throughout the programming/design/construction time frame are based on an existing Web-based WBS structure. Project managers calculate quantities, and the District Office engineer determines unit prices, generally using historical data. In some instances, funds are currently redirected from one project to another to cover costs that exceed the targeted budget due to scope changes or cost escalation.

**Reasons for Change**

Refining and formalizing the cost estimating process would facilitate improved consistency and control on project estimates. Project managers would provide information and necessary scope and review input, while cost estimates would be prepared by an estimator or estimating staff familiar with cost trends and pricing information.

Proper benchmarking and change control is necessary to prevent scope creep for both capital project costs and support costs; it is also necessary for the proper reporting of approved changes.

**Proposed Improvements**

A consolidated cost collection and estimating approach is recommended, including having risk and probability tied into the estimates. Use of historical data, current local industry trends, and project size should be incorporated into this system. We also recommend considering benchmarking and cost estimating practices adopted by other agencies.

A method to benchmark the cost for each project should be developed. This activity is closely related to the need to develop a method of controlling changes to the benchmark cost for each project. In addition, as stated earlier in the report, SANDAG sponsored a study and hired an outside consultant to identify factors that were linked to the increases and developed recommendations on the methodologies used to estimate costs.

**Expected Outcome**

Consolidated cost estimating would increase the consistency, accuracy, and efficiency of project cost estimates. It would also facilitate improved reporting and tracking of changes and minimize last minute surprises.

Developing a benchmark cost would provide a tool to measure project success. Controlling costs and keeping them at a benchmark level would increase the probability that all projects promised would be delivered on a timely basis to the taxpayers funding the program.

**Time Frame to Implement**

The time frame to implement such a recommendation could vary from the short to mid term (6 to 12 months). We recommend that both agencies consider this a high-priority item.

**5.5 Resource Management**

Resource management is the process of organizing and managing resources (including the project team) and properly assigning roles and responsibilities for completing each task. Proper resource management and control also helps with the identification and management of schedule and cost control.
**Existing Situation**  
Caltrans currently uses resource-loaded work plans for annual projections.

**Reasons for Change**  
Resource-loaded work plans are excellent planning and decision-making tools. However, when multiple schedule changes occur, it is difficult and labor-intensive to update the work plans and have accurate resource plans. Loading resources into an integrated program schedule would facilitate the reporting, summarizing, and analyzing of resources at any corridor level or the TransNet program as a whole at all times, including when schedule changes occur.

**Proposed Improvements**  
Use the recommended Primavera P3e/c scheduling system to load SANDAG and Caltrans resources. This will allow for scheduling activities (or summary activities) and to plan and make decisions on resources based on the current integrated program schedule.

**Expected Outcome**  
Implementation of the recommended scheduling system would provide updated resource information as schedule and/or scope changes occur across the entire TransNet program. This would enhance efficiency to manage the program and thus the program delivery.

**Time Frame to Implement**  
The time frame to implement such a recommendation is expected to be mid term (6 to 12 months).

5.6 **Quality Management**

A quality management process determines quality policies, objectives, and responsibilities that will satisfy the project needs. It is a continuous process conducted throughout the project. The quality management process includes quality planning (the standards), quality assurance (applying the standards), and quality control (monitoring the results to determine whether quality standards are met or are relevant and then taking corrective action).

**Existing Situation**  
At Caltrans and SANDAG, in addition to value engineering, plan reviews occur at the 30, 60, and 90 percent plans development. Constructability and safety reviews are also performed. As an ongoing policy, Caltrans also does independent checks of calculations for all structural design elements.

**Reasons for Change**  
Value engineering/value management, constructability, and biddability reviews by independent parties would identify issues that could impact construction costs and schedule. These reviews could also identify savings and improvements.

Value engineering studies can be performed any time. Ideally, two studies should be performed on each project. The first should be done early in the development phase to help minimize project impacts, develop an environmental impact statement or Record of Decision, decide the best type of facility to build, and pinpoint its location. The second study should be performed...
during the final design phase to address design issues (such as geometrics, final vertical and horizontal alignments, drainage, construction staging, traffic control, signalization, pavement, and structure details) and refine the project before construction. Value engineering at the final design stage could enhance overall quality.

Obviously, some design items can be reviewed whenever a value engineering study is performed; however, when a value engineering study is performed early in the development phase, there is generally insufficient design information available and the study team make-up does not include the various design/construction specialists to properly analyze the project design.

**Proposed Improvements**
Generally, no noticeable improvements are required at either agency; however, consideration should be given to two value engineering studies, as discussed above, when justified and if not already being done. This may be also beneficial at the corridor level.

For project reviews, SANDAG and Caltrans should consider a workshop team that includes industry representation from outside the project delivery team. It is also worth considering the inclusion of a risk/probability evaluation during value engineering studies.

**Expected Outcome**
Innovative ideas and the incorporation of practices from independent parties could identify issues not discovered by the project team or during design reviews.

**Time Frame to Implement**
The time frame to implement such as a recommendation could occur in the short term (6 months) and would run throughout the execution of the design and construction program.

5.7 **Information Management**
Efficient information management is crucial to a successful program. Program information management provides the critical link among all stakeholders and the program management staff with on-demand access to accurate information such as budget and schedule status; potential risks; resource availability; and scope, budget, and schedule changes. Having immediate and accurate access to the information derived from the management tools as described in this chapter will assist program managers in their ability to make effective decisions that will elevate the success of the TransNet program. Finally, implementation of an efficient information management system will improve both risk management processes and program quality, both of which are discussed in this chapter. Information management is one of the primary responsibilities of a program management office.

**Existing Situation**
SANDAG uses Microsoft SharePoint to manage information. From discussions with SANDAG, individual project managers and engineers maintain their own project files. SANDAG and Caltrans have their own independent systems for financial management and schedule management. Caltrans is also developing a Project Management Information System (PROMIS) dashboard report that will include information on TransNet projects. Most of the information
viewed is at the project level, and it does not appear to be easily summarized at the corridor or program levels.

Caltrans and SANDAG use a variety of information systems, ranging from long-established legacy systems to state-of-the-art Web applications, to support program and project management activities such as project status, schedule, and budget. SANDAG and Caltrans do not currently share all applications electronically.

Much project and program management data exist at the two agencies; however, consistency and ease of access do not exist for reports on project budget, schedule, and status.

Caltrans uses an effective data integration system called the Project Information Reporting System (PIRS), which electronically integrates data from Caltrans project management data systems and presents it in various summary formats.

SANDAG does not have an integrated system that correlates information from data sources of project information. SANDAG’s IFAS is an accounting system that has summary reports available to project managers with budget and expenditure data, but the overall project summary information currently does not exist. As a result, finance department staff must perform numerous manual calculations to create overall project-level or program-level summary reports.

Due to the lack of a consistent project numbering scheme, SANDAG has no easy automated method to identify the phase, budget, schedule, funding source, and schedule status of TransNet projects. Most project status summaries are created manually by engineering staff.

At Caltrans, the ability to track TransNet project status is more automated because of the PIRS system. Data quality may need to be verified because budget and schedule status updates are not consistently available for many project tasks.

Appendix F summarizes information management systems used at SANDAG and Caltrans.

**Reasons for Change**

Although each of the systems mentioned above has its own reasons for enhancements, it is important to recognize that, when combined, they play a key role in providing live, accurate, and complete information management. A more detailed discussion of each component is in the sections below.

Currently, staff generates a significant amount of manual data entry and calculations to create project summary reports; as a result, data quality is subject to compromise, and will be more difficult to handle on the program level. Project budget and status updating is not automated and is labor intensive. Although a variety of reports are successfully and separately generated at both SANDAG and Caltrans, none consolidate the information into a project-level or program-level summary report.
Because of the lack of a consistent project numbering system between SANDAG and Caltrans, developing project-level and program-level summary reports is cumbersome and, again, the results and information quality are compromised.

The data exchange between SANDAG and Caltrans is not seamless. Data are exchanged as static data dumps, such as in Adobe PDF files and in spreadsheets. The inability of SANDAG staff to access Caltrans systems affects project coordination and the ability to review current information. Data access to project managers is inconsistent; therefore, steps must be taken to provide consistent, streamlined reports with regularly updated information.

No mechanism exists to readily track budget and scope changes across the life of the project. As a result, it is sometimes difficult to explain why cost estimates or schedules changed significantly from original estimates. This information is currently in Microsoft Word documents at Caltrans and in spreadsheets at SANDAG.

Expenditure and earned value tracking information is currently captured in spreadsheets created by project managers on a project-by-project basis. This method is susceptible to errors and inconsistencies and data cannot be presented in program-level reports such as TransNet TRIP reports (see Appendix E, Proposed Trends, Risks, Issues, and Progress [TRIP] Process).

No centralized system exists to access project documents, correspondence, and schedules. Appendix F contains examples of what an integrated information management system can do.

**Proposed Improvements**

We propose that an integrated information management system be implemented for the TransNet program. Many systems are available that allow for full electronic document management, capturing all collaboration and work flow processes during a project and program. The selected system must have the flexibility to integrate with existing financial and other systems. Most of these other system upgrades or enhancements are described in the sections below.

We also propose that information-rich, relational dashboard reports be developed for each level of program execution (that is, project, corridor, and program level). The proposed TransNet dashboard application, called TRIP (see Figure 13), will automatically read and contain the information that would permit the decision makers at each of these levels to quickly grasp the state of their own work product. These same decision makers would be able to easily obtain access to greater levels of detail, underlying the components of their dashboard. This access would help them to identify the reasons behind the data display and set the stage for effective intervention to improve program results.

SANDAG and Caltrans financial systems data can be integrated to develop comprehensive dashboard reports that summarize data from the two financial systems (IFAS and TRAMS/PIRS). Integration between IFAS and TRAMS/PIRS can be achieved by taking the steps described in Appendix F.

SANDAG and Caltrans will provide staff and direction to evaluate the recommended action items and will assist in developing the final dashboard report templates and project numbering systems.
Recommendations

Program Summary Schedule

Program Information

Program Metrics

Drill down for further information
Go to projects
Go to corridors

Major Trends/Risks/Issues/Progress

TRENDS
Cost: Steel price stabilized; aggregate increasing due to short supply; asphalt rising due to oil prices. Schedule: Innovative delivery methods have improved on-time performance.

Changes: Major change on I-15 bridge redesign being reviewed. Changes are tracking lower than budgeted.

RISKS
Volume in construction is impacting local supply of qualified firms, labor, and materials.

ISSUES
ITOC requests increase public involvement.

PROGRESS
To-Date: Actual progress is tracking close to planned. Several concepts are behind pending environmental issues.

LOOK AHEAD
Major initiative is to bid two major corridor projects next month.

Quarterly Cost Comparison

Earned Value

Variance Analysis.
Caltrans currently has a comprehensive project reporting system in PIRS that can be used as a starting point to develop the overall TransNet dashboard application. If the PIRS is to be considered for this use, additional staff training and backup staff resources should be put in place for support so that progress will not be impeded by changes in staff responsibilities and availability.

**Expected Outcome**

After the proposed information management recommendations are implemented, TransNet corridor and project managers from both SANDAG and Caltrans would have access to project and program information such as budget, schedule, and status. Appropriate summary reports at varying levels of detail would be available to stakeholders such as TransNet project staff and management, consultants/contractors working on TransNet projects, the ITOC, and the general public. The reports will have easy-to-use roll-up capabilities and will show current financial information from the two financial systems. Because overall project-, corridor-, and program-level information would be readily available and regularly updated, managers could identify potential problems before they occur and plan for appropriate actions to minimize risk. An effective information system would also enhance quality while helping managers with document management and change tracking in project budget estimates and estimated schedules.

**Time Frame to Implement**

Establishing a consistent WBS and project numbering system and integrating data from the financial systems used in SANDAG and Caltrans is a high-priority requirement. This integration should be implemented immediately. We estimate that designing and implementing the integration environment between SANDAG and Caltrans systems could occur in the short term (approximately 6 months).

Additional information management recommendations (such as a program/project document management system, burn rate calculations, and budget/schedule change tracking) can be implemented in the mid term (within 6 to 12 months).

### 5.8 Organizational Structure

With the passage of the TransNet extension ordinance, SANDAG and its partners identified several Early Action Projects on multiple corridors in San Diego County. The projects are generally large and typically have both transit and highway components. Largely because of the program’s size, SANDAG and Caltrans recognized the need for a corridor manager to be a single focal point to better integrate the highway and transit components, coordinate issues, and monitor scope, schedule, and cost to successfully deliver the final project.

Timely completion of the Early Action Projects is vital to the traveling public. This can be achieved only if a dedicated team consisting of SANDAG, Caltrans, transit agencies, and other stakeholders coordinates regularly to meet the common objective of early program delivery.

