

VALUE ANALYSIS TEAM LEADER GUIDE

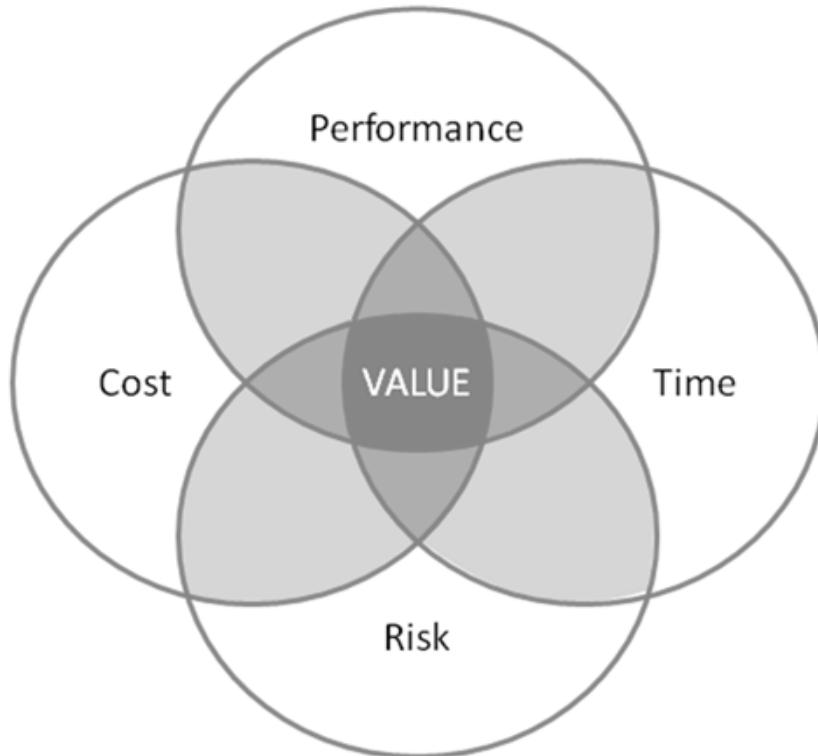


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ACKNOWLEDGMENT

The purpose of this guide is to help Value Analysis (VA) practitioners in the delivery of a Caltrans VA Study. This guide is a basic understanding of the VA process, highlights some differences between Caltrans process and the SAVE International VA process, and to guide Team Leaders in delivering an approved VA Study for Caltrans. Many of the graphics were developed from our friends at Value Management Strategies, Inc. Special thanks are given to them for their years of dedicated service to the Caltrans VA Program.

CHAPTER 1 CALTRANS VALUE ANALYSIS PROGRAM OVERVIEW

SECTION 1 VA Program Goals

The Caltrans VA Program is designed to ensure:

1. Full compliance with Caltrans policy (DD-92 – Value Analysis) and FHWA.
2. Consistent statewide application of the VA process and study documentation.
3. VA Study properly considers cost, project performance, schedule, and risk to optimize the value of the project on the State Highway System.
4. Implemented changes reported as a result of the VA Study are properly documented, reported, and validated by the Design Manager and Project Manager at Ready-to-List (RTL).
5. Provide an auditable process that can easily report the VA program performance to FHWA on an annual basis.

SECTION 2 VA Study Schedule

To properly accomplish the goals for the VA Study, sufficient time needs to be dedicated to the preparation, VA Study workshop and documentation. As a result, typical VA Study workshops are to be 6 days (often spread over 2 weeks) for projects meeting the mandate., . Often for large complex projects, FHWA will request longer studies and/or multiple studies.

Some projects smaller in scope (simple grade separations, maintenance projects, or projects with minimal R/W or environmental impacts) may use the exception process to request a 3½- or 4-day study. The District VA Coordinator (DVAC), in conjunction with the PM or Local Lead Agency and Team Leader, may submit a “Modified Job Plan Proposal” (see Appendix 3) with justification for the reduced timeframe to the Headquarters’ VA Program Manager. HQ Acceptance of the Modified Job Plan will be based on study scope, complexity of the project, project schedule, and duration of the study. Decisions will be made on a project-by-project basis. Studies of shorter duration than 3½ days may jeopardize federal funding and/or be rejected for non-compliance with DD-92. *Note: Being late in the design phase is not a justifiable reason for a shortened VA Study.*

SECTION 3 VA Study Completion

After the completion of the VA Study, the VA Team Leader will produce a Preliminary VA Report. The function of this report is to provide the PDT and Project Stakeholders / Decision Makers information on the VA Alternatives to facilitate a disposition of each item. It is the responsibility of the VA Team Leader, Project Manager, and Design Manager to work together with stakeholders to determine the changes that will be made as a result of the VA Study. Once the disposition has been made on *all* VA Alternatives, the VA Team Leader will produce the Final VA Study Report and forward results to Caltrans HQ VA for reporting to the FHWA. ***This final VA Study Report is needed to ensure compliance and secure federal funding for the project.***

CHAPTER 2 VALUE ANALYSIS PROCESS

The Caltrans VA process involves 15 activities needed to accomplish a VA Study, organized into three parts: Pre-study, VA Study Workshops, and Implementation.

The following provides an overview of the Caltrans approach to VA. The Caltrans VA Study Activity Chart on page 15 identifies the steps in each activity, which is detailed as follows.

SECTION 1 Pre-Study

Meaningful and measurable results are directly related to the pre-study work performed. Depending on the type of study, all or part of the following information needs to be determined during the pre-study phase:

- Clear definition of the current situation and study objectives,
- Identification of study team members,
- Identification of project stakeholders,
- Definition of how stakeholders are impacted by the project,
- Identification of key issues and concerns,
- Identification of project's performance requirements and attributes,
- Status of project cost estimate, and/or
- Project data gathered to be distributed to VA Team.

In preparation for the VA Study, the VA Team Leader confers with owners and stakeholders to outline the VA process; initiate data gathering; refine project scope and objectives; structure the scope, team members, and technical specialists; and finalize study plans. Specific deliverables are provided.

Following the initial planning meeting, the VA Team Leader reviews the data collected for the project and develops a cost model. The VA Team Leader also consults with the technical specialists to prepare them for the VA Study.

SECTION 2 VA Study Workshop

The VA Job Plan guides the VA Team in their objective to enhance value in the project or process. Caltrans follows a seven-phase VA Job Plan:

1. Information Phase
2. Function Phase
3. Speculation Phase
4. Evaluation Phase
5. Development Phase
6. Presentation Phase
7. Implementation Phase

INFORMATION PHASE

At the beginning of the VA Study, the Project Development Team (PDT) presents a more detailed review of the design and the various systems. This includes an overview of the project and its various requirements, which further enhances the VA Team's knowledge and understanding of the project. The PDT also responds to questions posed by the VA Team.

The project's performance requirements and attributes are discussed, and the performance of the baseline concept is evaluated. (See Appendix 1 – Project Performance.)

FUNCTION PHASE

Key to the VA process is the function analysis techniques used during the Function Phase. Analyzing the functional requirements of a project is essential to assuring an owner that the project has been designed to meet the stated criteria and its need and purpose. The analysis of these functions in terms of cost, performance, time, and risk is a primary element in a VA Study, and is used to develop alternatives. This procedure is beneficial to the VA Team, as it forces the participants to think in terms of functions and their relative value in meeting the project's need and purpose. This facilitates a deeper understanding of the project.

SPECULATION PHASE

The Speculation Phase involves identifying and listing creative ideas. During this phase, the VA Team participates in a brainstorming session to identify as many means as possible to provide the necessary project functions. Judgment of the ideas is not permitted in order to generate a broad range of ideas.

The idea list includes all of the ideas suggested during the study. These ideas should be reviewed further by the PDT, since they may contain ideas that are worthy of further evaluation and may be used as the design develops. These ideas could also help stimulate additional ideas by others.

EVALUATION PHASE

The purpose of the Evaluation Phase is to systematically assess the potential impacts of ideas generated during the Speculation Phase relative to their potential for value improvement. Each idea is evaluated in terms of its potential impact to performance, cost, time, and risk. Once each idea is fully evaluated, it is given a total rating number. This is based on a scale of 1 to 7, as indicated by the rating index shown in Table 2-1.

Table 2-1 Idea Evaluation Rating Index

Rating Number	Rating Description
7 = Major Value Improvement	
6 = Moderate Value Improvement	
5 = Minor Value Improvement	
4 = Possible Value Improvement	
3 = Minor Value Degradation	Concept results in a minor cost or performance improvement at the expense of the other.
2 = Moderate Value Degradation	Concept reduces cost but creates an unacceptable degradation to performance.
1 = Major Value Degradation	Concept is not technically feasible or does not meet project need and purpose.

