Cal-B/C Training Module 8a
Cal-B/C Sketch
Understanding Project Input Sheets and Data
About This Module
This module will...

- Builds on Module 4a to provide more details on how to get data for your benefit-cost analysis (BCA) using Cal-B/C Sketch
- Identify data sources to use for demand, operational, and project cost data
Previous Modules…

- **Module 1** provided a basic introduction on benefit-cost analysis (BCA) and a general overview of how to conduct a BCA.
- **Module 2** described the Cal-B/C suite of tools, discussed the types of projects that can be evaluated, and provided guidance on which tools to use for various project types.
- **Module 3** presented the Cal-B/C results page, detailed what each output measure means, and explained how they are calculated.
- **Module 4a** presented an overview of how Cal-B/C Sketch works including a review of all worksheets and inputs.
- **Module 5** highlighted the information in the Parameters worksheet and discussed key assumptions used by Cal-B/C.
- **Module 6a** provided detailed information on how Cal-B/C Sketch calculates benefits.
- **Module 7a** presented the 1-2-3 approach to starting a Cal-B/C Sketch analysis.
Requirements for Making Full Use of This Module

- Basic understanding of traffic engineering and transportation planning methodologies, data and terminology
- Ability to navigate websites and download relevant data
- Knowledge of Microsoft Excel and data analysis features such as pivot tables and charting tools
Primary Cal-B/C Data Entry Worksheet

- For most analyses, two worksheets will be needed for data entry.
- Not all data entry needs will be covered such as:
  - Project specific information: project location, design and geometric data.
  - Default calculations for:
    - Speeds
    - Volumes
    - Collisions
  - Additional ramp and arterial inputs
  - Person-trip verification for HOV/HOT projects

**Worksheets where data will be entered**

**Worksheets where Cal-B/C performs calculations and tabulates results**

<table>
<thead>
<tr>
<th>Title</th>
<th>Instructions</th>
<th>1) Project Information</th>
<th>2) Model Inputs</th>
<th>3) Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Summary instructions on how to fill out each data item in Cal-B/C</td>
<td>Project Description/Type of Project</td>
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<td>Highway Geometric and Traffic Data</td>
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<td>Highway Collision Data</td>
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<td>Rail and Transit Data</td>
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<td>Project Costs</td>
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<td>Additional ramp and arterial inputs</td>
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<td>Person-trip verification for HOV/HOT projects</td>
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<td>BCA results</td>
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<td>Itemized Benefits ($$)</td>
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<td>Emission Savings (Tons)</td>
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<td>Calculates No Build and Build Person-Hours and</td>
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<td>Costs by:</td>
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<td>Calculates Highway No Build and Build Fuel and</td>
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<td>Non-Fuel Costs by:</td>
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<td>Calculates No Build and Build Collision Costs</td>
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<td>Calculates No Build and Build Running and Starting</td>
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<td>Emissions and Costs:</td>
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<td>Mode</td>
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<td>Tabulates final results, including:</td>
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<td>Net present value</td>
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<td>Internal rate of return</td>
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<td></td>
<td>Key default analysis parameters and assumptions for all Cal-B/C tools</td>
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</tbody>
</table>
Review: Cell Color-Coding

- Cal-B/C Sketch requires few user inputs, but allows you to enter more inputs when data is available

- **Green** cells indicate required data
  - You must input values for Cal-B/C to work for the particular analysis being performed
  - Cal-B/C descriptions tell you what cells need to be used for a given analysis
  - For example, if analyzing a highway project, highway traffic data must be entered in the appropriate green cells

- **Red** cells provide default values that you can change if needed
  - For example, Cal-B/C provides default values for percent trucks and average vehicle occupancy (AVO)

- **Blue** cells contain values calculated by the model for No Build and Build Scenarios
  - You can override the values in these cells if better data is available

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Cal-B/C Data Entry Worksheet – Project Information

- Not all cells require data entry
- Cal-B/C Sketch data item headers indicate if data is required
  - Pavement condition data is required only for pavement projects
  - Percent reduction in transit accidents is needed only for transit safety improvement projects