Based on comments provided by SANDAG and Caltrans staff, a program-specific organizational structure is necessary. The structure must adequately address the requirements set forth in the extension ordinance. In addition to providing overall program efficiency, this structure will also ensure that the fiduciary responsibility can be satisfied.
This organizational structure is new and will likely require a departure from established reporting mechanisms currently in place at SANDAG and Caltrans. PBS&J believes this structure will ensure the efficient use of funds and expeditious project delivery.

A strong need also exists for improved reporting tools and a process to streamline the resolution of potential conflicts and key decisions. It is crucial that the adopted organizational structure bring added value and not place an additional burden on project managers and others.

Figure 14 shows the defined lines of authority with built-in processes to monitor progress at many levels. Three key differences in traditional reporting include the addition of a program management office, corridor managers, and a project-specific office.

The corridor manager, best described as the “chief executive officer” of the corridor, has considerable authority to allow for expeditious and consistent decision making. This role also carries with it significant accountability for meeting corridor-level scope, schedule, and budget targets and will be expected to report progress directly to the SANDAG Transportation Committee. This position is designed around experienced Caltrans engineering managers who possess a keen sense of organizational skills and processes and a political aptitude. Understandably, having the respect of those reporting to the corridor manager is paramount to program success.

The project office will be staffed with schedulers and estimators and is designed to be a direct link and aid to the various segment project managers and support services. The primary role of this group is to assist in updating schedules and cost estimates, including providing consistency in reporting by Caltrans staff working on the TransNet program.

The concept of a program management office is not new and is typically implemented on many programs of this size. Such an office is essential to the program success and, ultimately, accountability to the public. Consisting primarily of SANDAG, Caltrans, and outside resources, the program management office will provide added value in risk management, scheduling, and cost control not only at the project and corridor levels but also at the program level.

Also unique to the program is the additional assignment of SANDAG and Caltrans principals to each corridor. The principal would have specific responsibility for seeing that adequate staff is provided throughout project development.

Recommended roles and responsibilities are further described below.

**Corridor Manager**

- Serves as the “chief executive officer” of the corridor delivery team.
- Leads/manages the corridor delivery team.
- Manages, and is responsible for, delivery of the corridor (from concept to concrete).
- Manages, and is responsible for, scope, cost, schedule, resource, and budget management, including cash flow projections.
Figure 14. Sample Organizational Structure for a Single TransNet Corridor
Monitors progress.
Oversees, and is responsible for, authority with accountability.
Coordinates with stakeholders and partners.
Coordinates with principals.
Participates in the conflict resolution process.
Directs interaction with the TransNet program management office.
Coordinates directly with the Caltrans project office.
Reports to SANDAG and Caltrans executives.
Makes presentations to the SANDAG Transportation Committee and Board.

**SANDAG Principal**

Ensures qualified SANDAG resources are available to provide the services required by the corridor manager for successful delivery of projects.
Serves as liaison to the corridor manager and program management office.
Assists the corridor manager in resolving conflicts.
Assists the corridor manager in addressing transit-related issues and obtaining permits and approvals.

**Caltrans Principal**

Ensures qualified resources within Caltrans are available and are capable of providing the services required by the corridor manager for successful delivery of projects.
Assists the corridor manager in resolving conflicts.
Assists the corridor manager in addressing highway-related issues and obtaining permits and approvals.

The organizational chart (Figure 14) shows an enhanced management structure for SANDAG to manage and implement the TransNet extension program. In particular, it includes a new program management office specifically responsible for quality, schedule and cost monitoring, development and maintenance of a program Web site, risk management, reporting, and a built-in process for conflict resolution, as outlined in this chapter. It is anticipated the program management office will consist of a combination of staff from SANDAG, Caltrans, and, to the extent necessary, outside resources. Figure 15 shows a recommended structure for a program management office.

The proposed program management staff will reside in SANDAG’s office and will bring added value to the efficient and effective management of the TransNet program. The office will be charged with the responsibility to monitor the program implementation and project control procedures and to produce regular progress reports to inform the SANDAG Board, Caltrans, and the ITOC of program progress. Without significantly additional workload on SANDAG and Caltrans staff, the program management office will serve as an extension of existing staff and provide project managers with the support they need to help simplify their jobs. This can be accomplished while still maintaining a vigilant approach to scope, schedule, and budget control, which is absolutely necessary within the context of the mandate sent by the taxpayers of San Diego County.
Figure 15. TransNet Program Management Office Organizational Structure

Program Manager
- Provide oversight of program management activities
- Serve as liaison with corridor managers, SANDAG/Caltrans principals, and other stakeholders
- Serve as senior advisor to SANDAG executives
- Provide quality assurance and oversee consistency

Administrative Assistant
- Perform document control through electronic filing
- Act as liaison with SANDAG administrative staff

Risk Manager/Dashboard Reporting
- Forecast/address potential impacts to TransNet program before reaching critical decision points
- Assess impact of scope and schedule changes
- Make recommendations to SANDAG executives and/or corridor managers
- Develop and maintain Dashboard report.

Scheduling/Estimating
- Input and maintain comprehensive schedules as developed by project managers
- Operate and maintain SANDAG scheduling systems at project, corridor, and TransNet program level
- Provide total project estimates for TransNet program in collaboration with corridor and project managers
- Provide quality assurance

Planning/Quality Assurance
- Develop innovative concept to improve quality, cost, and production
- Ensure consistency across TransNet program
- Provide quality assurance

Web Site
- Develop and maintain project-specific Web site
- Direct interaction with corridor managers and/or SANDAG/Caltrans public information officers

Work Program
- Track and project cash flow at the program/project levels
- Assess production capabilities
- Communicate capabilities as they influence operations
Although much needs to be done before a program management office will be fully operational, many of the activities necessary for implementation have already been identified and studied. Consequently, there is an immediate need to continue refining and adopting new operational and behavioral techniques for use by both agencies. This mechanism will help ensure that transportation improvements become reality as quickly as possible and with an established method of accountability.

The concept of program management is not new to SANDAG, Caltrans, or the industry. To compare and assess business practices implemented by others in the industry, we contacted several other agencies that have addressed, or that are currently working on, programs as large and as challenging as the TransNet extension. As expected, the roles and responsibilities placed on program management offices vary widely. However, increased accountability through improved reporting continually resulted in added value and overwhelming public acceptance.
With passage of the TransNet extension ordinance, the taxpayers of San Diego County sent a clear message: they want to see much needed transportation improvements at the earliest possible opportunity. They also want stricter requirements, including documented adherence to schedule and budget, implemented for regular reports on project progress. To further ensure that their mandate is met, they sought and successfully gained support for creation of the ITOC. This committee is charged with ensuring that changes in process do in fact occur and that they will improve efficiency and accountability. Either annually, or more frequently if needed, the ITOC will report their findings directly to the SANDAG Board of Directors.

SANDAG and Caltrans management and staff have not taken the public mandate lightly. Both agencies understand the sensitivity and importance of delivering the TransNet program in a timely and cost-effective manner, and they have embraced the mandate as a challenge and an opportunity to succeed beyond public expectations.

SANDAG and Caltrans have jointly made a commitment to use a single corridor manager to help streamline the decision-making process through more direct authority and the attendant increased accountability.

With complete support from the Caltrans District office, SANDAG has taken the initiative to conduct a comprehensive analysis of existing processes currently in place at Caltrans and SANDAG. They have also identified methodologies that must be changed to produce the timely delivery of projects. This project delivery will have a heavy emphasis on maintenance and consistency of scope as well as close monitoring and reporting of budget adherence.

PBS&J has assessed the TransNet program, reviewed the current business practices of SANDAG and Caltrans, summarized relevant industry best practices, and made recommendations for improvement in areas critical for the successful delivery of the TransNet program. Ultimately, it will be up to SANDAG and Caltrans to implement these recommendations.

Worksheets 1 and 2 on the following pages are provided for SANDAG and Caltrans to facilitate the implementation of the recommendations. Worksheet 1 summarizes the recommendations described in this report. Following Worksheet 1, Figure 16 identifies a proposed schedule of implementation based on the priorities in the worksheet. SANDAG and Caltrans should then meet to discuss and develop concurrence on the priorities. Once priorities are agreed upon, Worksheet 2 can be used to add definition to the recommendations, define measurable objectives, assign responsibility, and establish a timeline for implementation.
Worksheet 1. Continuing Improvement of TransNet Program Management Priorities

<table>
<thead>
<tr>
<th>Measure</th>
<th>Description</th>
<th>Joint Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Scope and Cost Estimate</strong></td>
<td></td>
<td>High</td>
</tr>
<tr>
<td>Budget Control</td>
<td>Develop a process and implement tools to have a better control on budget.</td>
<td></td>
</tr>
<tr>
<td>Cost Estimating</td>
<td>Discuss, evaluate current process, and develop and implement a modified process to frequently update cost estimates.</td>
<td></td>
</tr>
<tr>
<td>Project Risk</td>
<td>Establish risk factors and a process.</td>
<td></td>
</tr>
<tr>
<td>Scope Tracking</td>
<td>Discuss current process and develop a modified process to monitor and approve scope changes and their impacts on costs and schedules.</td>
<td></td>
</tr>
<tr>
<td><strong>Organization Structure</strong></td>
<td></td>
<td>High</td>
</tr>
<tr>
<td>Caltrans Corridor Managers</td>
<td>Appoint a corridor manager, a single focal point, to better integrate the highway and transit components, coordinate issues, and monitor scope, schedule, and cost to successfully deliver the final project.</td>
<td></td>
</tr>
<tr>
<td>Decision-Making Process</td>
<td>Develop a formal “change management” process that outlines steps as to what, how, and who make decisions. In addition, develop a multi-level process to make decisions and resolve issues at the lowest level, when possible. The process should follow mutually developed and acceptable criteria.</td>
<td></td>
</tr>
<tr>
<td>Roles and Responsibilities</td>
<td>These offices will be charged with the responsibility to monitor program implementation and project control procedures, and produce progress reports.</td>
<td></td>
</tr>
<tr>
<td><strong>Dashboard</strong></td>
<td></td>
<td>High</td>
</tr>
<tr>
<td>Dashboard Concept</td>
<td>Develop reports that offer snapshots of projects, corridors, and the TransNet program.</td>
<td></td>
</tr>
<tr>
<td>Economic Trends</td>
<td>Discuss ways to monitor economic trends and their impact on projects.</td>
<td></td>
</tr>
<tr>
<td><strong>Project Expenditures</strong></td>
<td></td>
<td>High</td>
</tr>
<tr>
<td>Project Expenditures</td>
<td>Produce reports to track expenditures and establish a mechanism to implement required preventative and corrective steps.</td>
<td></td>
</tr>
</tbody>
</table>
Worksheet 1. Continuing Improvement of TransNet Program Management Priorities (Continued)

<table>
<thead>
<tr>
<th>Measure</th>
<th>Description</th>
<th>Joint Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Schedule Management</strong></td>
<td></td>
<td>Medium</td>
</tr>
<tr>
<td>Project Scheduling</td>
<td>SANDAG and Caltrans use different software for scheduling. Use a standardized scheduling system on a common scheduling platform that enables cross-project integration of logic and resources.</td>
<td></td>
</tr>
<tr>
<td>Resource Loading</td>
<td>Highlight the importance of resource-loading schedules and monitoring status.</td>
<td></td>
</tr>
<tr>
<td>QA/QC (Includes Value Analysis)</td>
<td></td>
<td>Low</td>
</tr>
<tr>
<td>QA/QC (Includes Value Analysis)</td>
<td>Enforce quality assurance and quality control procedures.</td>
<td></td>
</tr>
<tr>
<td><strong>Earned Value</strong></td>
<td></td>
<td>Low</td>
</tr>
<tr>
<td>Earned Value</td>
<td>Implement earned value concept to integrate cost, schedule, and performance to measure, monitor, and control project resources.</td>
<td></td>
</tr>
<tr>
<td><strong>Document Control</strong></td>
<td></td>
<td>Low</td>
</tr>
<tr>
<td>Document Control</td>
<td>Discuss the need for document control on projects and the program; evaluate existing software such as Expedition, SharePoint, and Edge Builder; and consider selecting one of them to enhance control of events, changes, and impacts.</td>
<td></td>
</tr>
</tbody>
</table>
### Figure 16. TransNet Program Management Priorities Implementation Schedule