Ideas rated 4 to 7 are developed further and those found to have the greatest potential for value improvement are documented in the VA Alternatives section of the VA Study Report. A more refined definition of what a 4-7 rating is (Major Value Improvement, etc.) will be developed by the VA Team Leader and team members for each study. The rationale for why ideas were rated highly but not developed as alternatives is documented in the Idea Evaluation section of the VA Study Report.

DEVELOPMENT PHASE

During the Development Phase, the highly rated ideas are expanded and developed into VA Alternatives. The development process considers the impact to performance, cost, time, and risk of the alternative concepts relative to the baseline concept. This analysis is prepared as appropriate for each alternative, and the information may include a performance assessment, initial cost and life-cycle cost comparisons, schedule analysis, and an assessment of risk. Each alternative describes the baseline concept and proposed changes and includes a technical discussion. Sketches and calculations are also prepared for each VA Alternative as appropriate. (See Appendix 2 - Writing the Value Analysis Alternative for Caltrans.)

PRESENTATION PHASE

The VA Study workshops conclude with a preliminary presentation of the VA Team’s assessment of the project and VA Alternatives. The presentation provides an opportunity for the owner, PDT, and stakeholders to preview the VA Alternatives and develop an understanding of the rationale behind them. This presentation is neither intended nor designed to be a “decision-making” meeting.

IMPLEMENTATION PHASE

After the stakeholders have had an opportunity to review the alternatives identified by the VA Team, the VA Team Leader conducts an implementation meeting to discuss the VA Alternatives and resolve appropriate action for each VA Alternative. Also, if necessary, any other edits requested by the representatives to the Final VA Study Report are made by the VA Team Leader at this time.

This “decision making” meeting facilitates the disposition of each alternative. Once complete, each alternative will be “Accepted” into the project or “Rejected” for a particular reason. The disposition of each alternative will be well documented in the Final VA Study Report and the Implementation Plan Authorization will be signed by the decision maker (District Management).

This implementation meeting helps to ensure that project savings are not lost due to lack of communication and that the “Accepted” VA Alternatives are properly integrated into the project design. As time goes on, many projects change due to unforeseen circumstances. If an “Accepted” VA Alternative has become a “Rejected” VA Alternative, an amended Implementation Plan Authorization must be signed by District

Management confirming the change. These authorizations are audited by FHWA to verify Caltrans due diligence.

SECTION 3 VA Study Report

The VA Study reporting requirements are very important to facilitate change to the project. Proper documentation and facilitation is essential. A VA Study Report is prepared by the VA Team Leader following each VA Study. The VA Team Leader is primarily responsible for gathering the documentation generated during the study and systematically compiling it into a report.

The VA Study Report is a working document, which evolves throughout the VA Study Process. The VA Study Report has two primary purposes. First, it is intended to provoke responses to the VA Alternatives, so that all of the stakeholders' interests are considered before implementation decisions are reached. The report proposes recommended VA Alternatives developed in the workshop by the VA Team members. These recommended alternatives, ideally, are developed to enhance "value" of the project by increasing performance while reducing cost. Secondly, the VA Study Report is the documentation used to support the decisions. It is also used to document the entire VA Study, which includes: project description, issues and concerns, implementation of recommended VA Alternatives, summary of the results, and details of the VA process performed for the project.

To streamline the implementation of VA Alternatives, the HQ VA program has supplied the necessary documents/samples for a typical VA Study on the VA internet site:

<http://www.dot.ca.gov/hq/oppd/value/guides.htm>

The VA Study Reports are divided into seven different documents to signify which stage of the study is being reported. (See Appendix 3 - Caltrans VA Report Requirements and Process Guidance.)

VA Study Summary – Preliminary Findings

Summarizes the Proposed Alternatives derived by the VA Team in the VA Study. The report includes a summary of the project, the VA Study objectives, as well as a summary of proposed VA alternatives. Blank Implementation Action Recommendation form(s) are included to document the decision-maker's and stakeholder's actions. This report is the first section of the "Preliminary VA Study Report", and is delivered electronically with

the VA Study Preliminary Report. Its intention is to provide a “short version” of the detailed report, and will later become the “Executive Summary” in the “Final VA Study Report”.

Preliminary VA Study Report

The Preliminary VA Study Report includes the VA Study Summary – Preliminary Findings as the “Executive Summary.” In addition, it includes details of the Project Information, Project Analysis, Idea Evaluation, VA Study Information/Process, VA Alternative details, and VA Study attendance sheets. This report is delivered electronically with the VA Study Summary – Preliminary Findings.

VA Implementation Action Memo

The VA Implementation Action Memo documents the implementation dispositions of the proposed VA Alternatives should any of the proposed VA Alternatives be “Conditionally Accepted.” All “Conditionally Accepted” VA Alternatives will include an Action Plan to accept or reject. The Action Plan will include person(s) responsible for resolving the condition and a timeline for completion.

Implementation Plan Authorization

Once all VA Alternatives are accepted or rejected, a Decision Maker (Design Manager) will certify the implementation plan with a signature. This will be filed in the Final VA Study Report. If an “Accepted” alternative is ever “Rejected” in the future, an amended Authorization should be filed in the project history file to document the change. This authorization is used by FHWA as an auditing tool.

Two-Page Study Results Summary

The Two-Page Study Results Summary is a brief overview of the VA Study results. It will be included in the Final Report, but should also be delivered to stakeholders and HQ VA program separately for annual reporting to FHWA. The Two-Page Results Summary is also used for knowledge transfers, national award applications, and sharing of the VA accomplishments.

Final VA Study Report

This Final VA Study Report will outline the accepted VA Alternatives and document the VA Study results. This will serve as the final documentation of the VA Study and be archived in the project history file, with the DVAC, and with the HQ VA Program.

VA Study Summary Report

The VA Study Summary Report (VASSR) is to be delivered to the HQ VA Program. These documents are used for performance reporting to FHWA and Caltrans management.

As the VA Study documents are published, the VA Team Leader will distribute the documents to the appropriate personnel and be responsible for comments and updates as shown in Table 2-2.

Table 2-2 Overview of Deliverables

Name of Report	Publishing Time	Delivered To	Format	Expected Outcome
VA Study Summary – Preliminary Findings	1-2 weeks after Workshop	Decision Makers, Stakeholders, VA Team, DVAC, HQ VA Program	Electronic PDF and/or hard copy (if desired)	None
Preliminary VA Study Report	1-2 weeks after Workshop	Decision Makers, Stakeholders, VA Team, DVAC, HQ VA Program	Electronic PDF and/or hard copy (if desired)	Completed Implementation Action Recommendation Forms from Decision Makers and Stakeholders
VA Implementation Action Memo	1 week after Implementation Meeting (should there be Conditionally Accepted VA Alternatives)	Decision Makers, Stakeholders, VA Team, DVAC, HQ VA Program	Electronic PDF and/or hard copy (if desired)	Accepted VA Alternative(s) implemented into project, and Action Plan for Conditionally Accepted VA Alternatives.
Implementation Plan Authorization	After all VA Alternatives are accepted or rejected	Decision Makers, Stakeholders, DVAC, HQ VA Program	Electronic PDF and/or hard copy (if desired)	Decision Maker's signature agreement for Accepted VA Alternatives
Final VA Study Report	2 weeks after signed Implementation Plan Authorization	Stakeholders, VA Team, DVAC, HQ VA Program	Electronic PDF and/or hard copy (if desired)	Archived documentation. reportable to Caltrans' Management and FHWA
VASSR and Two-Page Study Results Summary	2 weeks after Final VA Study Report	HQ VA Program	Electronic	Annual performance reporting to FHWA and Caltrans management

Name of Report	Publishing Time	Delivered To	Format	Expected Outcome
Implementation Plan Authorization - Addendum	As needed (Optional – responsibility of the Project Manager, PDT, DVAC)	PDT, HQ VA Program	Electronic PDF and/or hard copy (if desired)	Memo stating any changes in outcomes or implementation plans

The implementation of a VA Alternative can be a delicate subject. In most cases, once the Preliminary VA Study Report is distributed, and the Implementation Meeting is held, decisions are made at the meeting to finalize the VA Study. In that case, the process moves very quickly to Final Report. However, some VA Alternatives require additional research or vetting. These interim implementation plans are put in place so the VA Team Leader and PDT can move forward with a resolution in a timely manner and the VA Team's alternative does not become “lost in the shuffle.”