<table>
<thead>
<tr>
<th>Section 1A: Project Data</th>
<th>Section 1C: Highway Accident Data</th>
<th>Section 1D: Rail and Transit Data</th>
<th>Section 1E: Project Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Button to analyze multiple roads for bypass and intersection projects</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Cal-B/C Data Entry Worksheet – Model Inputs

- Blue cells are calculated based on inputs from 1) Project Information worksheet
- Green cells are “Changed by User”
- Gray cells are what is used for project evaluation
- This allows user to review detailed information estimated from the model and make adjustments if necessary
Suggested Data Sources for Evaluations in Cal-B/C Sketch

Traffic and Transit Passenger Demand and Performance Data
- Caltrans Performance Measurement System (PeMS)
- Caltrans Division of Traffic Operations, Traffic Census Program Traffic Volumes
- Caltrans Managed Lane Annual Report
- Federal Highway Administration (FHWA) Performance Measures
- Federal Transit Administration (FTA) National Transit Database
- Other Sources for data (Field data collection, crowd-sourced data)

Traffic Collision and Safety Data
- Caltrans Traffic Accident Surveillance and Analysis System (TASAS)
- California Highway Patrol (CHP) Statewide Integrated Traffic Records System (SWITRS)
- Other Sources (e.g., Transportation Research Board publications)
Suggested Data Sources for Evaluations in Cal-B/C Sketch (cont.)

Traffic Pavement Data
- Caltrans Pavement Program, Pavement Condition Report (PCR) PaveM Summary

Project Costing Data
- Project Study Report (PSR) or other Project Initiation Document
- Project Report (PR)
- Regional Transportation Improvement Program (RTIP)
- State Highway Operations and Protection Program (SHOPP)
- FTA Capital cost database
## Suggested Data Sources for Cal-B/C Sketch Evaluations by Input Item

<table>
<thead>
<tr>
<th>Section Title</th>
<th>Data Input Item</th>
<th>To Find, Look at Cell</th>
<th>Suggested Data Sources (for required input cells; or to update Cal-B/C estimates or default values)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1A) Project Data</strong></td>
<td>Type of Project</td>
<td>D10</td>
<td>Depends on proposed project</td>
</tr>
<tr>
<td></td>
<td>Project Location</td>
<td>D12</td>
<td>Depends on proposed project location</td>
</tr>
<tr>
<td></td>
<td>Length of Construction Period</td>
<td>D14</td>
<td>Project Initiation Document (PID)/Project Study Report (PSR)/Project Report (PR) or other source</td>
</tr>
<tr>
<td></td>
<td>One- or Two-Way Data</td>
<td>D15</td>
<td>Caltrans Traffic Census (AADT) or PeMS for two-way data; PeMS for one-way data</td>
</tr>
<tr>
<td></td>
<td>Length of Peak Period(s)</td>
<td>D17</td>
<td>PeMS; Travel time studies</td>
</tr>
<tr>
<td><strong>1B) Highway Design And Traffic Data</strong></td>
<td>Highway Design</td>
<td>D24-E33</td>
<td>Depends on proposed project</td>
</tr>
<tr>
<td>Average Daily Traffic (ADT)</td>
<td>Current</td>
<td>E36</td>
<td>Caltrans Traffic Census (AADT), PeMS</td>
</tr>
<tr>
<td></td>
<td>Base (Year 1)</td>
<td>E38</td>
<td>Calculated by Cal-B/C, but user can update if better estimate available.</td>
</tr>
<tr>
<td></td>
<td>Forecast (Year 20)</td>
<td>E39</td>
<td>Value or growth factors provided by modeling/forecasting or other estimation method</td>
</tr>
<tr>
<td>Average Hourly HOV/HOT Lane Traffic</td>
<td>Percent of Induced Trips in HOV</td>
<td>D41</td>
<td>Provided by modeling/forecasting or other estimation method</td>
</tr>
<tr>
<td>Percent Traffic in Weave</td>
<td></td>
<td>D42</td>
<td>Calculated by Cal-B/C; Field data collection can be used for refined estimate.</td>
</tr>
<tr>
<td>Percent Trucks</td>
<td></td>
<td>D43</td>
<td>Cal-B/C default value; Caltrans Traffic Census (Truck AADT)</td>
</tr>
<tr>
<td>Truck Speed</td>
<td></td>
<td>D44</td>
<td>FHWA HEPGIS; Field data collection</td>
</tr>
<tr>
<td>On-Ramp Volume</td>
<td>Hourly Ramp Volume</td>
<td>D47</td>
<td>Provided by Cal-B/C using standard design volumes, but can be changed depending on project</td>
</tr>
<tr>
<td></td>
<td>Metering Strategy</td>
<td>D48</td>
<td>Depends on proposed project</td>
</tr>
<tr>
<td>Queue Formation</td>
<td>Arrival and Departure Rates</td>
<td>D51-D52</td>
<td>Calculated by Cal-B/C; Field data collection (if better data available)</td>
</tr>
<tr>
<td>Pavement Condition</td>
<td>IRI (inches/mile)</td>
<td>E55-E56</td>
<td>Caltrans Pavement Program, Pavement Condition Report (PCR) PaveM Summary</td>
</tr>
<tr>
<td>Average Vehicle Occupancy (AVO)</td>
<td>General Traffic</td>
<td>E59-E60</td>
<td></td>
</tr>
<tr>
<td></td>
<td>High Occupancy Vehicle (if HOV/HOT lanes)</td>
<td>D61</td>
<td>Calculated by Cal-B/C; Caltrans Managed Lane Annual Report can provide refined estimates</td>
</tr>
</tbody>
</table>
# Suggested Data Sources for Cal-B/C Sketch Evaluations by Input Item (cont.)