<table>
<thead>
<tr>
<th>Activity ID</th>
<th>Activity Description</th>
<th>Orig Dur</th>
<th>Rem Dur</th>
<th>%</th>
<th>Early Start</th>
<th>Early Finish</th>
<th>Joint Priority</th>
<th>2006</th>
<th>2007</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>SCOPE AND COST ESTIMATE</td>
<td>10</td>
<td>10</td>
<td>0</td>
<td>01JAN06</td>
<td>31OCT06</td>
<td>HIGH</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>ORGANIZATION STRUCTURE</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>01JAN06</td>
<td>31MAR06</td>
<td>HIGH</td>
<td></td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>DASHBOARD</td>
<td>6</td>
<td>6</td>
<td>0</td>
<td>01JAN06</td>
<td>30JUN06</td>
<td>HIGH</td>
<td></td>
<td></td>
</tr>
<tr>
<td>40</td>
<td>PROJECT EXPENDITURES</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>01JAN06</td>
<td>31MAR06</td>
<td>HIGH</td>
<td></td>
<td></td>
</tr>
<tr>
<td>50</td>
<td>SCHEDULE MANAGEMENT</td>
<td>10</td>
<td>10</td>
<td>0</td>
<td>01APR06</td>
<td>31JAN07</td>
<td>MEDIUM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>60</td>
<td>QA/QC (INCLUDES VALUE ANALYSIS)</td>
<td>4</td>
<td>4</td>
<td>0</td>
<td>01JAN07</td>
<td>30APR07</td>
<td>LOW</td>
<td></td>
<td></td>
</tr>
<tr>
<td>70</td>
<td>EARNED VALUE</td>
<td>10</td>
<td>10</td>
<td>0</td>
<td>01JAN07</td>
<td>31OCT07</td>
<td>LOW</td>
<td></td>
<td></td>
</tr>
<tr>
<td>80</td>
<td>DOCUMENT CONTROL</td>
<td>4</td>
<td>4</td>
<td>0</td>
<td>01JAN07</td>
<td>30APR07</td>
<td>LOW</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Legend:**
- **SCOPE AND COST ESTIMATE**
- **ORGANIZATION STRUCTURE**
- **DASHBOARD**
- **PROJECT EXPENDITURES**
- **SCHEDULE MANAGEMENT**
- **QA/QC (INCLUDES VALUE ANALYSIS)**
- **EARNED VALUE**
- **DOCUMENT CONTROL**

**Notes:**
- **Start Date:** 01JAN06
- **Finish Date:** 31OCT07
- **Data Date:** 01JAN06
- **Run Date:** 30OCT06 0507

© Primavera Systems, Inc.
### Worksheet 2. Continuing Improvement of TransNet Program Management Priorities

<table>
<thead>
<tr>
<th>No.</th>
<th>Description</th>
<th>Recommendation</th>
<th>Measurable Objective</th>
<th>Priority</th>
<th>Timeline</th>
<th>Level of Effort</th>
<th>Responsibility for Implementation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Appendix A
Interviews

A significant part of this effort was to interview SANDAG and Caltrans staff to better understand their current challenges and to identify available tools to implement their respective programs. As part of this process, we also established the agencies’ expectations of the TransNet program and of each other.

During a 3-week discovery process, we identified how best to optimize and integrate different, yet effective, processes currently in place by both agencies.

The interview findings summarized in this chapter are organized as follows:

- General Comments
- Program Management
- Information Management
- Project Management
- Risk Management
- Scope Management
- Schedule Management
- Cost Management
- Resource Management

A.1 General Comments

A. SANDAG and Caltrans District 11 (San Diego offices) staff commented that theirs is the best relationship in the state of any district and local Metropolitan Planning Organization or agency; both are understandably proud of this.

B. SANDAG staff believes their current tools are still effective; they are pleased with developments to date.

C. SANDAG staff felt that Caltrans staff is technically excellent, and they prefer to use them as their “consultant of choice.”

D. The ITOC is responsible for the TransNet work program. Previously, activities were monitored by internal SANDAG staff who developed the work program through 2008.

E. The ITOC has seven members who were appointed by a selection committee. Members have diversified backgrounds with specialties in areas such as real estate, business, and transportation.

F. The ITOC meetings currently focus on apprising ITOC members on SANDAG’s operations. The ITOC members are eager to provide an independent review of the SANDAG and Caltrans processes.
G. SANDAG and Caltrans would like to see a clear communications process among the stakeholders.

**A.2 Program Management**

A. California SB 1703 changed SANDAG from a planning and oversight agency to an implementing agency with project development and construction responsibilities and authority. With this legislation, SANDAG absorbed all of the Metropolitan Transit Development Authority’s engineering staff, and their role changed to encompass technical and financial responsibilities.

B. SANDAG relies heavily upon Caltrans for TransNet program management. SANDAG noted that Caltrans has much data; however, due to the lack of proper linking tools or precise requests they have been unable to fully develop useful, easily understood project monitoring technique. Caltrans staff recently developed a tool (dashboard) to manage TransNet projects; this tool could be available for use by both agencies. The Caltrans dashboard report incorporates scope, schedule, and cost data from several existing Caltrans sources, but data completeness and quality needs to be verified.

C. Management of both SANDAG and Caltrans felt that assigning a manager for each corridor is essential to better coordinate issues, resolve issues, and make decisions in a timely manner. Implementation of this innovative concept is a high priority goal of both agencies. This concept will bring responsibility and authority to the corridor manager. The concept will expedite the decision-making process. The corridor managers will report the status of their respective corridors directly to the SANDAG Board. SANDAG management wants “checks and balances” before any presentations are made to politicians, and they also want to keep the ITOC informed. It will be necessary to dedicate resources to this concept in order to bring desired results.

D. In addition to the corridor manager concept, it was strongly felt that a well-defined dispute resolution process must be established to streamline decision making.

E. Project managers have many projects, and it is difficult to maintain a project manager with a dedicated team on each project. Heavy workload makes it challenging for a project manager to regularly monitor progress and update pertinent information such as scope, costs, and schedule changes.

F. SANDAG noted some of their challenges associated with the TransNet program:

- Efficient, quality data flow to and from SANDAG, Caltrans, the ITOC, and the Transportation Committee
- Identification and accommodation of the needs of SANDAG and Caltrans project managers
- Awareness of the needs of the finance/budget staff
- Identification of what the ITOC needs to fulfill their responsibilities
Appendix A

Interviews

Development of an integrated organizational chart
Development of a clearly defined change control process
Focus on enhancing existing systems rather than developing new ones
Accounting for all funds for reporting back through the ITOC

G. Caltrans noted some of their challenges associated with the TransNet program:

- Improved communications and quality data flow.
- User friendly methods for any new processes.
- Using this program management assessment as an opportunity to learn industry practices to manage transportation systems.
- Caltrans and SANDAG must continue to work as one unit; that is, as one team.
- Everyone involved with the TransNet program must have one vision.

A.3 Information Management

A. Data sharing between SANDAG and Caltrans is a key issue to be addressed for TransNet program management. SANDAG has been open in sharing their data and providing access to interested stakeholders. SANDAG provides systems access to Caltrans; however, access to Caltrans systems is not provided to SANDAG because of Headquarters Information Technology staff security concerns. Security protocol at Caltrans is dictated by Headquarters (Sacramento). District 11 staff is open to data sharing.

B. SANDAG wants to see a Web-based reporting system containing concise information and the ability to see earned value and expenditure rates for each project. The report should also reveal planned versus actual expenditures, baseline versus current schedule, scope creep, and reporting of potential risks to schedule and budget.

C. Information requests from SANDAG and Caltrans are typically confusing to each organization. For example, project expenditures that might include all expenditures from one organization might contain only partial expenditures from the other.

D. SANDAG and Caltrans would like to, and want to, know whether their financial systems such as Integrated Financial and Accounting System (IFAS) of SANDAG can be linked to the Caltrans systems with correlated project identification numbers and work breakdown structure (WBS), noting that this is vital for tracking project expenditures.

E. SANDAG project managers access IFAS through a Web client.

F. Lack of a consistent project numbering system is a challenge in integrating datasets from Caltrans and SANDAG. No consistent project numbering scheme is shared by Caltrans and SANDAG. A project number comes from the SANDAG overall work program (OWP),
which does not have a direct correlation with the Caltrans WBS number. A concept was discussed and developed to correlate the two numbering systems.

G. SANDAG staff use the OWP number to track timesheet hours. Staff also input timesheet information on individual spreadsheets; this information is manually keyed by finance department staff into IFAS. Another timesheet system is being evaluated to replace the current system.

H. Staff noted frustration with the existing document controls, and they believe the current practice of using paper is ineffective and unworkable. Instead, they would prefer an electronic system with backups (on CD), security and version control, and search capabilities. The TransNet program requires one central file location accessible by SANDAG, Caltrans, consultants, and other stakeholders.

I. Project Information Reporting, a tool developed by Caltrans District 11, provides a project snapshot. Caltrans uses Primavera P3 for schedule and resources. Another program, Project Management Control System (PMCS), is used to generate project information including scope, project description, work allocation, post miles, data warehouse, capital improvement plan cost estimate(s) and project assignment numbers, a unique number in the California Transportation Improvement Program with associated funding, and programming requirements.

J. The Caltrans server has the following characteristics:

- Houses more than 400 projects
- Has 116 projects in close-out process
- Houses more than 23,000 activities (total district)

K. Senate Bill 45 (SB 45) mandates Caltrans to identify resources by phases. Based on the Caltrans business control process, WBS charge numbers are controlled by phase. If necessary, project managers work around this system to advance work in the schedule. If given a choice, Caltrans staff would prefer to remove phases for flexibility.

L. In conjunction with the TransNet program, a process must be established for Caltrans to coordinate their expenditure authorization/WBS numbering system to the SANDAG OWP/IFAS numbering system.

M. Caltrans has been unable to create a dynamic connection between the Caltrans intranet and SANDAG systems. Caltrans feels strongly that one agency must be responsible for managing and maintaining the database schedule. This need is based on the complex coordination required for the large corridor projects.

N. According to Caltrans staff, SANDAG has previously stated that they will give expenditure data to Caltrans and Caltrans will track the projects; however, Caltrans remains flexible on the selected process.
A.4 Project Management

A. SANDAG noted challenges in working with Caltrans on multimodal highway and transit projects, primarily due to the difficulties in coordination between the cross-functional and cross-organizational teams. Moreover, SANDAG does not have a unique project numbering system that integrates with a Caltrans system.

B. SANDAG project managers had questions about how the interaction between SANDAG and Caltrans would operate relative to overall organizational structure and budget and reporting mechanisms.

C. SANDAG and Caltrans finance staff expressed interest in a numbering scheme/middleware that would allow for cross communication with project schedules.

D. Caltrans currently provides continuing project manager training, which has resulted in certification of many employees.

E. Significant discussion ensued on the system tools that Caltrans uses, many of which are legacy systems that cannot be replaced. Caltrans uses Primavera P3 (version 3.1) as a “front end” scheduling package. District P3 reports are uploaded periodically for Headquarters use. Caltrans hopes to introduce a scheduling/resource-loaded system within the next 18 to 24 months that will link directly to Caltrans timesheets. Proposals are currently being reviewed.

F. Some Caltrans project managers feel they should have consultants perform functional work (such as environmental) because of their heavy workloads and staff shortages. TransNet extension projects are just one of several types of projects that Caltrans project managers are responsible for delivering.

G. Project status meetings are conducted and reported upon monthly. Projects are generally quality and milestone delivery driven; that is, at times, resources are redirected to fulfill delivery commitments while meeting desired quality.

H. All work plans are loaded each January and incorporate an 18-month forecast report. The annual delivery plan tracks only 12 months of milestones. Currently, projects undergo a “re-baseline” every 12 months. As a result, the original baseline data are lost. It is anticipated a new Caltrans system will retain the original baseline budget and schedule.

I. Typically, Caltrans project managers have as many as 20 projects, sometimes totaling nearly $1 billion in construction. This heavy workload impedes their ability to actually manage projects. It was reported that project managers spend most of their time managing day-to-day crises, and relief in this area would be greatly appreciated.

A.5 Risk Management

A. SANDAG project managers favor the concept of risk management as a way to prepare by having contingency plans in place. In fact, since 2003 Caltrans has enforced a District Directive for Risk Management, which has been implemented on projects.
B. No formal process is currently in place to communicate scope changes from Caltrans to SANDAG. SANDAG project managers reportedly learn more from frequent, impromptu meetings with Caltrans project managers than they do from the monthly status meetings.

C. Staff is generally frustrated with existing document controls. They would like an electronic system with backups (on CD), security and version control, and search capabilities stored in a central file location.

D. Staff would also like to see reason(s) for project cost inflation linked with year of expenditure.

E. Staff wants a conflict resolution process (between SANDAG and Caltrans) in place. They recognize that such a process would be challenging and possibly adversarial.

F. It is anticipated that the ITOC requiring either monthly or quarterly meetings to provide updates on TransNet progress. A definite need exists to determine the type of report the ITOC will want.

G. A Web-based reporting system with the following features is seen as a basic need:
   - Concise information
   - Ability to see earned value for each project
   - Ability to see planned versus actual expenditures for each project
   - Baseline versus current schedule
   - Risk management reporting with recommended actions
   - Tracking of project scope changes

H. Caltrans has an existing process for scope change; however, the process focuses more on capital costs and schedule and does not address support costs. Staff at varying levels sees the tracking and identification of changes as major weaknesses.