Once the disposition of each VA Alternative is “accepted” or “rejected”, the VA Study Report will be finalized, archived in the Project History File, and distributed to the stakeholders, DVAC, and HQ VA Program Manager for auditing purposes. These reports are also used by the HQ VA Program to report the outcomes to FHWA and Caltrans management on an annual basis.

VA STUDY REPORT CONTENT GUIDELINE

The VA Study Report content guideline on the follow page outlines the needed information and layout of the VA Study Report.

Report Front Material

- Front Cover
- Cover Letter with instructions for Addressee(s)
- Table of Contents

VA Study Summary Report – Preliminary Findings

- Study Description
- Project Description
- Project Purpose & Need
- VA Study Timing
- VA Study Objectives
- Key Project Issues
- Evaluation of Baseline Concept
- Performance Attributes
- VA Study Results
- Summary of VA Alternatives or Key VA Alternatives
- Summary of VA Strategies (VA Team Recommended Sets)
- VA Team (Team Members and Key Project Contacts)

VA Study Details Report

VA Alternatives

- Description of VA Alternatives
- Summary of Developed VA Alternatives
- Summary of VA Strategies (VA Team Recommended Sets)
- Other Considerations
- Summary of Performance Improvements for Proposed VA Alternatives
- VA Alternative Documentation

Project Information

- Background
- Project Description
- Project Design Exceptions – Mandatory and Advisory
- Information Provided to the VA Team
- Project Drawings
- Project Cost Estimate

Project Analysis

- Summary of Analysis
- Key Project Factors – Project Issues and Site Visit Observations
- Cost Model or Summary
- Function Analysis/FAST Diagram
- Value Metrics
 - Performance Requirements
 - Performance Attribute and Scale Definitions
 - Performance Attribute Prioritization
 - Performance of Baseline Concept
 - Performance of VA Alternatives
 - Summary of VA Strategy(s)
 - Comparison of Performance –Baseline Concept and VA Strategy(s)
 - Rating Rationale for VA Strategy(s)
 - Value Matrix – Baseline Concept and VA Strategy(s)
 - Comparison of Value – Baseline Concept and VA Strategy(s)
- Risk Analysis (Optional)

Idea Evaluation

- Performance Attributes
- Evaluation Process
- Idea Summary
- Idea Summary List
- Detailed Idea Evaluation Summary

VA Study Process

- Pre-Study
- VA Study
 - Information Phase
 - Function Analysis Phase
 - Creative Phase
 - Evaluation Phase
 - Development Phase
 - Presentation Phase
 - Implementation Phase
- VA Report
 - Preliminary Report
 - VA Implementation Action Memo
 - Final Report
- Caltrans VA Job Plan & Study Activity Chart
- VA Study Agenda
- VA Study Attendance Sheets

VA Implementation Action Memo

- Summary of Implementation Action Meeting
- Action Items and Dates
- VA Study Results
 - Accepted VA Alternatives (if any)
 - Rejected VA Alternatives (if any) and Reason for Rejection

Final Report Updates

- Cover Letter
- VA Study Summary Report – Final Results (in place of VA Study Summary Report – Preliminary Findings)
 - Summary of Accepted VA Alternatives (in place of Summary of VA Alternatives or Key VA Alternatives)

- Net Effect of Accepted VA Alternatives (in place of Summary of VA Strategies)
- Final VA Study Results (in place of VA Study Results)
- Rejected VA Alternatives and Reason for Rejection (added)
- VA Implementation Authorization
- In the VA Alternatives Section:
 - Summary of Performance Improvements for Accepted VA Alternatives (added)
 - Completed VA Alternative Implementation Action Forms (added)
- In the Project Analysis Section:
 - Rating Rationale for Accepted VA Alternatives (added)
 - Comparison of Value – Baseline Concept and Accepted VA Alternatives (added)
 - Value Matrix – Baseline Concept and Accepted VA Alternatives (added)

HQ VA Program Deliverables

- Final VA Study Report
- VA Study Summary Report (VASSR)
- Two-Page Study Results Summary

CT Value Analysis Job Plan & Study Activity Chart

PREPARATION	INITIATE STUDY 1	ORGANIZE STUDY 2	PREPARE DATA 3
	<ul style="list-style-type: none"> ➢ Identify study project ➢ Identify study roles and responsibilities ➢ Define study goals ➢ Select team leader ➢ Prepare draft Study Charter 	<ul style="list-style-type: none"> ➢ Conduct Pre-Study Meeting ➢ Select team members ➢ Identify stakeholders, decision-makers, and technical reviewers ➢ Identify data collection ➢ Select study dates ➢ Determine study logistics ➢ Update VA Study Charter ➢ Identify and define performance requirements 	<ul style="list-style-type: none"> ➢ Collect and distribute data ➢ Develop construction cost models ➢ Develop highway user benefit / life cycle cost (LCC) model (if required)
VA STUDY WORKSHOP	INFORM TEAM 4	ANALYZE FUNCTIONS 5	CREATE IDEAS 6
	<ul style="list-style-type: none"> ➢ Review study activities and confirm reviewers ➢ Present design concept ➢ Present stakeholders' interests ➢ Review project issues and objectives ➢ Discuss Design Exceptions ➢ Rate performance of baseline concept ➢ Visit project site 	<ul style="list-style-type: none"> ➢ Analyze project data ➢ Expand project functions ➢ Prepare FAST diagram ➢ Determine functional cost drivers and performance ➢ Assess Risk (if needed) 	<ul style="list-style-type: none"> ➢ Focus on functions ➢ List all ideas ➢ Apply creativity and innovation techniques (group and individual)
DETERMINE DISPOSITION	DEVELOP ALTERNATIVES 8	CRITIQUE ALTERNATIVES 9	EVALUATE IDEAS 7
	<ul style="list-style-type: none"> ➢ Develop alternative concepts ➢ Prepare sketches and calculations ➢ Measure performance ➢ Estimate costs, LCC benefits/costs 	<ul style="list-style-type: none"> ➢ VA Alternatives Technical Review ➢ VA Alternatives Team Consensus Review ➢ Identify mutually exclusive groups of alternatives ➢ Identify VA strategies ➢ Validate performance 	<ul style="list-style-type: none"> ➢ Apply key performance attributes to rate idea ➢ List advantages and disadvantages ➢ Consider cost impacts ➢ Rank all ideas ➢ Assign alternatives for development
			<p><i>*Interim presentation of study findings</i></p>
REPORTING RESULTS	DOCUMENT VA STUDY 11	ASSESS ALTERNATIVES** 12	PRESENT ALTERNATIVES* 10
	<ul style="list-style-type: none"> ➢ Document process and study findings ➢ Develop and Distribute VA <i>Study Summary Report - Preliminary Findings and VA Study Preliminary Report</i> ➢ Distribute electronic report to HQ VA Branch 	<ul style="list-style-type: none"> ➢ Review Study Summary Report ➢ Assess alternatives for project acceptance ➢ Prepare draft implementation dispositions <p><i>**Activities performed by PDT, Technical Reviewers, and Stakeholders</i></p>	<ul style="list-style-type: none"> ➢ Present findings ➢ Document feedback ➢ Confirm pending reviews
REPORTING RESULTS			
	PUBLISH RESULTS 15	RESOLVE ALTERNATIVES 13	FINALIZE ALTERNATIVES 14
	<ul style="list-style-type: none"> ➢ Document process and study results ➢ Incorporate all comments and implementation plan ➢ Distribute <i>Final VA Study Report</i> in PDF format ➢ Submit <i>VA Study Summary Report</i> (VASSR) and two-page summary to HQ VA for FHWA Auditing ➢ Include Implementation Plan Authorization Memo in Final VA Report 	<ul style="list-style-type: none"> ➢ Review implementation dispositions ➢ Conduct Implementation Meeting ➢ Resolve implementation actions with decision-makers and stakeholders ➢ Document VA Alternative Disposition ➢ Develop Implementation Action Memo (if Conditionally Accepted (CA) Alternatives remain) 	<ul style="list-style-type: none"> ➢ VA Team Leader follow up with PM on CA Alternatives ➢ Resolve Conditionally Accepted Alternatives ➢ Develop Implementation Plan with PM ➢ Design Manager Sign off on VA Implementation Plan Authorization ➢ Final presentation of study results (if needed)

APPENDIX 1 – Project Performance: The Value Metrics Process

The Value Metrics process is an integral part of the Caltrans Value Analysis Process. This process provides the cornerstone of the VA process by providing a systematic and structured means of considering the relationship of a project's performance and cost as they relate to quantify value. Project performance must be properly defined and agreed upon by the stakeholders at the beginning of the VA Study. The performance attributes and requirements developed are then used throughout the study to identify, evaluate, and document alternatives.