<table>
<thead>
<tr>
<th>Section Title</th>
<th>Data Input Item</th>
<th>To Find, Look at Cell</th>
<th>Suggested Data Sources (for required input cells; or to update Cal-B/C estimates or default values)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1C) Highway Accident Data</strong></td>
<td>Actual 3-Year Accident Data (from Table B)</td>
<td>Total, Fatal, Injury, PDO</td>
<td>M11-M14</td>
</tr>
<tr>
<td></td>
<td>Statewide Basic Average Accident Rate</td>
<td>Rate Group</td>
<td>M18</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Accident Rate (per million vehicle-miles)</td>
<td>M19</td>
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<tr>
<td></td>
<td></td>
<td>Percent Fatal/Injury</td>
<td>M20-M21</td>
</tr>
<tr>
<td><strong>1D) Rail And Transit Data</strong></td>
<td>Annual Person-Trips</td>
<td>N28-N29</td>
<td>Modeling/Forecasting; FTA National Transit Database</td>
</tr>
<tr>
<td></td>
<td>Percent Trips during Peak Period</td>
<td>L30</td>
<td>Calculated by Cal-B/C; FTA National Transit Database</td>
</tr>
<tr>
<td></td>
<td>Percent New Trips from Parallel Highway</td>
<td>L31</td>
<td>Calculated by Cal-B/C; Modeling/Forecasting</td>
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<tr>
<td></td>
<td>Annual Vehicle-Miles</td>
<td>N34-N35</td>
<td>Modeling/Forecasting; FTA National Transit Database</td>
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<td></td>
<td>Average Vehicles/Train</td>
<td>L36</td>
<td>FTA National Transit Database</td>
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<tr>
<td></td>
<td>Reduction in Transit Accidents</td>
<td>Percent Reduction (if safety project)</td>
<td>L39</td>
</tr>
<tr>
<td></td>
<td>Average Transit Travel Time</td>
<td>In-Vehicle</td>
<td>N42-N43</td>
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<td>Out-of-Vehicle</td>
<td>N44-N45</td>
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<td></td>
<td>Highway Grade Crossing</td>
<td>Annual Number of Trains</td>
<td>M48</td>
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<td>Avg. Gate Down Time (in min.)</td>
<td>M49</td>
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<td>Transit Agency Costs</td>
<td>Annual Capital Expenditure</td>
<td>M52</td>
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<td>Annual Ops. And Maintenance Expenditure</td>
<td>M53</td>
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<tr>
<td><strong>1E) Project Costs</strong></td>
<td>Direct Project Costs</td>
<td>Initial Project Costs (Support, R/W, Const.)</td>
<td>W12-Y12</td>
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<td>Subsequent Costs (O&amp;M, Rehab)</td>
<td>Z24-AA43</td>
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<td></td>
<td>Other Costs</td>
<td>Mitigation/Transit Agency Cost Savings</td>
<td>AB10-AC10</td>
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</tbody>
</table>
03 Traffic and Transit Passenger Demand and Performance Data
Caltrans Performance Measurement System (PeMS)