A.6 **Scope Management**

A. SANDAG has detailed project controls for larger, but not for smaller, projects.

B. SANDAG believes it has adequate tools to measure scope changes. Their detailed process requires a meeting with the resident engineer, the project manager, and the program manager.

C. A formal process is not currently in place for communicating scope changes from Caltrans to SANDAG. However, if a proposed change is valid (that is, it is in the public’s interest or it improves the project), then the change is made. There is, however, no evaluation of budget or schedule implications resulting from the change.

D. Scope changes occur routinely. It was noted that it is not uncommon to see the scope increase by as much as 50 percent by direction of management. For TransNet projects, scope changes are perceived to be typically through the direction of SANDAG.
A.7 Schedule Management

A. Caltrans currently uses Primavera P3 scheduling software; SANDAG uses Microsoft Project. SANDAG specifically wanted to know if these two applications can be linked and integrated for reporting purposes. If necessary, SANDAG indicated a willingness to move away from Microsoft Project for the TransNet extension corridors, provided new software would allow for a resource-loaded schedule across the entire program. SANDAG project managers want monthly meetings where a 90-day forecast is developed to discuss key issues with critical path items discussed.

B. Because of workload constraints, project managers want to see dedicated scheduling staff in the TransNet project oversight office. Currently, SANDAG has six project managers, three of whom use Microsoft Project to track their projects; the other three are making varying degrees of effort to use Microsoft Project. In both cases, the schedules are standalone, with no attempt to link them to a master schedule.

C. Until now it has not been seen as important to have detailed schedules because details could be managed on spreadsheets or from schedules submitted by designers or contractors. Typically, these schedules have been submitted in Primavera and occasionally in Microsoft Project. Contractor schedules have been used to report project progress to management.

D. SANDAG needs to be aware of issues requiring attention and those on the critical path. With this information, they could then determine necessary actions to meet schedule requirements. Many times project managers are suddenly confronted with an influx of critical work items; therefore, SANDAG has an overall need for resource leveling.

E. Caltrans District 11 has 16 server-based copies of Primavera P3 with automated e-mail messages sent monthly to Caltrans task managers who request updates. They reportedly receive a 60 to 70 percent response rate. When key reports are due, Caltrans task managers indicated they have to do a lot of catching up. It was also mentioned at various levels that there is no clear understanding of who is responsible (project managers or task managers) for tracking budget, scope, and schedule.

F. Because of their heavy workloads, it is often difficult to get project managers to input data into the schedules. This situation is further complicated because it is rare for a project manager to remain with a job for its duration.

G. Caltrans establishes an expenditure authorization (EA) for a phase of a project to work on WBS activities identified under the phase. EA for the subsequent phases are not opened until the first phase is completely done.

H. It was reported that this set up compels project managers to be creative in charging their efforts on activities that are listed in other phases; in other words, it results in improper charging practices. It is important to note that this is a statewide issue, but some flexibility may assist in resolving this situation.
I. Primavera P3 is used to store resources and milestones; however, the hours in P3 are typically unreliable. The dashboard represents the best project tracking tool that Caltrans has.

A.8 Cost Management

A. SANDAG would like to see quarterly “living estimates” from Caltrans and others.

B. SANDAG staff wanted to know how the financial system could be reconfigured to receive updated Caltrans expenditures during the TransNet program. They want to see monthly reports for Caltrans and SANDAG WBS expenditures.

C. Internal cost estimates for TransNet work items have already increased by 7.5 percent, as a result of material cost inflation.

D. SANDAG noted that Caltrans billing sometimes continues after a project is complete. This occurs for a variety of reasons, ranging from Caltrans having to do additional scope at the request of SANDAG, or late invoicing for previously completed work. Additional items of note include (1) the need for status reports to be included with Caltrans invoices, (2) SANDAG’s inability to track the amount spent to complete work efforts, and (3) the cost to complete not being provided.

E. SANDAG project managers indicated that scope changes placed on Caltrans are sometimes requested by senior SANDAG staff, and at times, the internal SANDAG project manager may be unaware of the requested changes.

F. The original cost estimates in the TransNet ordinance were recently updated, with the result that the cost of many program components increased significantly. Hence, SANDAG sponsored a study and hired an outside consultant to identify the factors that were linked to the increases and developed recommendations on the methodologies used to estimate costs.

G. Established budget numbers in the TransNet ordinance are considered baselines and include some escalation, although there is no upper cap for expenditure authorizations. In the past, costs have not been established with a firm baseline.

H. SANDAG project managers indicated it is difficult to track inappropriate charges to their projects. A further complication is that Caltrans project managers reportedly do not document changes in detail.

I. Caltrans wants to develop a database that maintains the original estimate while tracking changes such as increases in unit costs. They are willing to consider a new tool or system that is tied to managing risk and one that would track changes automatically.

J. Because of the requirements set forth in the ordinance, all expenditures must be balanced and accounted for. Unfortunately, many projects have support costs over budget, partly because much time elapses from when an estimate is performed to when work is completed.
K. Caltrans often bases support costs on a percentage of construction, which may or may not be accurate. For example, recent increases in construction costs due to factors such as fuel and material shortages should not increase design support costs; however, support costs are generally small compared to overall project costs.

L. In response to questions about how they manage money from different funding sources, Caltrans project managers noted that they merely track what has been spent. They stated that their main target is to deliver projects on time, primarily because the public is given a commitment of a project opening date and it is difficult to miss these dates without considerable criticism.

A.9 Resource Management

A. A system must be in place to track budgeted spending versus actual production costs. A custom spreadsheet developed in-house has a built-in detailed linking spreadsheet broken into Caltrans phases; this was determined to be the desired approach. The spreadsheet would also link to SANDAG expenditures with support costs reported quarterly or annually.

B. Currently, SANDAG capital projects are assigned new numbers that do not correspond to planning numbers, and costs are not transferred from one phase to another. Consequently, a manual reconciliation must be completed to determine the total project cost.

C. SANDAG staff expressed difficulty in extracting and sharing financial information generated from their existing financial system.

D. Caltrans is a proponent of the dashboard form of reporting; some SANDAG staff, however, claimed they have not seen it, and they are not convinced that the data are meaningful or accurate. The system may require modifications; but, it was noted that this is a good start and a needed tool.

E. Caltrans uses expenditure authorization to track support cost by Caltrans phase and by job category. SANDAG is still far from adopting earned value tracking. SANDAG felt it is more efficient to talk directly to Caltrans project managers and design engineers to obtain information.

F. SANDAG would like to see if their organizational work plan (OWP) system used for planning projects can be integrated with the capital improvement plan system, which was absorbed into SANDAG from the Metropolitan Transit Development Board upon the merger of the two agencies.

G. The Caltrans WBS has seven levels, with the flexibility for individual districts to add lower levels if desired.

H. The tracking mechanism is tied to cost centers or branches that generally house 8 to 12 Caltrans staff members.
I. Caltrans senior staff indicated they are unsure of what financial reports SANDAG has or their status.

J. Caltrans processes allow for invoices identified by expenditure authorization and WBS numbers. SANDAG does not currently break consultants’ invoices into further detail. Reportedly, Caltrans invoices SANDAG with a one-page invoice with no detail or back up. Staff recognizes the need to develop a process for Caltrans and SANDAG to better communicate invoices.

K. A problem was noted with scheduling, when durations can range from 5 days for one activity to 500 days for another. One Caltrans staff member said that “…you can’t manage a 500-day task. In effect, it just becomes a bar on the timeline that you just keep dragging out until the activity is complete. You just hope you come close.”

L. Right-of-way employees indicated the level of effort required to code time specific to a project creates more work for them and requires more support resources to address changes and re-estimating. As needed, the right-of-way section does use external resources to meet the delivery timeline.
APPENDIX B
Benchmarking-Industry Best Practices
Appendix B
Benchmarking

The primary purpose of this report effort is to provide SANDAG and other affected stakeholders with an overview of existing program management practices and to benchmark them against industry best practices of similar agencies throughout the nation. Agencies selected for comparison were chosen based on their program size and staffing demands as well as possible similarities in accountability to the public and interaction with other governing bodies. Agencies chosen for comparison were:

- Florida Turnpike Enterprise
- North Texas Tollway Authority
- New York State Thruway Authority
- Maricopa Association of Governments, Phoenix, Arizona
- Sound Transit, Seattle, Washington

Many of the recommendations and conclusions in this appendix directly reflect input and findings obtained during the interviews and reviews of these transportation agency processes. This activity is consistent with the overall objective of identifying specific program management tools that are necessary to effectively and efficiently deliver the TransNet program.

B.1 General Characteristics

<table>
<thead>
<tr>
<th>Agency</th>
<th>Description</th>
</tr>
</thead>
</table>
| Florida Turnpike Enterprise         | - The Enterprise oversees 450 miles of limited access toll highways.  
                                   | - Annual 2004 revenues exceeded $520 million.                                                                                               |
| North Texas Tollway Authority       | - This regional tollway authority serves four counties in the Dallas-Fort Worth area and services 900,000 motorists on 48.7 miles of roadway daily.  
                                   | - The Authority has more than 700 employees, with the majority engaged in toll collection and maintenance activities.  
                                   | - In the past 6 years, the Authority has implemented more than $1 billion in capital projects, with an additional $2 billion in planned improvements in various stages of development. |
| New York State Thruway Authority    | - The Authority maintains 641 miles of roadway, including the 496-mile-long Governor Dewey Thruway, the longest toll superhighway system in the nation.  
                                   | - The Thruway's 496-mile mainline connects New York City and Buffalo, the state's two largest cities. About 230 million vehicles travel more than 8 billion miles on the Thruway annually.  
                                   | - On average, traffic increases at a rate of 2 to 4 percent annually.  
                                   | - The Authority, which receives no state funds for its operations, is entirely funded by user fees. |
### Appendix B
Benchmarking—Industry Best Practices

<table>
<thead>
<tr>
<th>Agency</th>
<th>Description</th>
</tr>
</thead>
</table>
| Maricopa Association of Governments Phoenix, Arizona | - The MAG, a Council of Governments that serves as the regional agency for the metropolitan Phoenix area, is also the designated Metropolitan Planning Organization.  
- Provides regional planning and policy decisions in transportation, air quality, water quality, regional development, and human services.  
- Plans and finances the regional transportation system, which consists of 30 members from 29 agencies.  
- Passage of Proposition 300 (one-half cent sales tax in 1985) continues to generate much needed transportation funding.  
- Total federal, state, and local funding for the FY 2004-2007 Transportation Improvement Program is nearly $4 billion, with $2.8 billion in highway expenditures and $1.1 billion in transit. |
| Sound Transit, Seattle, Washington              | - Sound Transit was specifically chosen for analysis because its mission and history will be paralleled by SANDAG well into the future.  
- The three-county area, including most of the local communities, voted to participate in, and be taxed for, improvements including high-occupancy vehicle lane access, express bus routes, commuter rail, and light rail.  
- In 2005 SANDAG had more than $1 billion in rail improvements; the Transit operates based on a $500 per year program. |

#### B.2 Risk Management

<table>
<thead>
<tr>
<th>Agency</th>
<th>Description</th>
</tr>
</thead>
</table>
| Florida Turnpike Enterprise                      | - Each component of the work program, including the scheduling process, cost estimating, and revenue forecasts, is based on historically conservative figures.  
- No specific measures for risk management were noted. |
| New York State Thruway Authority                 | - Information developed in both Primavera P3 and CapitalSoft is used to identify risks to the project.  
- No specific measures for risk management were noted. |
| New York State Tollway Authority                 | - No specific measures for risk management were noted.                                                                                                                                                      |
| Maricopa Association of Governments Phoenix, Arizona | - No specific measures for risk management were noted.                                                                                                                                                       |
| Sound Transit, Seattle, Washington              | - As a result of the Transit’s Owner-Controlled Insurance Program, there is keen interest in health, safety, and contractor risk management; however, no particular measures for risk management were noted. |
# B.3 Schedule Control