SECTION 1 Introduction

Value Analysis has traditionally been perceived as an effective means for reducing project costs. This paradigm only addresses one part of the value equation, oftentimes at the expense of the role that VA can play with regard to improving project performance. Project costs are fairly easy to quantify and compare through traditional estimating techniques. Performance is not so easily quantifiable.

The direct and active involvement of the project's PDT is at the core of this process. The VA Team Leader will lead Caltrans and external stakeholders through the methodology using the power of the process itself to distill subjective thought into an objective language to which everyone can relate and understand. The dialog that develops forms the basis for the VA Team's understanding of the performance requirements of the project and to what degree the current design concept is meeting those requirements. From this baseline, the VA Team can focus on developing alternative concepts that will quantify both performance and cost and contribute to overall project value.

Value Metrics yields the following benefits:

- Builds consensus among project stakeholders (especially those holding conflicting views)
- Develops a better understanding of a project's goals and objectives
- Develops a baseline understanding of how the project is meeting performance goals and objectives

- Identifies areas where project performance can be improved through the VA process
- Develops a better understanding of a VA Alternative's effect on project performance
- Develops an understanding of the relationship between performance and cost in determining value
- Uses value as the true measurement for the basis of selecting the right project or design concept
- Provides decision makers with a means of comparing costs and performance (i.e., costs vs. benefits) in a way that can assist them in making better decisions

SECTION 2 Methodology

The methodology described herein measures project value by correlating the performance of project scope and schedule to the project costs. This process is known as Value Metrics. The objective of this methodology is to prescribe a systematic, structured approach to study and optimize a project's scope, schedule, and cost.

The application of Value Metrics consists of the following steps:

1. Identify key project (scope and delivery) performance attributes and requirements for the project.
2. Establish the hierarchy and impact of these attributes upon the project.
3. Establish the baseline of the current project performance by evaluating and rating the effectiveness of the current design concepts.
4. Identify the change in performance of alternative project concepts generated by the VA Study.
5. Measure the aggregate effect of alternative concepts relative to the baseline project's performance as a measure of overall value improvement.

The primary goal of Value Analysis is to improve project value. A simple way to think of value in terms of an equation is as follows (where time is equivalent to delivery / schedule):

$$\text{VALUE} = \text{PERFORMANCE} / \text{COST}$$

A more sophisticated version of this algorithm is described as follows:

$$V_f(P, C, t)_{total} = \frac{\sum_{n=1}^{\infty} P_n \cdot \alpha}{\sum_{n=1}^{\infty} [(C_n \cdot \alpha) + (t_n \cdot \alpha)]}$$

V = Value P = Performance t = Time f = Function C = Cost α = Risk

SECTION 3 Assumptions

Before embarking on the details of this methodology some assumptions need to be identified:

- An evaluation of the creative ideas (generated during the brainstorming creative sessions—not to be confused with VA Alternative concepts) is done between Steps 3 and 4, below. The idea evaluation process remains true to the “value” approach of measuring performance and costs; however, due to the time constraints, the idea evaluation is a qualitative form of evaluating ideas, as opposed to the quantitative procedures done in the other steps.
- The methodology described in the following steps assumes the project functions are well established. Project functions are the “what” the project delivers to its users and stakeholders; a good reference for the project functions can be found in the Environmental Document’s purpose and need statement. Project functions are generally well defined prior to the start of the VA Study. In the event that project functions have been substantially modified, the methodology must begin anew from the beginning (Step 1).

Step 1 – Determine the Major Performance Attributes

Performance attributes can generally be divided between Project Scope components (Highway Operations, Environmental Impacts, and System Preservation) and Project Delivery components. It is important to make a distinction between performance attributes and performance requirements. Performance requirements are mandatory and are binary in nature. All performance requirements must be met by any VA Alternative concept being considered. Performance attributes possess a range of acceptable levels of performance. For example, if the project was the design and construction of a new bridge, a performance *requirement* might be that the bridge must meet all current seismic design criteria. In contrast, a performance *attribute* might be Environmental Impacts,

which means that a wide range of alternatives could be acceptable with different varying degrees of impact.

The VA Team Leader will initially request that representatives from Caltrans and external stakeholders identify performance attributes that they feel are essential to meeting the overall need and purpose of the project. Usually four to eight attributes are selected. It is important that all potential attributes be thoroughly discussed. The information that comes out of this discussion will be valuable to both the VA Team and Caltrans. It is important that the attribute be discretely defined, and they must be quantifiable in some form. By quantifiable, it is meant that a useable scale must be delineated with values given on a scale of 0 to 10. A “0” indicates unacceptable performance, while a “10” indicates optimal or ideal performance. (Note: A “10” must not be confused with “perfection,” but rather what is the highest reasonable level of performance for a given attribute relative to the project conditions.)

STANDARD PERFORMANCE ATTRIBUTES

The vast majority of performance attributes that typically appear in transportation VA studies have been standardized. This standardized list can be used “as is” or adopted with minor adjustments as required. Every effort should be made to make the ratings as objective as possible.

The following seven attributes are most frequently used on Caltrans transportation projects.

1. Mainline Operations

An assessment of traffic operations and safety on the mainline facility(s), including off-ramps and collector-distributor roads. Operational considerations include level of service relative to the 20-year traffic projections, as well as geometric considerations such as design speed, sight distance, lane widths, and shoulder widths.

Table A1-1 Mainline Operations Performance Attribute Rating Scale

Rating	Label	Description
0.0	Unacceptable	Mainline operations equivalent to LOS F during peak hour. Very poor level of traffic operations. May require multiple design exceptions.
2.0	Poor	Mainline operations equivalent to LOS E during peak hour. Poor level of traffic operations. May require multiple design exceptions.
4.0	Fair	Mainline operations equivalent to LOS D during peak hour. Fair level of traffic operations. May require some design exceptions.

Rating	Label	Description
6.0	Good	Mainline operations equivalent to LOS C during peak hour. Good level of traffic operations. Meets all or most design standards.
8.0	Very Good	Mainline operations equivalent to LOS B during peak hour. High level of traffic operations. Meets all mandatory design standards. Meets all or most advisory design standards.
10.0	Ideal	Mainline operations equivalent to LOS A during peak hour. Highest level of traffic operations. Meets or exceeds all design standards.

Note: The sample scale demonstrated above (as well as below, for Local Operations) correlates a “0”/Unacceptable rating with LOS F and a “10”/Ideal rating with LOS A. Be advised that these scales are samples only. It is very possible that one project’s “Very Good” rating would be the equivalent of a “Fair” rating on another project, especially attributes involving Levels of Service. For example, an LOS D in District 7 may be rated “Very Good” depending on the highway segment under study, whereas such an LOS would be considered “Poor” in District 1.) Therefore, these scales should be customized to fit the project.

2. Local Operations

An assessment of traffic operations and safety on the local roadway infrastructure, including on-ramps and frontage roads. Operational considerations include level of service relative to the 20-year traffic projections; geometric considerations such as design speed, sight distance, and lane widths; bicycle and pedestrian operations and access.

Table A1-2 Local Operations Performance Attribute Rating Scale

Rating	Label	Description
0.0	Unacceptable	Local operations equivalent to LOS F during peak hour. Very poor level of traffic operations. Severely impacts existing local access. May require multiple design exceptions.
2.0	Poor	Local operations equivalent to LOS E during peak hour. Poor level of traffic operations. Significantly impacts existing local access. May require multiple design exceptions.
4.0	Fair	Local operations equivalent to LOS D during peak hour. Fair level of traffic operations. Somewhat impacts existing local access. May require some design exceptions.
6.0	Good	Local operations equivalent to LOS C during peak hour. Good level of traffic operations. Maintains existing local access. Meets all or most design standards.
8.0	Very Good	Local operations equivalent to LOS B during peak hour. High level of traffic operations. Maintains or improves existing local access. Meets all mandatory design standards. Meets all or most advisory design standards.
10.0	Ideal	Local operations equivalent to LOS A during peak hour. Highest level of traffic operations. Significantly maintains or improves upon existing local access. Meets or exceeds all design standards.

3. Environmental Impacts

An assessment of the permanent impacts to the environment, including ecological (i.e., flora, fauna, air quality, water quality, visual, noise); socioeconomic impacts (i.e., environmental justice); impacts to cultural, recreational, and historic resources. Also considered under this attribute are drainage and hydraulic issues.