- Provides real-time and historical performance data in a range of presentation styles and downloadable data sets
- Data available where Vehicle Detection Station (VDS) sensors are located
- Can perform analyses at single VDS locations or along a defined corridor
- Data includes:
  - Volumes (5-minute to annual) and VMT
  - Speeds
  - Performance measures (delay, productivity)
- Data that can be used in Cal-B/C includes:
  - Lengths of Peak Periods (estimated from average hourly speed, flow, or delay data)
  - ADT
  - Average Hourly HOV/HOT Lane Traffic
- Apply for an account at [http://pems.dot.ca.gov/](http://pems.dot.ca.gov/)
PeMS – Single VDS Analysis

- PeMS allows user to analyze and download traffic data at specific VDS locations.
- Provides aggregate data for ADT, hourly flows and speeds for a single detector station can be exported.
- Allows data to be selected for time series and by time intervals (hour, day, month).
- Able to select specific days of the week to analyze.
- Data can be downloaded from the PeMS clearinghouse by Caltrans District.
Module 8a: Traffic and Transit Demand Data

PeMS – Corridor Level Analysis

- Define a Corridor in PeMS
- Select Aggregates for VMT
- Select dates
  - Fall and/or Spring
  - Non-holiday, mid-week
- Can export Aggregates to Excel or Text files
- Average ADT for corridor = VMT/Corridor Length
- Can also check Cal-B/C model speed results
  - Select Quantity: Q (VMT/VHT)
  - Average speed for corridor = Q = VMT/VHT
- Do opposite direction, if needed
Caltrans Division of Traffic Operations Traffic Census Program

- Caltrans Traffic Counts are summarized annually into four categories (presented in detail on following slides):
  - Traffic Volumes: Annual Average Daily Traffic (AADT)
  - Truck Traffic: Annual Average Daily Truck Traffic
  - Ramp Volumes
  - Peak Hour Volume Data

- Data that can be used in Cal-B/C includes:
  - Traffic Volumes: Annual Average Daily Traffic (AADT)
    - Average Daily Traffic (ADT)
  - Truck Traffic: Annual Average Daily Truck Traffic
    - Truck Percent of Total Vehicles
  - Ramp Volumes
    - Ramp Average Daily Traffic (ADT)

- https://dot.ca.gov/programs/traffic-operations/census
Census – Traffic Volumes: Annual Average Daily Traffic (AADT)

- Traffic Volumes for count locations on the California State Highway System
  - Annual Average Daily Traffic (AADT)
  - Peak Month Average Daily Traffic (ADT)
  - Peak Hour

- Locations remain fairly consistent over the years

- Data that can be used in Cal-B/C includes:
  - Ahead/Back AADT
Census – Annual Average Daily Truck Traffic

- Truck Traffic on California State Highways System
- Truck Traffic is classified by number of axles by location
- Locations remain fairly consistent over the years
- Data that can be used in Cal-B/C includes:
  - Truck ADDT Total
  - Truck Percent of Total Vehicles
Census – Ramp Volumes

- Ramp Volumes on California State Highways System
- Ramp ADT for location over ten-year period
- No seasonal or daily adjustment is made
- Ramps are not counted every year, but generally every three years
- Ramps without an ADT in the last ten years will not be published.
- Locations remain fairly consistent over the years

Data that can be used in Cal-B/C Sketch includes:

- Ramp ADT (ADT_YEAR)
Caltrans Managed Lane Annual Report

- Caltrans district offices prepare annual reports with statistics on managed facilities
  - Covers express lanes and high occupancy vehicle (HOV) lanes
- Provides vehicle classification and occupancy counts during peak travel periods for managed lanes and adjacent general purpose lanes
- Data that can be used in Cal-B/C Sketch includes:
  - Managed lane peak period and peak hour volumes
  - Average vehicle occupancy (AVO) statistics for managed lane and adjacent general purpose lane
Federal Highway Administration (FHWA) – Truck Speeds

- Planning, Environment, Realty (HEPGIS) website map server allows users to navigate, view, and print maps and tabular performance measure data

- National Performance Management Research Data Set: has average travel times for trucks on the National Highway System

- Monthly Travel Time Reliability Index Layer can be used to calculate Truck Speeds by Traffic Message Channel (TMC) segment:
  - Length (TMC segment in miles)
  - Truck Weekday [time period] Avg (TMC Average Travel Time in Seconds)
  - Speed (mph) = Length / (Truck Weekday [time period] Avg/3600)

- https://hepgis.fhwa.dot.gov/
Module 8a: Traffic and Transit Demand Data

FTA National Transit Database (NTD)

- NTD data products include:
  - Detailed transit capital and operational data and measures
  - Time series data on transit systems dating back to 1991
  - Time series of monthly ridership data

- NTD data can be used to supplement Cal-B/C transit evaluations:
  - Ridership trends and ridership per unit of service provided to help estimate potential ridership
  - Estimate transit in-vehicle speeds and similar systems (Vehicle Service Miles/Train Service Miles)
  - Estimate cars per train based on other similar systems and modes (Vehicle Service Miles/Train Service Miles)

- https://www.transit.dot.gov/ntd
Field Data Collection

- Field data collection can be used where other automatically collected data may not be available or have sufficient quality

- Travel Time Studies (Probe / Floating Vehicles)
  - Uses cars equipped with Global Positioning System (GPS) devices that drive at regularly spaced intervals along the study corridor
  - Results include direction of travel, travel times, and speeds along a corridor and can indicate where queuing occurs

- Vehicle Classification and Occupancy Counts
  - Conducted using field observations at key locations, typically over a 2-3 midweek period in spring or fall of year
  - Vehicles classified (e.g. SOV, High Occupancy Vehicle 2 people (HOV2), HOV with 3 or more persons (HOV3+), buses, motorcycles, trucks, etc.)

- ADT counts
  - Hourly and daily volumes where no current data is available
  - Typically collected over continuous 2 to 3 midweek days during the fall or spring
  - Hourly volumes can help identify the number of hours in the peak period
Traffic Collision Data
Traffic Accident Surveillance and Analysis System (TASAS) – Transportation Systems Network (TSN) Reports

- Highway inventory database which contains the current and historical collisions on the SHS
- This is the preferred source for SHS accidents for projects
- Data/Reports only accessible through Caltrans Staff
- Data that can be used in Cal-B/C includes:
  - Total Accidents (Tot)
  - Fatal Accidents (Fat)
  - Injury Accidents (Inj)
  - Property Damage Only (PDO) Accidents (Tot – (Fat+Inj))
  - Accident Rate (per million vehicle-miles)
  - Percent Fatal Accidents (Pct Fat)

Statewide Integrated Traffic Records System (SWITRS)

- Database that collects and processes detailed data gathered from a collision scene by CHP and local law enforcement
- Account required to access detailed reports and data
- California accident data by locations, dates and collision types
- Used for collision data off the State Highway System (SHS) – TASAS should be used for SHS projects
- Downloadable but requires extensive data manipulation
- Data that can be used in Cal-B/C includes:
  - Total Accidents (Tot)
  - Fatal Accidents (Fat)
  - Injury Accidents (Inj)
  - Property Damage Only (PDO) Accidents

- https://iswitrs.chp.ca.gov/Reports/jsp/index.jsp
Crash Modifications Factors (CMF) Clearinghouse

- A searchable database of CMFs
- A CMF is used to compute the expected number of collisions after implementing a countermeasure
- Find appropriate countermeasures and CMFs
  - Collision type
  - Roadway type
  - Location
  - Severity
  - Time of Day
  - Roadway Condition
- [http://www.cmfclearinghouse.org/](http://www.cmfclearinghouse.org/)
Other Sources for Safety Data