<table>
<thead>
<tr>
<th>Agency</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Florida Turnpike Enterprise</td>
<td>- Staff and consultants use Primavera to track work; currently in the process of transitioning to P3e/c.</td>
</tr>
<tr>
<td></td>
<td>- Staff use separate schedules to track production and construction activities.</td>
</tr>
<tr>
<td></td>
<td>- Scheduling responsibilities are clearly defined and executed. Staff uses a master generic schedule, similar to the WBS used by Caltrans. Project managers tailor the generic schedule for specific projects. Those having an interest in the schedule have access and receive regular update alerts.</td>
</tr>
<tr>
<td>North Texas Tollway Authority</td>
<td>- Staff uses Primavera and SureTrak to control schedules. The environmental, design, right-of-way, and permitting departments use Primavera P3 exclusively.</td>
</tr>
<tr>
<td></td>
<td>- Detailed schedule and budget changes are updated monthly as a result of input from the corridor manager.</td>
</tr>
<tr>
<td>New York State Thruway Authority</td>
<td>- The Authority does not use scheduling programs to track projects; projects are tracked with written monthly reports.</td>
</tr>
<tr>
<td></td>
<td>- Monthly reports are sent to the Director of Engineering Services.</td>
</tr>
<tr>
<td></td>
<td>- A limited number of people make schedule changes. Schedule problems are typically related to obtaining environmental and building permits.</td>
</tr>
<tr>
<td>Maricopa Association of Governments Phoenix, Arizona</td>
<td>- Arizona Department of Transportation design and construction project managers are responsible for cost and time management. Tools and reports vary. Most construction projects are tracked using Primavera P3.</td>
</tr>
<tr>
<td></td>
<td>- The schedule is fully loaded and is used to track the effects of change on the budget versus actual.</td>
</tr>
<tr>
<td>Sound Transit, Seattle, Washington</td>
<td>- Staff use Primavera P3; will soon transition to P3e/c.</td>
</tr>
<tr>
<td></td>
<td>- Contractors substantiate their progress using Primavera P3, P3e/c, SureTrak, or Microsoft Project.</td>
</tr>
</tbody>
</table>
### B.4 Budget Control

<table>
<thead>
<tr>
<th>Agency</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Florida Turnpike Enterprise</td>
<td>Primary budget control tools are the Project Concept Report and the Florida Department of Transportation work plan; each is given meaning and depth via reporting and comparing results from the P3e/c schedule for each project.</td>
</tr>
<tr>
<td>North Texas Tollway Authority</td>
<td>Staff uses a proprietary software system called CapitalSoft, a Web-based interface for managing all aspects of capital project delivery. CapitalSoft allows efficient management of day-to-day operations throughout the capital program life cycle. Data flow seamlessly between each capital development phase, including planning and design management, bidding and procurement, construction management, change management, and cost control.</td>
</tr>
</tbody>
</table>
| New York State Thruway Authority | The Authority has a 6-year capital projects outlay program.  
|                                | Staff, using the Capital Program Management System, an in-house-developed network system, works closely with the finance department to track projects. |
| Maricopa Association of Governments Phoenix, Arizona | Staff uses a Long-Range Transportation Plan that defines projects and budgets.  
|                                | Arizona Department of Transportation design and construction managers are responsible for cost and time management.  
|                                | State legislation mandates that project cost and schedule changes be approved by the MAG Board. |
| Sound Transit, Seattle, Washington | Staff uses Enterprise One accounting software by J.D. Edwards. It is integrated with Primavera Expedition for current status reporting.  
|                                | Staff use monthly reports for public updates and have several in-house project-based dashboard reports.  
|                                | The dashboard reports do not permit easily obtained access to greater levels of detail; however, back-up data are accessible as required. |

### B.5 Business Processes

<table>
<thead>
<tr>
<th>Agency</th>
<th>Details</th>
</tr>
</thead>
</table>
| Florida Turnpike Enterprise    | The Project Concept Report identifies the project and scope, provides for input from stakeholders, and specifies project schedule and cost. Resulting information is incorporated into the overall Florida Department of Transportation work plan.  
|                                | The Enterprise has been successful in managing project scope, budget, and schedule. A recent program expansion included 131 miles of new alignment projects that were all delivered on time and within the initial estimates used in the initial project bonding. |
### Agency

<table>
<thead>
<tr>
<th>Agency</th>
<th>Features</th>
<th>Issues of Concern</th>
</tr>
</thead>
</table>
| North Texas Tollway Authority               | - CapitalSoft supports both traditional document-based and electronic bidding processes.  
- Currently implementing a management dashboard application and remote project updates by onsite construction field inspectors via hand-held input devices.  
- Field data, review comments, shop drawings, and other correspondence can be entered real-time for viewing by all team members. The program lends itself to the integration of capital project payments into the Authority's general ledger. | - Increase in costs for project delivery is a major concern.  
- Some elements of CapitalSoft still do not work seamlessly with PeopleSoft; integration efforts continue.  
- Escalation of construction bids is a major concern.  
- The 2005 Draft Financial Plan notes financial concerns, including program scope creep and vagaries in when funds are expected versus when they appear.  
- A state voter initiative may remove some funding. Federal funding may be cut due to stresses on their own budget.  
- There is uncertainty in local tax projections with interest rate projections perhaps not as reliable as hoped.  
- Inflation is a major concern. |
| New York State Thruway Authority            | - Capital budget includes annual budgets for each of 6 years.  
- Budget changes are determined through a required consensus among key parties and generally need Board approval.  
- When capital shortfalls are expected, funding is often recategorized from new construction to a rehabilitation project. |                                                                                                                                                                                                                  |
| Maricopa Association of Governments Phoenix, Arizona | - The Long-Range Transportation Plan and updates are used to track projects. As projects progress, field reports are used to update the plan.                                                                 |                                                                                                                                                                                                                  |
| Sound Transit, Seattle, Washington          | - The Transit has a reputation for successfully and conservatively handling the stewardship of public funds.  
- Part of controlling capital expenditures is to include a citizen’s advisory group to oversee efforts. Extensive use of independent audits helps to see that the funds entrusted to the Transit are being well managed. |                                                                                                                                                                                                                  |

**B.6 Issues of Concern**
## B.7 Analytical Tools/Earned Value

<table>
<thead>
<tr>
<th>Agency</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Florida Turnpike Enterprise</td>
<td>The basis for the analysis of project progress and earned value includes monthly reports from design consultants and in-house progress meetings.</td>
</tr>
<tr>
<td>North Texas Tollway Authority</td>
<td>CapitalSoft is used to track project budget.</td>
</tr>
<tr>
<td>New York State Thruway Authority</td>
<td>A program is used to estimate individual facility conditions to predict future needs; this lends to consistency in measuring needs and evaluating funding requests.</td>
</tr>
<tr>
<td>Maricopa Association of Governments</td>
<td>Staff do not use earned value tracking; they use a broader, more labor intensive manual reporting mechanism.</td>
</tr>
<tr>
<td>Phoenix, Arizona</td>
<td></td>
</tr>
<tr>
<td>Sound Transit, Seattle, Washington</td>
<td>The Transit has a unique requirement that forces the measurement of value earned, not only on an overall level, but also in the unique perspective of equity gained for each participating community.</td>
</tr>
<tr>
<td></td>
<td>The objective of the construction program is to see that each of the tax-contributing communities is gaining a fair share of the facilities and services generated by each community.</td>
</tr>
<tr>
<td></td>
<td>There is a provision for the community to be provided with a tax roll-back when it is seen that the community has received a lesser benefit from revenues spent; this obviously necessitates careful measurement of the revenues acquired and how they are spent.</td>
</tr>
</tbody>
</table>

## B.8 Change Control

<table>
<thead>
<tr>
<th>Agency</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Florida Turnpike Enterprise</td>
<td>The Project Concept Report is the main tool to determine project make-up, which is determined through a consensus process; the process helps to minimize revisions to the project scope. The Project Concept Report measures compliance with project parameters; it is used as the basis of design and construction.</td>
</tr>
<tr>
<td>North Texas Tollway Authority</td>
<td>CapitalSoft is the source of key indicators of unplanned changes. The Authority maintains a contingency fund for unplanned changes. Management has the authority to administratively approve change orders up to $300,000. All change orders in excess of $300,000, or 25 percent of the total project cost, must be approved by the Board of Directors.</td>
</tr>
</tbody>
</table>
### Appendix B
*Benchmarking—Industry Best Practices*

#### B.9 Communications Management

<table>
<thead>
<tr>
<th>Agency</th>
<th>Description</th>
</tr>
</thead>
</table>
| New York State Thruway Authority            | - Change control is relatively new; the system is being refined and further developed.  
- The practice has typically been to require individuals observing changing conditions to arouse interest in the issue, develop a consensus, and have the Director of Engineering authorize necessary actions to confront the issue. |
| Maricopa Association of Governments         | - The Long-Range Transportation Plan identifies individual project scope. The plan is used as a measuring tool to determine how project scope is being maintained.                                    |
| Phoenix, Arizona                            |                                                                                                                                                                                                             |
| Sound Transit, Seattle, Washington          | - Scope changes have usually been traced to permitting, right-of-way, and unforeseen field conditions.  
- The Transit has endeavored to learn from past lessons and has employed this information through improved application of design contingencies, revision of construction details, and the use of community outreach to keep the public aware of project scope, schedule, and budget. |
| Florida Turnpike Enterprise                 | - Project teams use monthly dashboard reports to stay informed and to share project status information.                                                                                                  |
| North Texas Tollway Authority               | - Uses a series of executive summaries developed in-house and reports from their construction management consultant to report on project progress and status. The Authority reports to the Board monthly on project management. |
| New York State Thruway Authority            | - Basic communications are accomplished through monthly reports and staff meetings.                                                                                                                                 |
| Maricopa Association of Governments         | - Except for required public meetings, does not use a formal communication process.                                                                                                                         |
| Phoenix, Arizona                            |                                                                                                                                                                                                             |
| Sound Transit, Seattle, Washington          | - Uses the Web, e-mail, public hearings, and community outreach programs to inform citizens and colleagues of project status and the disposition of expenditures. These measures have been used to great advantage, particularly for construction activities that interfere with local traffic. |

*December 2005*  
*Program Management Assessment*
APPENDIX C
Proposed Process to Develop Benchmark Cost, Schedules, and Scope
Appendix C
Proposed Process to Develop Benchmark Costs, Schedules, and Scope

Establish a “culture change” wherein staff focuses on program costs, schedule, and scope.

- Set up standards and approach for scoping, cost estimating, and scheduling.
- Set up strong base controls for scope, cost, and schedule.
- Ensure full senior management support.
- Ensure accountability by the project/corridor managers.
- Invest in systems where needed.
- Allocate resources to meet needs and provide proper training.
- Provide consistent follow-up and attention.

Develop a benchmark cost for each project.

- Make recommendations to enhance existing cost estimating procedures.
  - Ensure estimates are being updated at proper frequencies.
  - Update at every design stage and/or every 6 months, and just before bidding.
  - Ensure trend information is being used when updating estimates.
  - Ensure industry or standards changes (i.e., environmental requirements) are updated throughout the program.
  - Ensure contingencies are being developed based on risks and probabilities.
  - Ensure contingencies are identified for design and construction cost impacts.
  - Ensure proper cost escalation/inflation factors are being used at the program level.
- Establish cost trend information
  - Review current bids and local pricing for local industry changes
  - Set up forum for information on scarcity of resources (material, equipment, labor)
  - Review national and international trends for information that may have local impact
  - Establish a reporting mechanism (at least quarterly) on cost trends
Appendix C

Proposed Process to Develop Benchmark Costs, Schedules, and Scope

- Establish cost risk assessment.
  - Establish a formalized risk assessment tool.
  - Use “Pareto” analysis to enhance risk assessments (evaluate largest potential cost impact items first).
  - Set up project/corridor team risk assessment by project line item.
  - Use risks to develop specific contingencies.
  - Track risks through project development to identify those that have been mitigated.
  - Review front end bid documents to make recommendations on assignment of risk.
  - Consider contract language to mitigate cost and schedule risk.
  - Consider steps to reduce contractor risks at the start of construction.
  - Implement methods to incorporate proper risks into project cost estimates.

- Establish cost probabilities.
  - Establish a formalized probability assessment tool.
  - Set up a project/corridor probability assessment by line item.
  - Report to senior management probabilities at the corridor and program level.
  - Develop “range” reporting of probabilities based on team assessments.

- Establish cost change controls.
  - Establish change review process during the design stage.
  - Have process that could trigger value analysis/value engineering (VE) on major changes.
  - Hire experienced contractors to evaluate project design/participate in VE studies.
  - Review construction work hours in the bid documents to determine impact on the project.
  - Review change control process to expedite response and resolution at all program stages.

- Establish cost tracking and reporting.
  - Develop consistent tracking and reporting on budget versus actual costs.
  - Establish consistent information between SANDAG and Caltrans cost tracking.
  - Review existing tracking of design phase costs to consider enhanced tracking and reporting.
  - Review pay application process to suggest methods of improving actual construction cost data.
Establish value analysis/value engineering (VA/VE) process.
- Establish “trigger” values for VA/VE studies.
- Develop teams of discipline experts to participate in VA/VE.
- Establish parameters for the VA/VE approach.
- Evaluate studies that combine VA/VE with risk assessment and probability analysis.

Implement constructability reviews on projects.
- Develop a team of experienced construction personnel for reviews.
- Develop checklist to ensure reviews are thorough and meaningful.
- Establish procedures to review constructability comments and implement changes to the plans if necessary.

Develop a benchmark schedule for each project.