Table A1-3 Environmental Impacts Performance Attribute Rating Scale

Rating	Label	Description
0.0	Unacceptable	The environmental impacts are severe and the project does not comply with state and/or federal environmental laws.
2.0	Poor	The project introduces environmental impacts that are both significant in number and impact that require extensive mitigation.
4.0	Fair	The project introduces many new environmental impacts that will require extensive mitigation.
6.0	Good	The project introduces some new environmental impacts that can be addressed through standard and accepted mitigation approaches.
8.0	Very Good	The project introduces no new environmental impacts.
10.0	Ideal	The project improves upon the existing environmental conditions while introducing no new environmental impacts.

4. Construction Impacts

An assessment of the temporary impacts to the public during construction related to traffic disruptions, detours, and delays; impacts to businesses and residents relative to access, visual, noise, vibration, dust, and construction traffic; environmental impacts related to water quality, air quality, soil erosion, and local flora and fauna.

Table A1-4 Construction Impacts Performance Attribute Rating Scale

Rating	Label	Description
0.0	Unacceptable	Temporary traffic and/or environmental impacts will be severe and create impacts that are unacceptable to the public.
2.0	Poor	Temporary traffic impacts will be extensive, lengthy, and very disruptive. Temporary environmental impacts will require extraordinary mitigation measures and create major inconveniences to the public.
4.0	Fair	Temporary traffic impacts will be significant and be much greater than what would normally be anticipated for similar projects. Temporary environmental impacts will be more significant in nature and require greater mitigation measures and/or inconveniences to the public.

Rating	Label	Description
6.0	Good	There will be some nighttime lane closures and/or temporary ramp closures. There will be some minor to moderate temporary environmental impacts. Impacts will be fairly "typical" for this type of project and can be handled through normal processes and procedures.
8.0	Very Good	There will be some minor temporary traffic and/or environmental impacts expected during construction. Impacts will be less than typical.
10.0	Ideal	There will be no temporary traffic or environmental impacts during construction.

5. Maintainability

An assessment of the long-term maintainability of the transportation facility(s).

Maintenance considerations include the overall durability, longevity, and maintainability of pavements, structures, and systems; ease of maintenance; accessibility and safety considerations for maintenance personnel.

Table A1-5 Maintainability Performance Attribute Rating Scale

Rating	Label	Description
0.0	Unacceptable	The anticipated level of maintenance for the project will be extreme and unacceptably high.
2.0	Poor	The project is expected to require maintenance that far exceeds the norm for a facility of its kind.
4.0	Fair	The highway facility is expected to require greater than normal maintenance due to existing site conditions or materials selection.
6.0	Good	The project provides a satisfactory level of maintainability and is typical of a highway facility of this kind statewide.
8.0	Very Good	The project provides a high level of maintainability. The facility utilizes many low maintenance features and is better than average in terms of expected maintenance.
10.0	Ideal	The project provides the highest possible level of maintainability and far exceeds expectations when compared to comparable facilities statewide. Examples are the use of long-life pavement, low maintenance water quality facilities, low maintenance structures, etc.

6. Phaseability

An assessment of how easily a transportation facility can be improved or expanded upon at some future date. This attribute considers the degree of "throwaway work" involved, as well as future traffic and public impacts when the planned future improvements are made.

Table A1-6 Phaseability Performance Attribute Rating Scale

Rating	Label	Description
0.0	Unacceptable	It is not possible for the project to be built in phases.
2.0	Poor	Constructing the project in multiple phases is possible, but faces severe challenges. Interim benefits may be negligible.
4.0	Fair	The project can be built in multiple phases; however, the interim benefits will be limited in nature and/or significant “throwaway” work will be required.
6.0	Good	The project can be built in multiple phases while providing some interim benefits, however, moderate “throwaway” work will be required.
8.0	Very Good	The project can be built in multiple phases while providing interim benefits that will require some “throwaway” work.
10.0	Ideal	The project can be easily built in multiple phases while providing interim benefits that will require little or no “throwaway” work.

7. Land-Use Compatibility

An assessment of the overall compatibility of transportation facilities with existing and planned land uses. This attribute considers how a transportation facility will directly affect the quality and viability of the land uses around it.

Table A1-7 Land-Use Compatibility Performance Attribute Rating Scale

Rating	Label	Description
0.0	Unacceptable	The project is completely incompatible with both existing and planned land uses and is unacceptable to project stakeholders.
2.0	Poor	The project is highly incompatible with both existing and planned land uses but would still be acceptable to project stakeholders.
4.0	Fair	The highway facility is only partially compatible with existing and/or planned land uses.
6.0	Good	The project provides a satisfactory level of compatibility with both existing and planned land uses.
8.0	Very Good	The project is highly compatible with both existing and planned land uses.
10.0	Ideal	The project provides the highest possible level of compatibility with both existing and planned land uses.

OPTIONAL PERFORMANCE ATTRIBUTES

In addition to these seven “standard” performance attributes, up to two additional attributes should be made available to address site-specific issues. The use of these attributes should be based upon the discretion of the PDT and/or stakeholders. The commonly used additional attributes that may be relevant are provided below. It should

be noted that this list is not all-inclusive and that the VA process must be flexible enough to consider any potential aspect of performance.

1. Cultural Impacts

An assessment of the permanent impacts to cultural, recreational, and historic resources. [Note: Sometimes it is desirable to split the standard attribute “Environmental Impacts” into multiple, free-standing attributes. This is in recognition that sometimes socioeconomic, cultural, and natural resources are in conflict with one another.]

2. Ecological Impacts

An assessment of the permanent impacts to the ecological resources including flora, fauna, air quality and water quality. [Note: Sometimes it is desirable to split the standard attribute “Environmental Impacts” into multiple, free-standing attributes. This is in recognition that sometimes socioeconomic, cultural, and natural resources are in conflict with one another.]

3. Hydrological Impacts

An assessment of the project’s impact to lakes, rivers, and streams in its vicinity. The attribute also considers the performance of the transportation facility during flood events.

4. Ride Quality

A qualitative measure of the smoothness of the pavement surface which also considers noise and vibration. Caltrans is moving toward the International Roughness Index (IRI). The IRI was developed by the World Bank in the 1980s (UMTRI, 1998). IRI is used to define a characteristic of the longitudinal profile of a traveled wheeltrack and constitutes a standardized roughness measurement. The commonly recommended units are meters per kilometer (m/km) or millimeters per meter (mm/m). The IRI is based on the average rectified slope (ARS), which is a filtered ratio of a standard vehicle’s accumulated suspension motion (in mm, inches, etc.) divided by the distance traveled by the vehicle during the measurement (km, mi, etc.). IRI is then equal to ARS multiplied by 1,000.

PERFORMANCE ATTRIBUTES TO BE DISCOURAGED

The use of the following performance attributes (or any variation of these) should be strongly discouraged.

1. Public Acceptance

This attribute commonly appears but should be avoided due to the difficulty in trying to assess the broad notion of community or public acceptance by such a small group of

individuals possessing a relatively narrow perspective (i.e., the PDT). In reality, “public” or “community” acceptance is a byproduct of the “standard” performance attributes described previously. In other words, the public is more likely to accept a design solution that performs well in these areas (and/or costs less) and less likely to accept one that does not (and/or costs more). Therefore, the use of such an attribute is redundant.

2. Constructibility

This attribute also commonly appears on VA Studies, however, it is really a byproduct of “Project Schedule,” “Construction Impacts,” and cost. A design solution that is more constructible than another will involve trade-offs between these three areas. Therefore, inclusion of an attribute such as “Constructibility” is redundant.

3. Right-of-Way Impacts

This attribute is better described by attributes such as “Environmental Impacts,” “Land-Use Compatibility,” or possibly “Cultural Impacts,” as well as cost. When this attribute is used, in effect, performance is really related to cost, which results in “double counting” by considering this as both an output (i.e., performance) and an input (i.e., cost).

PERFORMANCE REQUIREMENTS

The inclusion of well-defined performance requirements has also proven to be an essential element in properly considering project performance. Participants frequently confuse performance requirements (essential performance) with performance attributes (discretionary performance beyond minimum requirements).

Below are samples of Performance Requirements that have frequently appeared on VA Studies for Caltrans.

- Design Standards

Example: Any deviations from design standards must be approvable by Design Reviewer.

- Environmental Issues

Example: Meet NEPA and CEQA guidelines; no adverse effects to 4f properties.

- Structure Design Criteria

Example: Must meet current seismic standards; must meet Load Resistance Factor Design (LRFD).