- For percent reduction in transit accidents, other documentation and research can be utilized.
Traffic Pavement Data
Traffic Pavement Data Sources

- The Caltrans Office of Pavement Management collects, analyzes, and manages pavement data on the State Highway System (SHS)
  - Pavement Management System (PaveM)
    - PaveM utilizes pavement history, current pavement condition, current programmed projects, traffic, and climate data to predict future pavement conditions
  - Automated Pavement Condition Survey (APCS) data
    - Critical PaveM input for current pavement condition and to validate pavement performance prediction models
  - State of the Pavement Report (SOP)
    - Annual report based the APCS data collected throughout California

- https://dot.ca.gov/programs/maintenance/pavement/pavement-management
06

Project Costing Data
Project Costs – Direct Initial Costs

- The level of detail for cost estimates depends on where the project is in the development process
  - Plans, Specifications and Estimate (PS&E), Project Report (PR), and Project Study Reports (PSR) will provide detailed cost estimates in the appendices
    - These costs typically include support costs (e.g., design), right of way (ROW or R/W), and construction costs (including contingency)
  - Regional Transportation Improvement Programs (RTIP) and Caltrans State Highway Operation and Protection Program (SHOPP) have project costs broken down by “capital” and “support”, but without details

Note: Remember to enter costs in thousands of dollars (1000$). Otherwise, you will not get a correct Benefit/Cost Ratio
Project Costs – Direct Initial Costs

- Pre-planning stages are more difficult
  - Caltrans has a project cost database that has rule-of-thumb cost guides, but quantities will be needed to estimate project costs.
  - Cost-per-mile estimates are available
    - Costs per mile vary significantly depending on the location, region, and project type.
    - Look for a similar completed project in the same region with known costs, then estimate the cost per mile for the similar type of improvements.
    - If ROW impacts are likely, then a reserve amount should be included. Caltrans has rule-of-thumb ROW estimates available.

Note: Remember to enter costs in thousands of dollars (1000$). Otherwise, you will not get a correct Benefit/Cost Ratio.
Project Costs – Federal Transit Administration (FTA) Capital Costs Database

- Microsoft Access database that can be used to estimate order-of-magnitude cost for conceptual transit projects
- Uses the FTA Standard Cost Category (SCC) codes for comparisons among transit operators
- Contains "as-built" costs for 54 federally funded projects:
  - Bus rapid transit
  - Commuter rail
  - Light rail
  - Heavy rail
  - Trolley
Project Costs – Subsequent Costs

- Caltrans and regional agencies have estimates for maintenance and operating costs for various facilities.
- Transit annual operating expenses can be estimated from NTD data tables.
- Subsequent costs should be entered as a NET increase or decrease from the No Build case.
  - May be positive (e.g., increased cost due to a new lane being constructed)
  - May be negative (e.g., avoided maintenance or rehabilitation)
Project Costs – Mitigation Costs

- Mitigation costs (in thousands of dollars) include costs to protect communities and the environment from negative impacts
  - Include wetland and community preservation as well as sound walls to reduce highway or rail transit noise

- Plans, PS&E, PR, and PSR will provide mitigation cost estimates (with details found in the appendices)

- Often these costs can be included in the “construction” costs for a project and may not need to be entered into Cal-B/C as a separate costs
  - Soundwalls and environmental mitigations are examples of mitigations that are built into the cost of projects presented in PRs

- On-going mitigation costs that continue after the project construction is completed will be included in PRs
Project Costs – Savings to Transit Agency

- For projects with a Transit Vehicle Location (AVL) TMS Strategy, Cal-B/C will estimate annual cost savings to the transit agency
  - Based on the Transit Agency Costs data entry and the Transit Travel Time and Agency Cost Savings parameters
Conclusion
In this module, you learned…

- About potential data sources for data input and project costing for Cal-B/C Sketch
- How to get data from these sources
What’s Next?

- **Modules 9a1** and **Module 9a2** walk through example projects showing how to perform a BCA

- **Module 10** closes out the training and will summarize other resources to learn more about BCA