Review/make recommendations on scheduling procedures.
- Establish a system that can accurately report current schedule progress on a program, corridor, or project basis.
- Use existing procedures to ensure the proper development, updating, tracking, change review, and reporting on program schedule activity.
- Establish consistent reporting between SANDAG and Caltrans on scheduling information.
- Ensure industry or program changes are implemented in all schedules.

Implement procedures for benchmark schedule development.
- Ensure benchmark schedule for each project follows the approved scheduling procedures.
- Develop a checklist to ensure benchmark schedule covers the scope for each project.
- Ensure information from project schedules can be summarized for corridor and/or program reporting.

Establish scheduling trend information.
- Track schedules to evaluate trend issues that are typically impacting various phases of projects to evaluate impact on the program.
- Track construction schedules to evaluate trends related to change issues on projects that may impact the program.
- Report those issues that have been identified in a quarterly report.

Establish schedule risk assessment.
- Develop a “Monte Carlo” or other schedule risk assessment process to evaluate risk on major projects.
Proposed Process to Develop Benchmark Costs, Schedules, and Scope

- Develop a team to evaluate schedule risk on projects.
- Use schedule risk to establish a portion of construction contingency on projects.
- Establish “triggers” and an approach for schedule “what-if” analysis on projects.

- Establish schedule change controls.
  - Review and make recommendations on the process for evaluating schedule changes.
  - Include flow chart on establishing schedule change impacts.
  - Develop reporting and tracking of potential schedule changes.

- Establish schedule tracking and reporting.
  - Develop consistent tracking and reporting on schedules.
  - Establish consistent information between SANDAG and Caltrans schedule reporting.
  - Review existing tracking of design phase schedules to consider enhanced tracking and reporting.
  - Review monthly schedule review procedures to suggest any methods to improve actual construction schedule reporting.
  - Implement TRIP report to update management on schedule information.

Develop a benchmark scope for each project.

- Develop a checklist of scoping information to ensure that all intended project scope is included in the benchmark.
- Assign a review team, representing all project disciplines, to provide scope information to the project manager.
- Set the benchmark scoping as the basis for design, costs, and schedules.
APPENDIX D
Scope Statement for Inclusion in Future Consultant Task Orders, Schedule to Implement, and Risks and Estimates
Appendix D
Scope Statement for Inclusion in Future Consultant Task Orders, Schedule to Implement, Risks, and Estimates

1. Establish standards for scheduling, reporting, document archiving, reporting risk, dealing with project changes, and participating in the FTA required project standards.

The TransNet project delivery program will have several different organizations providing support to program managers. Program managers will need timely and accurate information on progress on the separate corridors and individual projects. There will also be Federal Transit Administration (FTA) requirements for specific reporting methods and content. Program managers will be unable to run a responsive program if input from the project delivery managers is not fashioned to mesh with the reporting tools used by SANDAG. As a result, it will be necessary to establish specific standards for:

- Reporting on project scope changes
- Analyzing and reporting on project risks and mitigation
- Handling documents and archiving them in a manner that meets FTA requirements
- Reporting project status (schedule/capital use versus projections)
- Actions at key milestones in the project delivery

These standards need to be in place and reinforced by management at all levels. With them, the program managers will be able to keep the general public and the Independent Taxpayer Oversight Committee (ITOC) informed about progress and stewardship of time and money. Program managers will also understand more fully the problems and opportunities ahead on the projects and be able to address project difficulties more effectively. Lessons learned will be readily apparent.

2. Develop a uniform set of procedures to mobilize the skills of all participants.

This action item will have numerous components. Each component will be a work-in-progress that will improve with use. These components will be made-up from the best practices of the top organizations in the business, the key words being uniformity and clarity of intent:

- **Technical Services Procurement.** Procedures to be followed will ensure that the providers of these services, whether Caltrans or independent consultants, understand clearly their responsibilities and the level of quality services required. They will know from the procurement process that they are entering into an agreement with SANDAG for the purpose of meeting the project funding, schedule and quality expectations. While the relationship of Caltrans to SANDAG will fundamentally differ from that of independent consultants, each will know that they are on equal ground with regard to project objectives.

- **RFP Requirements and General Conditions.** Assuming that the program managers decide on procuring supportive services by issuing an RFP for engineering/construction management services, this document will give the invited providers a level playing field for offering their
services. In moving a project from program management planning to Caltrans for execution, we recommend that the following topics be included:

- General
- Diversity program requirements
- Public disclosure requirements
- Submittal content
- Schedule type, format, frequency, and accuracy requirements
- Procedures to be follow for requests for information (RFI)
- Instructions for acting on addenda
- Proposal review processes
- Engineering/construction management services contract negotiations
- Content of cost proposal
- Contract award and notice to proceed
- Notice of FTA requirements
- Expected Request for Proposal (RFP) attachments:
  - Scope of work and current planning documentation
  - Draft contract
  - Acknowledgement of addenda
  - Recommended cost proposal format
  - Business participation plan
  - Disadvantaged business enterprise (DBE)/Small Business Outreach Documentation Form
  - Certification regarding conflicts of interest
  - RFI form

- **Scope of Work Overview.** This document will reflect the program manager’s views on the scope of work, make clear what information and resources are available, identify the quality standards to be followed, and reference CADD standards and cost/schedule/progress reporting requirements.

**Roles and Responsibilities**

These two action items will require the vigorous support of SANDAG management as the Program Managers invest the energy and time to refine the standards that are to be asked of the program participants. This will affect the Caltrans Staff, the consultants, and contractors who construct the finished projects.

1. **Requirements for Project Management Consultant Contracts**

   A. Scope
      1. Close coordination with corridor manager.
      2. Follow established lines of authority.
3. Exercise risk management processes.

4. Project control
   b. Expeditious notification of right-of-way changes in scope/cost.
   c. Follow conflict resolution process.
   d. Use automated electronic file system.

B. Schedule
   5. Use SANDAG adopted scheduling processed/software.
   6. Coordinate with program management office.
   7. Manage projects in accordance with established WBS.

C. Cost
   8. Update estimates on quarterly basis or sooner if major changes occur.

2. Requirements for Accounting Consultant Contracts

   A. Ensure project number is consistent throughout project development.
   B. Follow established invoice format.

3. Requirements for Reporting Consultant Contracts

   A. Update Trends, Risks, Issues, and Progress (TRIP) report monthly basis.
   B. Attend monthly production meetings and report project status.
   C. Use all established reporting mechanisms.
   D. Provide input for Web site updates on continual basis.
   E. Produce budget versus actual reports monthly.
APPENDIX E
Proposed Trends, Risks, Issues, and Progress (TRIP) Process
SANDAG Dashboard Concept
“TRIP” – Trends, Risks, Issues, Progress
SANDAG Dashboard Concept

PROGRAM TRIP (DASHBOARD)
- Program Summary Schedule
- Program TRIP (Trends, Risks, Issues, Progress)
- Program Cash Flow
- Program Phase Information
- Program Metrics
- Program Earned Value

CORRIDOR TRIPS
- Corridor Summary Schedule
- Corridor TRIP (Trends, Risks, Issues, Progress)
- Corridor Cash Flow
- Corridor Phase Information
- Corridor Manager Narrative
- Corridor Earned Value

PROJECT TRIPS
- Project Schedule
- Project TRIP Report (Trends / Risks / Issues / Progress)
- Project Cash Flow
- Project Phase Information
- Project Manager Narrative
- Project Earned Value
PROGRAM “TRIP” Concept

Program Summary Schedule

Intent is to provide Senior Management with a summary of the program schedule by corridor. Variance analysis could be included or be a click away.

Program Summary is directly from the project schedules that make up each corridor.
Program TRIP Report
Major Trends / Risks / Issues / Progress

Trends
• Cost: Steel price stabilized; aggregate increasing due to short supply; asphalt rising due to oil prices
• Schedule: Innovative delivery methods have improved on-time performance
• Changes: Major change on I-15 bridge redesign being reviewed. Changes are tracking lower than budgeted

Risks:
• Volume in construction is impacting local supply of qualified firms, labor and materials

Issues:
• ITOC requests increased public involvement

Progress:
• Major initiative is to bid two major corridor projects next month

Intent of TRIP information is to provide Project, Corridor and Senior Management with pertinent information on what the trends, risks, issues and near term plans are for each project, corridor and for the entire program.

This allows major issues that impact multiple projects and are being discussed at the project level to be brought forward to the program level.
Intent of cost comparison is to compare actual and planned expenditures. Variance analysis can be included or be a click away.

Program level is a summary of the Corridor level which is a summary of the projects within each corridor.

Information could be as frequent as monthly.
Program Metrics (Option A)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Concept</td>
<td></td>
<td>92%</td>
</tr>
<tr>
<td>Design</td>
<td></td>
<td>50%</td>
</tr>
<tr>
<td>ROW</td>
<td></td>
<td>29%</td>
</tr>
<tr>
<td>Construction</td>
<td></td>
<td>11%</td>
</tr>
</tbody>
</table>

Intent of Program Metrics is to provide Senior Management with metrics on how the Program is progressing at a summary level.

At the Corridor and Project levels, a narrative is included in this location to allow project and corridor managers to provide a narrative on their project/corridor.
PROGRAM “TRIP” Concept

Program Metrics (Option A – with Corridor information)

Intent of Program Metrics is to provide Senior Management with metrics on how the Program is progressing at a summary level.

At the Corridor and Project levels, a narrative is included in this location to allow project and corridor managers to provide a narrative on their project/corridor.
## PROGRAM “TRIP” Concept

### Program Metrics (Option B)

<table>
<thead>
<tr>
<th>Stage</th>
<th>Total Projects</th>
<th>Ahead / on Schedule</th>
<th>Behind Schedule</th>
<th>Ahead / on Budget</th>
<th>Behind Budget</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concept</td>
<td>16</td>
<td>8</td>
<td>8</td>
<td>6</td>
<td>10</td>
</tr>
<tr>
<td>Right-of-Way</td>
<td>7</td>
<td>3</td>
<td>4</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>Design</td>
<td>5</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Construction</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Closeout</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Completed</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Intent of Program Metrics** is to provide Senior Management with metrics on how the Program is progressing at a summary level.

**At the Corridor and Project levels, a narrative is included in this location to allow project and corridor managers to provide a narrative on their project/corridor.**
**PROGRAM “TRIP” Concept**

### Program Information

<table>
<thead>
<tr>
<th>Phase</th>
<th>Budget</th>
<th>Current Est.</th>
<th>Actual Budget Hours</th>
<th>Actual Hours</th>
<th>P3 Planned % Complete</th>
<th>P3 Actual % Complete</th>
</tr>
</thead>
<tbody>
<tr>
<td>PA/ED</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Design</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ROW</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Construction</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>Total</strong></td>
<td><strong>Total</strong></td>
<td><strong>Total</strong></td>
<td><strong>Total</strong></td>
<td><strong>Total</strong></td>
<td><strong>Total</strong></td>
</tr>
</tbody>
</table>

**Intent of Program information is to provide Management with summary level cost and hour expenditures, along with percent complete measurements to evaluate the status of projects, corridors and the program.**

Drill Down for further information

Go to Projects
Go to Corridors
PROGRAM “TRIP” Concept

**Earned Value**

<table>
<thead>
<tr>
<th>8/05</th>
<th>11/05</th>
<th>2/06</th>
<th>5/06</th>
<th>8/06</th>
<th>11/06</th>
<th>2/07</th>
<th>5/07</th>
<th>8/07</th>
<th>11/07</th>
<th>2/08</th>
<th>5/08</th>
<th>7/08</th>
<th>10/08</th>
<th>1/09</th>
<th>4/09</th>
<th>7/09</th>
<th>10/09</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Schedule Variance (4 months)*

*Cost Variance 14%

Variance Analysis:

*In June 2008:*
- Actual project cost is 14% below planned cost
- Actual progress is 4 months behind planned progress

**Intent of Earned Value information is to provide Project, Corridor and Senior Management with performance information based on what has been earned vs. what was planned to have been earned.**

**Information provides a good tie-in of cash flow and schedule information to measure progress. Variance can be on dashboard or a click away.**
PROGRAM “TRIP” Concept

Program Summary Schedule

Program TRIP Report

(Major Trends / Risks / Issues / Progress)

Trends:
Cost: Steel price stabilized; aggregate increasing due to short supply; asphalt rising due to oil prices
• Schedule: Innovative delivery methods have improved on-time performance
• Changes: Major change on I-15 bridge redesign being reviewed. Changes are tracking lower than budgeted

Risks:
• Volume in construction is impacting local supply of qualified firms, labor and materials

Issues:
• ITOC requests increase public involvement

Progress:
To-Date: Actual progress is tracking close to planned. Several concepts are behind pending environmental issues.