- Scenic Corridor Requirements

Example: Any negative impacts to scenic viewshed (etc.) must be approved through a Visual Impact Analysis.

- Schedule Milestones

Example: Design must be finished by Feb. 2010 (to assure SHOPP funding).

- Right-of-Way Issues

Example: No takes on railroad right-of-way, or must stay within current Caltrans right-of-way.

- Safety

Safety is certainly a critical aspect of the performance of our highway system. It is also a very controversial and sensitive subject. First of all, there are legal issues related to any discussion of safety. If we are to evaluate safety quantitatively, we must come up with a reasonable, non-emotional rationale to do so. This is difficult to do – basically, we only have past accident data to go on. It is problematic to predict what an improvement will have in the future on past rates for a given facility and a given improvement. We can declare a facility “safe” based on it meeting certain safety standards (i.e., design criteria), however, we cannot know how safe “safe” really is until data is collected after the fact confirming or denying our predictions. Furthermore, we must consider the fact that DOTs commonly allow “design exceptions” (usually due to financial limitations) which allow for design features that do not meet current standards. Logically, this translates to the acceptance of highway facilities that are less “safe” than those that fully meet standards. However, the terms “unsafe” or “less safe” are generally not acceptable and are never used due to the threat of litigation. The typical approach is to say that all highway facilities are “safe” because they were approved by a DOT; the DOTs do not build “unsafe” projects according to language in official public documents. The concern with using “Safety” as a performance attribute relates to these legal issues. While we could *qualitatively* evaluate highway facilities for relative safety (i.e., a 10-foot-wide shoulder is “safer” than an 4-foot-wide shoulder), it could open the door for serious legal issues in the future by having a public document (i.e., a VA Study Report) available to the legal community for use in litigation against state DOTs. Furthermore, “safety” is an emotional issue that people have difficulty evaluating objectively. This is certainly true from a public perspective. In the past, when “Safety” is used as an attribute, it completely dominates all other attributes purely due to its emotionally charged nature. It is more logical to view “Safety” as an aspect of traffic operations. This is a logical and

sensible way to discuss safety as safety and operations go hand in hand. “Unsafe” conditions lead to accidents which lead to poor operations and poor operational conditions lead to higher accident rates. “Safe” conditions lead to fewer accidents, which lead to better operations. *“Safety” should therefore be regarded as a requirement as DOTs do not build “unsafe” highways.*

Step 2 – Determine the Relative Importance of the Attributes

Individual rating scales must be developed for each performance attribute. Once this has been completed, the importance of the various performance attributes relative to the project’s need and purpose should next be determined using an AHP paired comparison. AHP is an acronym for Analytic Hierarchy Process, which is a decision structure developed by Dr. Thomas Saaty in the 1970s while professor at the Wharton School of Business. AHP is a very flexible and powerful system for group decision making that uses scaled paired comparisons based upon a fundamental scale. Value Metrics is predicated on the principles of AHP.

The first step is to determine the relative importance (referred to as priorities) of the performance attributes. There are two dimensions to consider in determining relative importance: 1) the importance of the performance attribute in meeting the project’s need and purpose, and 2) the importance of the impacts relative to the ranges being considered in the rating scales. In other words, an attribute that is of high importance in meeting the project’s need and purpose that has a high degree of impact in terms of its measurement would dominate an attribute that is also of high importance that has a low degree of impact. The performance attributes are compared in pairs, asking, “Which of these two performance attributes is more important in satisfying the project’s purpose and need?” In this method, a pair of attributes is compared using the AHP Fundamental Scale shown below.

Table A1-8 Analytic Hierarchy Process (AHP) Fundamental Scale

Intensity of Importance	Definition	Explanation
1	Equal Importance	The two attributes contribute equally to the project’s need and purpose.
3	Moderate Importance	Experience and judgment slightly favor one attribute over another.

Intensity of Importance	Definition	Explanation
5	Strong Importance	Experience and judgment strongly favor one attribute over another.
7	Very Strong Importance	Experience and judgment very strongly favor one attribute over another.
9	Extreme Importance	The evidence favoring one activity over another is of the highest possible importance.
2, 4, 6, 8	For compromises between the preceding values	Sometimes there is a need to compromise between the preceding values in which case these intermediate values can be used.
Reciprocals	If attribute x has one of the above non-zero numbers assigned to it when compared to attribute y , then y has the reciprocal value when compared with x .	Used to represent the reciprocal value of the dominant attribute for the weak attribute for a paired comparison.

The PDT and other stakeholders evaluate the relative importance of the performance attributes that are used to evaluate the baseline concept and VA Alternatives. The process for completing the Performance Attribute Matrix involves the following steps:

1. List performance attributes.

Enter the names of all of the performance attributes into the matrix.

2. Discuss pairs.

Compare attribute pairs by asking, “Which of these two performance attributes is more important in satisfying the project’s purpose and need?” The first step is to determine which attribute is more important. Once the dominant attribute has been identified, the next step is to apply the AHP Fundamental Scale to determine the degree of importance. An important aspect to understand is the meaning behind the numbers in the AHP Fundamental Scale.

3. Total the scores.

The Performance Attribute Matrix utilizes what is called a normalized eigenvector. The process for determining the priorities of the performance attributes involves the following steps:

- 1) Total the intensities for each column.
- 2) Determine the priorities of the attributes. This is calculated by taking the intensity value in each cell – row by row – dividing it by the sum of that column’s total, and then adding them all together and dividing the sum by the total number of attributes. (Example: The priority of Attribute 1 in

Figure A1-1 is calculated by adding

$$[(1 / 2.17) + (4 / 6.4) + (3 / 5.45) + (3 / 13.25) + (4 / 19)] / 5 = 0.41 \text{ or } 41\%$$

The VA Team Leader should elicit PDT and/or stakeholders priorities in the yellow boxes, shown in Figure A1-1. The reciprocal is auto-populated in the blue boxes via template formulas. Note that the attributes in the rows are being compared to the attributes in the columns. Therefore, in Figure A1-1, Maintainability is moderately more important (4) than Mainline Operations.

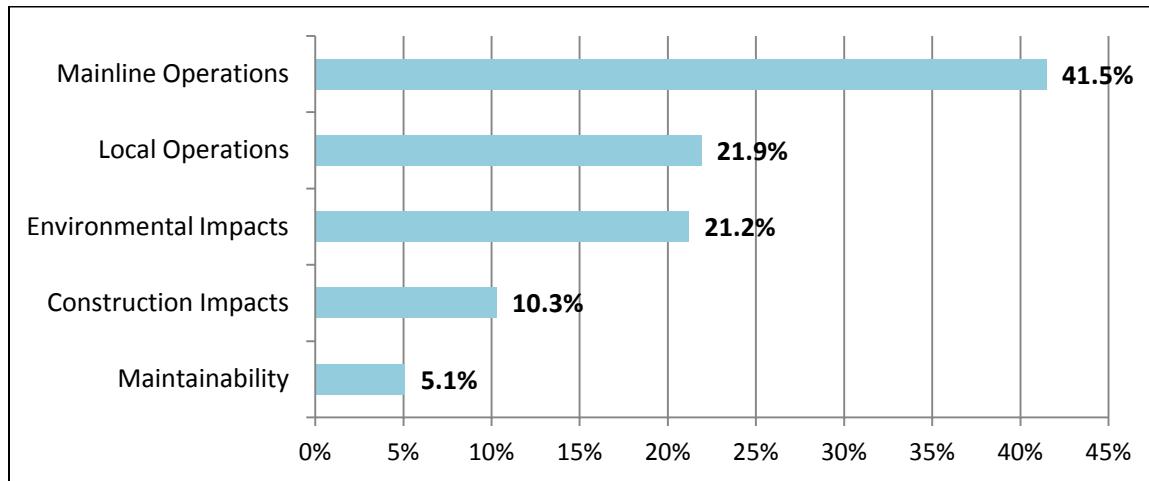
Figure A1-1 Sample Performance Attribute Matrix using AHP Paired Comparison

Performance Attributes	Mainline Operations	Local Operations	Environmental Impacts	Construction Impacts	Maintainability	WEIGHT
Mainline Operations	1	4	3	3	4	41.5%
Local Operations	0.250	1	1	5	5	21.9%
Environmental Impacts	0.333	1.000	1	4	5	21.2%
Construction Impacts	0.333	0.200	0.250	1	4	10.3%
Maintainability	0.250	0.200	0.200	0.250	1	5.1%
SUBTOTALS	2.17	6.40	5.45	13.25	19.00	100.0%

Note: Fractions represent reciprocals: $0.2 = 1/5$

The VA Team Leader should elicit project PDT and/ or stakeholders priorities in the yellow boxes. The reciprocal is auto-populated in the blue boxes via the template formulas. The attributes in the rows are being compared to those in the column. Therefore, Maintainability is moderately more important (4) than Mainline Operations.

Figure A1-2 Sample Chart Illustrating Priorities of Performance Attributes



Step 3 – Establish the Performance “Baseline” for the Baseline Concept

Assuming the performance attributes and their associated scales have been defined and their priorities derived, the next step is to establish the performance of the Baseline Concept. The PDT should take the lead in this process. Using the performance scales, each attribute should be rated accordingly. It is essential that a detailed description for the rating rationale be developed and recorded.

Figure A1-3 Sample Showing Ratings of Baseline Design Concept and Associated Rating Rationale

Mainline Operations	Rating: 6.1
Rationale: The design generally mitigates impacts of congestion that result in traffic backing up onto the mainline SR 60 freeway ramps. The mainline goods movement operations of the UPRR is not impacted and maintained throughout construction.	
Local Operations	Rating: 4.6
Rationale: The project is relieving congestion on the local roadways, thereby facilitating improved traffic operations and movement of goods. There are design compromises with the design speed and accessibility to driveways (some driveways are eliminated and others have steep grades). Some local business access is permanently impacted.	
Environmental Impacts	Rating: 4.8
Rationale: There are environmental issues (in particular with water quality); however, they can be mitigated. The reductions in congestion improve environmental factors and quality of life (as well as safety). The environmental impacts are not extreme and are also not minimal. The impacts can be dealt with in the design and are average.	
Construction Impacts	Rating: 3.8
Rationale: The construction impacts shut down Fairway Drive during construction and results in considerable local impacts. The construction of the “bath tub” in development of the underpass is time-consuming.	
Maintainability	Rating: 3.3
Rationale: The project design results in considerable maintenance increases over the existing conditions. The post-construction conditions results in long-term maintenance issues with groundwater and pumping of the water. The paved surfaces and structures are relatively consistent with average to better-than-average maintainability; however the major issue of maintenance lies within the groundwater.	

The rating rationale should be recorded for each attribute that reflects the basis for the rating.

Note that the ratings in this example are not whole numbers because multiple stakeholders rating were averaged, resulting in a fractional value.

**Figure A1-4 Sample Performance Calculation –
Multiplying the Priorities by the Ratings**

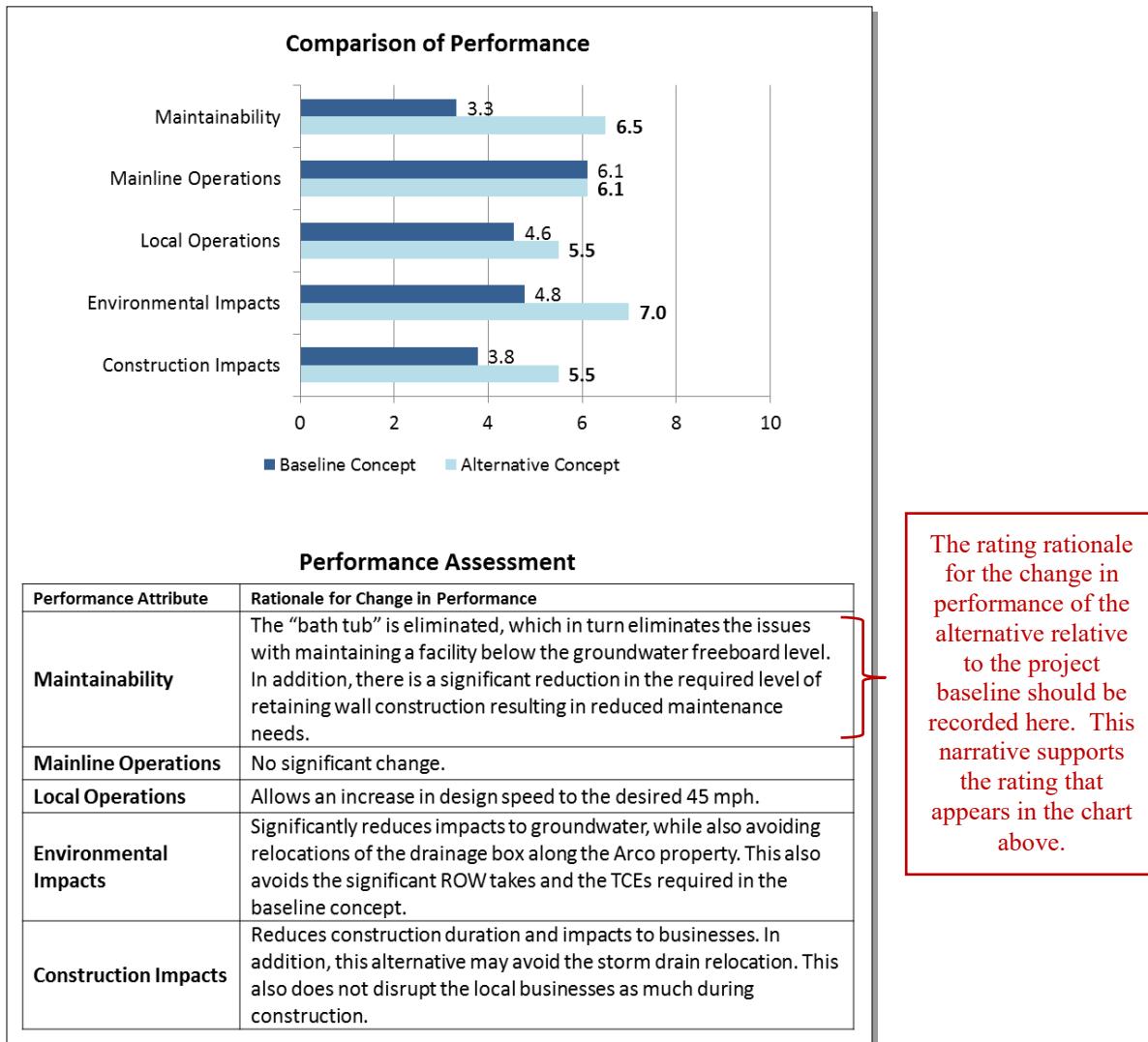
Performance Attributes	Priority (P)	Rating (R)	Score (PxR)
Mainline Operations	41.5%	6.1	2.5
Local Operations	21.9%	4.6	1.0
Environmental Impacts	21.2%	4.8	1.0
Construction Impacts	10.3%	3.8	0.4
Maintainability	5.1%	3.3	0.2
Total Performance Scores:			5.1

Some projects may have multiple design concepts; this is typical on public transportation and infrastructure projects where multiple design concepts are initially developed to satisfy environmental review processes. If this is the case, it is important to rate all of the design concepts and define their rating rationale. Once this has been completed, the performance ratings of the baseline concept and any other competing design options can be compared.

Step 4 – Evaluate the Performance of the VA Alternative Concepts

Once the performance baseline has been established for the baseline design concept, it can be used to help the VA Team develop performance ratings for individual VA Alternative concepts as they are developed during the course of the VA Study. It is important to consider the alternative concept's impact on the entire project, rather than on discrete components, when developing performance ratings for the alternative concept

Figure A1-5 Sample Performance Ratings and Change in Rationale of a VA Alternative



Step 5 – Compare the Performance Ratings of Alternative Concepts to the “Baseline” Project

Following the development of the VA Alternative concepts, the VA Team must next consider how they could be applied to the project in concert with one another. Typically, the VA Team should develop a number of potential implementation strategies (“VA Strategies”) that might be considered by the decision makers. It is not essential to consider every possible permutation at this point – just a few that seem to be the most logical.

Common themes for VA strategies include:

- Best Value
- Lowest Cost
- Highest Performance
- Shortest Project Schedule
- Lowest Risk

Other themes could revolve around competing design approaches. Often a VA Team will identify multiple ways to solve a problem that are mutually exclusive. The alternatives that support these separate approaches can be grouped into VA Strategies.

Once the VA Strategy or Strategies have been identified, the VA Team should review each of the VA Alternatives that are a part of each strategy with respect to its impact on performance. It may be that the cumulative effect of several minor performance improvements offered by various alternatives equate to a larger combined performance improvement. It may also be the case that the strengths of one alternative balance out the weaknesses of another. The focus should be on considering the aggregate, or synergistic, effect of the VA Alternatives relevant to the project as a whole.