Look-Ahead: Major initiative is to bid two major corridor projects next month

Program Information

<table>
<thead>
<tr>
<th>Phase</th>
<th>Budget</th>
<th>Actual</th>
<th>Var.</th>
<th>Budget</th>
<th>Actual</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Drill Down for further information

Go to Projects
Go to Corridors

Program Metrics

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Concept</td>
<td></td>
<td>92%</td>
</tr>
<tr>
<td>Design</td>
<td></td>
<td>50%</td>
</tr>
<tr>
<td>ROW</td>
<td></td>
<td>29%</td>
</tr>
<tr>
<td>Construction</td>
<td></td>
<td>11%</td>
</tr>
</tbody>
</table>

Variance Analysis:
- Variance, Q3 (2007): $14M Actual; $11.5M Planned

Quarterly Cost Comparison

- Planned Value
- Actual Value

Earned Value

- Earned Value
- Planned Value

Caltrans

SANDAG
PROGRAM “TRIP” Concept

Program Summary Schedule

Program TRIP Report

(Major Trends / Risks / Issues / Progress)

Trends:
Cost: Steel price stabilized; aggregate increasing due to short supply; asphalt rising due to oil prices
•Schedule: Innovative delivery methods have improved on-time performance
•Changes: Major change on I-15 bridge redesign being reviewed. Changes are tracking lower than budgeted

Risks:
•Volume in construction is impacting local supply of qualified firms, labor and materials

Issues:
• ITOC requests increase public involvement

Progress:
To-Date: Actual progress is tracking close to planned. Several concepts are behind pending environmental issues.

Look-Ahead: Major initiative is to bid two major corridor projects next month

Program Metrics

<table>
<thead>
<tr>
<th>Phase</th>
<th>Budget Hours</th>
<th>Planned Hours</th>
<th>Actual Hours</th>
<th>% Behind Schedule</th>
<th>% Behind Budget</th>
<th>Ahead / on Schedule</th>
<th>Ahead / on Budget</th>
<th>Behind Schedule</th>
<th>Behind Budget</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Design</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ROW</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Construction</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Drill Down for further information
Go to Projects
Go to Corridors

Variance Analysis:
CORRIDOR “TRIP” Concept

Corridor Summary Schedule

Corridor TRIP Report
(Major Trends / Risks / Issues / Progress)

Trends:
• Cost: Steel price stabilized; aggregate increasing due to short supply; asphalt rising due to oil prices
• Schedule: Innovative delivery methods have improved on-time performance
• Changes: Major change on I-15 bridge redesign being reviewed. Changes are tracking lower than budgeted

Risks:
• Volume in construction is impacting local supply of qualified firms, labor and materials

Issues:
• ITOC requests increase public involvement

Progress:
• To-date: This corridor in the initial stages of development. The schedule is set for construction to begin in early 2008. Current efforts will focus on getting the design consultant started on final design.

• Look Ahead - Major initiative is to resolve environmental issues to ensure concepts are completed. Also considering bidding strategies for the project nearing bid stage.

Quarterly Cost Comparison

Variance Analysis:

Earned Value

Drill Down for further information
Go to Projects
Go to Corridors
PROJECT "TRIP" Concept

Project Summary Schedule

Project Phase Information

<table>
<thead>
<tr>
<th>Phase</th>
<th>Budget</th>
<th>Current Est</th>
<th>Actual Budget Hours</th>
<th>Actual Hours</th>
<th>P3 Planned Complete</th>
<th>R/W Actual Complete</th>
</tr>
</thead>
<tbody>
<tr>
<td>PA/ED</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Design</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ROW</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Construction</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Drill Down for further information
Go to Projects
Go to Corridors

Project TRIP Report
(Major Trends / Risks / Issues / Progress)

Trends:
- Cost: Steel price stabilized; aggregate increasing due to short supply; asphalt rising due to oil prices
- Schedule: Innovative delivery methods have improved on-time performance
- Changes: Major change on I-15 bridge redesign being reviewed. Changes are tracking lower than budgeted

Risks:
- Volume in construction is impacting local supply of qualified firms, labor and materials

Issues:
- ITOC requests increase public involvement

Progress:
- To-date: Project is in the development stages and the environmental documents are being modified.
- Look Ahead:
  - Environmental document to be delivered next month
  - Community meeting planned for next quarter
  - R/W preliminary assessment to begin following corridor refinement

Variance Analysis:

Today

*Schedule Variance (4 months)

Actual project cost is 14% below planned cost
Actual progress is 4 months behind planned progress
Appendix F
Program Management

This appendix contains an inventory of the information management systems used at both SANDAG and Caltrans, gives examples of what an integrated information management system can do, and describes the steps that can be taken to achieve integration between IFAS and TRAMS/PIRS.

Information Management Systems Used at SANDAG and Caltrans District 11

<table>
<thead>
<tr>
<th>Activity</th>
<th>SANDAG</th>
<th>Caltrans District 11</th>
</tr>
</thead>
<tbody>
<tr>
<td>Financial Data Management</td>
<td>– IFAS</td>
<td>– Transportation Accounting and Management System (TRAMS)</td>
</tr>
<tr>
<td></td>
<td>– Microsoft Excel spreadsheets to track payments to consultants and contractors</td>
<td>– Microsoft Excel spreadsheets to track payments to consultants and contractors</td>
</tr>
<tr>
<td>Scheduling</td>
<td>– Microsoft Project not widely used</td>
<td>– Primavera P3</td>
</tr>
<tr>
<td></td>
<td>– No consistent WBS system</td>
<td>– Tasks not uniformly set up</td>
</tr>
<tr>
<td></td>
<td></td>
<td>– Tasks range from 20 to 20,000 hours</td>
</tr>
<tr>
<td></td>
<td></td>
<td>– Cannot accurately track large tasks</td>
</tr>
<tr>
<td>Project Cost/Budget Estimates</td>
<td>– Developed by project engineers and manually compiled by project managers</td>
<td>– Standardized Caltrans 11-page cost estimate forms (quantity based; does not relate to deliverables)</td>
</tr>
<tr>
<td></td>
<td>– Finance staff key data into IFAS</td>
<td>– Cannot track changes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>– Cannot prepare summaries because it is in a Microsoft Word document</td>
</tr>
<tr>
<td></td>
<td></td>
<td>– Information not stored in database format</td>
</tr>
<tr>
<td></td>
<td></td>
<td>– No formal budgeting process</td>
</tr>
<tr>
<td></td>
<td></td>
<td>– Data stored in Project Management and Control System</td>
</tr>
<tr>
<td>Employee Project Hours</td>
<td>– RCMS/Excel spreadsheets</td>
<td>– Staff Central (Caltrans employee time reporting system) to TRAMS</td>
</tr>
<tr>
<td></td>
<td>– Automated export to IFAS from RCMS; however, manual data entry from spreadsheets to IFAS is done by finance staff</td>
<td>– Data electronically downloaded from TRAMS into PIRS for summary reports</td>
</tr>
<tr>
<td></td>
<td>– Will migrate to Ceridian by December 2005</td>
<td></td>
</tr>
<tr>
<td>Project Status Reports</td>
<td>– Projects tracked by managers downloading information from IFAS into Microsoft Excel spreadsheets and documents</td>
<td>– Milestones tracked in Primavera P3 and reported through PIRS</td>
</tr>
<tr>
<td></td>
<td>– Status reported quarterly to Board</td>
<td>– Fact sheet database under development</td>
</tr>
<tr>
<td>Program Management Reports</td>
<td>– IFAS</td>
<td>– PIRS</td>
</tr>
<tr>
<td></td>
<td>– Microsoft Project</td>
<td>– PROMIS under development</td>
</tr>
<tr>
<td></td>
<td></td>
<td>– Microsoft Excel worksheets</td>
</tr>
<tr>
<td></td>
<td></td>
<td>– Microsoft Word documents</td>
</tr>
</tbody>
</table>
Information Management Systems Used at SANDAG and Caltrans District 11 (Continued)

<table>
<thead>
<tr>
<th>Activity</th>
<th>SANDAG</th>
<th>Caltrans District 11</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Budget Changes</td>
<td>Through Change Request Form and manual approval process based on dollar amount of change</td>
<td>Budget change process inconsistent and sometimes arbitrary</td>
</tr>
<tr>
<td></td>
<td>Finance staff update data in IFAS</td>
<td>Changes reflected in TRAMS</td>
</tr>
<tr>
<td></td>
<td>Significant delay before updated data shown in IFAS</td>
<td></td>
</tr>
<tr>
<td>Tracking Scope and Budget Changes</td>
<td>Electronic tracking is available</td>
<td>Electronic tracking not available</td>
</tr>
<tr>
<td></td>
<td>Change process in place but information can only be tracked/verified manually through hard copies</td>
<td>Change process in place but information can only be tracked/verified manually through hard copies</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

During a major program implementation, an integrated information management system can and should:

- **Maintain centralized, secure information control.** Most systems have secure control of access, automatic back up, and a centralized location.

- **Capture all project collaboration.** Documents, correspondence, e-mail messages, schedules, photos, and other information are all kept in the system (such as SharePoint, Expedition, or Edge Builder). This system would need to be evaluated by both agencies prior to a final selection.

- **Use relational databases.** The systems use relational databases to file, sort, report, and research any item in the database.

- **Capture work processes.** The work process (or flow of information) is captured at all points of the process: (1) draft report submitted electronically, (2) report comments by multiple parties captured electronically, and (3) final report included in the database. All dates, issues, and discussions are captured for future reference; notifications can be automatically sent to those who are required to respond or provide information.

- **Provide project/program reporting.** Recent information management systems can provide full reporting based on information captured in the database.

- **Provide for paperless collaboration.** Nearly all project collaboration can be performed without paper. Drawings, contract documents, and other information is stored electronically.

- **Allow for public access Web sites.** Some information management systems allow for using database information to populate Web sites that can be accessed for program/project information.

- **Provide the ability to integrate other systems.** Many information management systems are developed on a flexible platform that allows the system to share information with other systems. This can further automate systems and increase efficiency and quality.

- **Provide the ability to use information throughout project duration.** An information management system can be used to collect all project information from concept through construction closeout.
Integration between IFAS and TRAMS/PIRS can be achieved by taking the steps described below.

- Implement correlating TransNet project numbering and WBS system.

- Enhance Caltrans dashboard report to a TransNet TRIP report that will automatically read pertinent project data (financial, schedule, and status) from IFAS and TRAMS/PIRS and automatically save it to a dashboard data repository (database). Required elements of such a TRIP application are described below.
  - The TransNet TRIP report should read data from the two financial systems at pre-defined intervals and be saved into the dashboard data repository. If possible, this should be an automatic process with no need for manual intervention.
  - The TransNet TRIP report should be Web-based and accessible through a secure interface to all authorized SANDAG, Caltrans, and ITOC staff.
  - The TransNet TRIP report should contain predefined reports and search mechanisms to allow authorized users to generate reports easily at the project, corridor, or program level.
  - Data for a specific project should include elements from all underlying tasks from both SANDAG and Caltrans financial and other relevant project information systems.
  - The TransNet TRIP report should be hosted on an independent secure network (such as a hosting environment) so that it can be accessed by both SANDAG and Caltrans staff without the limitations of their respective security protocols.

- A conceptual view of how the TransNet dashboard application would correlate and compile data from various data sources in SANDAG and Caltrans is shown on Figure 1, with a more detailed look in Appendix A, Proposed Trends, Risks, Issues, and Progress (TRIP) Reports. This interface will serve as the information gateway for TransNet staff to obtain current program, corridor, and project information on demand.

- A conceptual dashboard data repository design that facilitates project and program reporting at a variety of groupings/summary levels is needed. Information from existing financial and other computer systems should be downloaded into the TransNet dashboard data repository using automated procedures programmed to be executed on predefined time intervals (daily, weekly, or monthly).

- To develop the final dashboard data repository, reports and data search criteria should be finalized among all parties.

- Data from the financial systems can be received in any standard data exchange format (such as CSV, Microsoft Excel, or relational database tables). Current data import/export routines already in place at Caltrans District 11 and SANDAG can be used and refined or expanded to meet the specific needs of the dashboard reports selected by the TransNet program management staff.

- When data exchange formats, update frequency, and access privileges are determined, a user-friendly interface can be developed using industry-standard Web application software to facilitate on-demand data access by authorized staff.
If desired, the dashboard interface can also be easily extrapolated to other non-TransNet projects to facilitate coordination between SANDAG and Caltrans on common projects.

A dashboard user manual and training program should be developed.

A feedback mechanism should be implemented so that suggestions for system improvements can be compiled and implemented on a planned schedule so that the dashboard continues to meet the needs of the TransNet staff through the life of the program.

The application and database architecture of the dashboard application will be open, flexible, and expandable to accommodate future project reporting needs.

A process to track project cost estimates in an enterprise system should be developed. This can be done by creating a simple Web application to facilitate tracking cost changes. Cost changes can be tied to associated comments on the reasons for cost changes. Cost estimates should be in a database format to facilitate analysis and to answer questions (for example, how much the right-of-way acquisition would be for a specific project or program).

Manual data entry is subject to errors that lead to inaccurate project summary reports. SANDAG is converting to a Web-based timesheet system (Ceridian) by December 2005. This change should eliminate manual data entry into IFAS.

Alerts to streamline problem identification in project budgets and schedules should be established. Simple alerts could be triggered when certain events (such as when 50 percent of the budget has been spent or a specified number of hours has been spent on a specific task). The system can be configured to alert project managers of impending problems.

The burn rate and earned value tracking systems should be integrated into IFAS or another simple enterprise system where information is readily accessible to project managers. Information can be obtained by querying by project expenditure authorization number or project name.

A variety of off-the-shelf software is available (such as Expedition, Edge Builder, OnVia, and Documentum) as are custom applications (such as PBS&J Right-of-Way Tracker, Electronic Review Comments Tracking, Geographic Permit Management and Compliance System, and TeamAccess based on SharePoint technology from Microsoft). These applications can streamline specific business functions and document management required for TransNet program management. After review by SANDAG and Caltrans staff, these applications can be incorporated into their business processes.
December 7, 2005

AGENDA ITEM NO.: 6

Action Requested: INFORMATION

TransNet ENVIRONMENTAL MITIGATION PROGRAM

File Number 1110200

Attachments related to this item include:

- A fact sheet summarizing the key features of the new TransNet Environmental Mitigation Program (EMP).
In 1987, voters approved the TransNet program — a half-cent sales tax to fund a variety of important transportation projects throughout the San Diego region. This 20-year, $3.3 billion transportation improvement program expires in 2008. In November 2004, 67 percent of the region’s voters supported the extension of TransNet to 2048 − thereby generating an additional $14 billion for highway, transit, and local road projects and other transportation improvements.

A unique component of the extension is the creation of an environmental mitigation program (EMP), which goes beyond traditional mitigation for regional and local transportation projects. While the EMP includes an allocation for the estimated direct costs for mitigation of upland and wetland habitat impacts for regional and local transportation projects, it also includes additional funding for habitat acquisition, management, and monitoring activities. The EMP will help implement the Multiple Species Conservation Program (MSCP) and the Multiple Habitat Conservation Program (MHCP).

The ballot measure identified $850 million to be used for the EMP. The EMP principles state that two funds shall be established. The first one, a “Transportation Project Mitigation Fund” covers direct mitigation costs for regional and local transportation projects estimated to be $650 million ($450 million for regional projects, $200 million for local projects).

These funds will be used for the mitigation needs of the major transportation infrastructure improvement projects and programs identified in the SANDAG Regional Transportation Plan. Although the extension does not begin until April 2008, an “early action program” has been designed to address priority projects. Satisfying the mitigation requirements for these priority projects will be addressed...
comprehensively rather than on a project-by-project basis in order to maximize early land acquisition opportunities.

The early action TransNet projects include: the widening of SR 76 between Melrose Drive and I-15; the extension of SR 52 from SR 125 to SR 67; the Mid-Coast regional transit extension from Old Town onto the UCSD campus and over to University City; the I-15 Managed Lanes from SR 78 to SR 163; the SR 52 reversible Managed Lanes from I-15 to SR 125; the I-5 North Coast Corridor projects; and the I-805 corridor projects.

The second fund, a “Regional Habitat Conservation Fund,” will be approximately $200 million ($150 million for regional projects and $50 million for local projects). These funds will be made available for regional habitat acquisition, management, and monitoring activities necessary to implement the MSCP and the MHCP. Funds are estimated based on the economic benefit derived from purchasing land with the “Transportation Project Mitigation Fund” in advance of need in larger blocks at a lower cost, and with mitigation ratios predetermined and held constant over time for each of the habitat conservation plans. The Environmental Mitigation Program guidelines identify up to $30 million in financing costs allocated from the expenditure plans.

The Environmental Mitigation Program will be a collaborative effort among SANDAG, the cities, the county, the wildlife agencies (California Department of Fish and Game and the US Fish and Wildlife Service), and other regulatory agencies (Coastal Commission, US Army Corps of Engineers, US Environmental Protection Agency, and the Regional Water Quality Control Board) as well as representatives of various stakeholder groups, including the environmental community and the science/technical community.

What do we mean by “Economic Benefit?”

With today’s rising land prices, we know that if we buy land today, it will cost less than if we wait and buy it later. Smart investors know this, which is why land in Southern California is at a premium.

Transportation projects will be built during the next 30 years. Whenever a project impacts sensitive habitats, mitigation lands must be acquired prior to the issuance of permits. If land is purchased in advance of need, with mitigation ratios held constant over time, an economic benefit is derived because the mitigation obligation is known and the land is purchased at today’s prices. The savings derived by purchasing land today, rather than at some time in the future, constitutes the economic benefit.
INDEPENDENT TAXPAYER
OVERSIGHT COMMITTEE

December 7, 2005

AGENDA ITEM NO.: 7

Action Requested: DISCUSSION/POTENTIAL ACTION

2007 REGIONAL TRANSPORTATION PLAN (RTP) PERFORMANCE MEASURES AND TRANSPORTATION PROJECT EVALUATION CRITERIA

File Number 1110200

Attachments related to this item are:

1. Agenda item 3 for the upcoming Transportation Committee meeting scheduled for December 9, 2005; and

2. Summary of the major ITOC responsibilities from the TransNet Extension Ordinance. Paragraph #6 related to performance measures and project evaluation criteria as part of the long-range Regional Transportation Plan (RTP).
TRANSPORTATION COMMITTEE

December 9, 2005

AGENDA ITEM NO.: 3

Action Requested: APPROVE

2007 COMPREHENSIVE REGIONAL TRANSPORTATION PLAN (RTP): File Number 3000400
FORMATION OF AN AD HOC WORKING GROUP TO REVIEW TRANSPORTATION PROJECT EVALUATION CRITERIA

Introduction

Over the years, SANDAG has developed and updated evaluation criteria for prioritizing transportation projects for inclusion in the Regional Transportation Plan (RTP). The last RTP update took place in 2003, during the preparation of MOBILITY 2030. Evaluation criteria are applied to regional arterial, highway, freeway connectors, high-occupancy-vehicle (HOV) connectors, and regional transit projects. These criteria will be reviewed and updated for the preparation of the Comprehensive 2007 RTP. Additional criteria were recently added for regional rail grade separations, and a goods movement category is also under consideration.

Recommendation

The Transportation Committee is asked to approve the formation of the Transportation Project Evaluation Criteria Ad Hoc Working Group.

Discussion

Staff proposes to form an ad hoc working group to lead the update of the transportation project evaluation criteria. Representatives from the following standing committees and working groups will be invited to participate:

- Regional Planning Stakeholders Working Group (SWG) 2
- Cities/County Transportation Advisory Committee (CTAC) 2
- Regional Planning Technical Working Group (TWG) 2
- Bicycle-Pedestrian Working Group (BPWG) 1
- Regional Housing Working Group (RHWG) 1
- Regional Freight Working Group (FWG) 1

In addition to SANDAG staff, staff from Caltrans, Metropolitan Transit System, and North County Transit District will be asked to join the new Ad Hoc Working Group.

The ad hoc working group is expected to meet monthly through fall 2006, but may meet more frequently depending on key milestone dates for the Comprehensive 2007 RTP. Recommendations from the ad hoc working group would be discussed with each of the participants' committees and working groups. Additionally, this ad hoc working group might be asked to review the performance indicators used in the analysis of transportation alternatives of the 2007 RTP. The performance
measures for the overall transportation system are closely related to the transportation project evaluation criteria.

The first meeting is tentatively scheduled for Monday, January 23, 2006, from 1:30 to 3:30 p.m. at SANDAG. A meeting agenda will be sent to the appointed representatives in advance.

Bob Leiter
Director of Transportation and Land Use Planning

Key Staff Contact: Rachel Kennedy, (619) 699-1929, rke@sandag.org
EXEMPLARY STATEMENT OF UNDERSTANDING REGARDING THE IMPLEMENTATION OF THE INDEPENDENT TAXPAYER OVERSIGHT COMMITTEE FOR THE TRANSNET PROGRAM

ITOC Responsibilities

The ITOC shall have the following responsibilities:

1. Conduct an annual fiscal and compliance audit of all TransNet-funded activities using the services of an independent fiscal auditor to assure compliance with the voter-approved Ordinance and Expenditure Plan. This annual audit will cover all recipients of TransNet funds during the fiscal year and will evaluate compliance with the maintenance of effort requirement and any other applicable requirements. The audits will identify expenditures made for each project in the prior fiscal year and will include the accumulated expenses and revenues for ongoing, multi-year projects.

2. Prepare an annual report to the SANDAG Board of Directors presenting the results of the annual audit process. The report should include an assessment of the consistency of the expenditures of TransNet funds with the Ordinance and Expenditure Plan and any recommendations for improving the financial operation and integrity of the program for consideration by the SANDAG Board of Directors. This consistency evaluation will include a review of expenditures by project type for each local jurisdiction. The ITOC shall share the initial findings of the independent fiscal audits and its recommendations with the SANDAG Transportation Committee 60 days prior to their release to resolve inconsistencies and technical issues related to the ITOC’s draft report and recommendations. Once this review has taken place, the ITOC shall make any final amendments it deems appropriate to its report and recommendations and adopt its report for submission directly to the SANDAG Board of Directors and the public. The ITOC shall strive to be as objective and accurate as possible in whatever final report it adopts. Upon completion by the ITOC, the report shall be presented to the SANDAG Board of Directors at its next regular meeting and shall be made available to the public.

3. Conduct triennial performance audits of SANDAG and other agencies involved in the implementation of TransNet-funded projects and programs to review project delivery, cost control, schedule adherence, and related activities. The review should include consideration of changes to contracting, construction, permitting, and related processes that could improve the efficiency and effectiveness of the expenditure of TransNet revenues. These performance audits shall be conducted using the services of an independent performance auditor and should include a review of the ITOC’s performance. A draft of the ITOC’s report and recommendations regarding the performance audits shall be made available to the SANDAG Transportation Committee at least 60 days before its final adoption by the ITOC to resolve inconsistencies and technical issues related to the ITOC’s draft report and recommendations. Once this review has taken place, the ITOC shall make any final amendments it deems appropriate to its report and related recommendations and adopt its report for presentation directly to the SANDAG Board of Directors and the public. The ITOC shall strive to be as...
objective and constructive as possible in the text and presentation of the performance audits. Upon completion by the ITOC, the report shall be presented to the SANDAG Board of Directors at its next regular meeting and shall be made available to the public.

4. Provide recommendations to the SANDAG Board of Directors regarding any proposed amendments to the Ordinance and Expenditure Plan.

5. Provide recommendations as part of the 10-year review process. This process provides an opportunity to undertake a comprehensive review of the TransNet program every ten years and to make recommendations for improving the program over the subsequent ten years. This review process should take into consideration the results of the TransNet-funded improvements as compared to the performance standards established through the Regional Transportation Plan and the Regional Comprehensive Plan.

6. Participate in the ongoing refinement of SANDAG’s transportation system performance measurement process and the project evaluation criteria used in development of the Regional Transportation Plan (RTP) and in prioritizing projects for funding in the Regional Transportation Improvement Program. The focus of this effort will be on TransNet-funded projects. Based on the periodic updates to the RTP, as required by state and federal law, the oversight committee shall develop a report to the SANDAG Transportation Committee, the SANDAG Board of Directors, and the public providing recommendations for possible improvements and modifications to the TransNet program.

7. On an annual basis, review ongoing SANDAG system performance evaluations, including SANDAG’s “State of the Commute” report, and provide an independent analysis of information included in that report. This evaluation process is expected to include such factors as level of service measurements by roadway segment and by time of day, throughput in major travel corridors, and travel time comparisons by mode between major trip origins and destinations. Such information will be used as a tool in the RTP development process.

8. Review and comment on the programming of TransNet revenues in the Regional Transportation Improvement Program (RTIP). This provides an opportunity for the ITOC to raise concerns regarding the eligibility of projects proposed for funding before any expenditures are made. In addition to a general eligibility review, this effort should focus on significant cost increases and/or scope changes on the major corridor projects identified in the Ordinance and Expenditure Plan.

9. Review proposed debt financings to ensure that the benefits of the proposed financing for accelerating project delivery, avoiding future cost escalation, and related factors exceed issuance and interest costs.

10. Review the major Congestion Relief projects identified in the Ordinance for performance in terms of cost control and schedule adherence on a quarterly basis.

In carrying out its responsibilities, the ITOC shall conduct its reviews in such a manner that does not cause unnecessary project delays, while providing sufficient time to ensure that adequate analysis can be completed to allow the ITOC to make objective recommendations and to provide the public with information about the implementation of the TransNet program.