The most effective approach to assess the aggregate effect of multiple VA Alternatives combined as a cohesive strategy is to summarize the performance ratings and rationale on a single matrix. The VA Team can then review the ratings for each performance attribute, the reasoning supporting the rating, and arrive at a new performance rating for the VA Strategy as a whole. The example in Figure A1-6 shows a summary of three VA Strategies (i.e., combinations of complimentary alternatives) that were selected by the VA Team.

Figure A1-6 Sample of VA Strategies Proposed During a VA Study

Strategy Description	Initial Cost Savings	Change in Schedule	Performance Change	Value Change
VA Strategy 1: <i>Improvements to Baseline Concept</i> VA Alternatives 1.1, 3.0, 4.0, 5.1, 6.0, 7.0	\$3,280,000	-6 months	+18 %	+25 %
VA Strategy 2: <i>Full Raising of Track Height</i> VA Alternatives 2.1, 3.0, 5.1, 6.0, 7.0	\$28,150,000	-16 months	+48 %	+94 %
VA Strategy 3: <i>Partial Raising of Track Height</i> VA Alternatives 2.2, 3.0, 5.1, 6.0, 7.0	\$30,550,000	-12 months	+41 %	+81 %

Figure A1-7 Sample Showing Ratings of a VA Strategy and Associated Rating Rationale

Mainline Operations	Rating: 6.1
Rationale: There is no significant change to the mainline operations. Mainline rail operations are not impacted or interrupted.	
Local Operations	Rating: 5.3
Rationale: Local operations are improved by maintaining local improvements at the Fairway Drive intersections of Business Parkway and at Walnut Drive. In addition, by incorporating a structure with a reduced depth, the sight distance is marginally increased, and the design speed on Fairway Drive can be increased to a more desirable 45 mph.	
Environmental Impacts	Rating: 5.8
Rationale: The environmental impacts are improved as a result of minimizing impacts to the groundwater and constructing the "bath tub" structure in a more water-tight fashion with the HDPE liner and integrated wall design. The elimination of a full taking of the Carl's Jr property also improves the permanent environmental condition.	
Construction Impacts	Rating: 4.8
Rationale: The constructability of the "bath tub" is simplified due to elimination of more extensive jet grouting. Integrating retaining walls with the secant pile wall design in the "bath tub" results in simplified constructability and reduced construction duration. This requires less earthwork. In addition, the improvements to the baseline concept decrease construction duration which results in a reduced impact horizon.	
Maintainability	Rating: 4.5
Rationale: Injection-grouting the base and utilizing reinforced concrete with a HDPE liner on top provides a more predictable and maintainable configuration of the "bath tub" structure. In addition, this allows for a water-tight solution that will require less pumping which results in reduced maintenance of a pump system. Also, integrating retaining walls with a secant pile wall design in the "bath tub" improves maintainability by configuring the wall structures to a single integral wall that will be more resistant to cracking over time. Inclusion of a steel structure marginally increases the maintenance needs on the span of the grade separation.	

The rating rationale should be recorded for each attribute that reflects the basis for the rating.

Note that the ratings in this example are not whole numbers because multiple VA Study team members rating were averaged, resulting in a fractional value.

The Value Matrix facilitates the comparison of competing VA Strategies by organizing and summarizing the data developed for performance, cost, and schedule into a matrix format.

All competing concepts are compared to the baseline concept for the all attributes in order to compare and contrast the potential for value improvement. The matrix is essential for understanding the relationship of cost, performance, schedule, and value of the project baseline and of the concepts developed during the VA process. Comparing the performance and cost suggests which alternatives are potentially as good as or better than the project's baseline concept in terms of overall value. Comparison at the value index level suggests which alternatives have the best performance versus cost, or provides the project with the “best value.”

The cost and time (i.e., schedule) elements are compared and normalized for the Baseline Concept and the VA Strategies using the following tables. These tables illustrate how cost and time (schedule) scores were derived. In this comparison, a lower score is desirable as the project will benefit from lower costs and a shorter schedule.

Figure A1-8 Normalizing Costs into Relative Scores to Input into the Value Matrix

Strategies	Cost	Score
Baseline Concept	\$121,298,533	0.287
VA Strategy 1: Improvements to Baseline Concept	\$118,018,533	0.279
VA Strategy 2: Full Raising of Track Height	\$93,148,533	0.220
VA Strategy 3: Partial Raising of Track Height	\$90,748,533	0.214
TOTAL	\$423,214,132	1.000

The cost scores are determined by dividing each cost by the sum of all costs; e.g., the cost score for the Baseline Concept is derived by dividing \$121,298,533 by \$423,214,132.

The same method is applied to derive the cost score, shown in Figure A1-9.

Figure A1-9 Normalizing Time into Relative Scores to Input into the Value Matrix

Strategies	Time	Score
Baseline Concept	65 months	0.288
VA Strategy 1: Improvements to Baseline Concept	59 months	0.261
VA Strategy 2: Full Raising of Track Height	49 months	0.217
VA Strategy 3: Partial Raising of Track Height	53 months	0.235
TOTAL	226 months	1.000

Project Management should determine the relative importance of project resources at the start of the VA Study, namely cost versus schedule. In the example below, the PM felt that cost and schedule were of equal importance with cost and time each worth 50%. So, to calculate the total cost/time score, one would multiply the cost score for each strategy by 50% and the time score by 50% before adding them together. So, for the example in Figures A1-8 and A1-9, to calculate the cost/time score for VA Strategy 1, the computation would be performed as follows: $(0.279 \times 0.5) + (0.261 \times 0.5) = 0.270$.

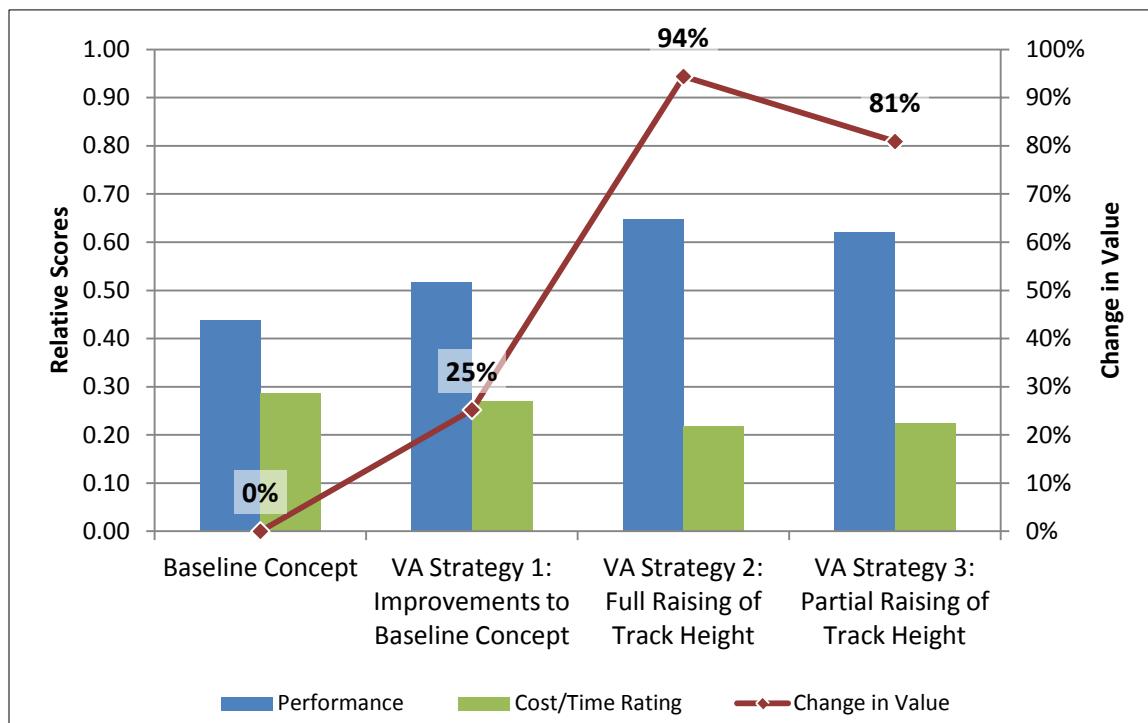
Once relative scores for performance, cost, and schedule have been derived, the next step is to synthesize a value index for the Baseline Concept and each of the VA Strategies. This is achieved by applying the value algorithm whereby $\text{Value} = \text{Performance} / \text{Cost} + \text{Schedule}$.

A Value Matrix is then prepared to facilitate the comparison of competing strategies by organizing and summarizing this data into a tabular format. The performance scores for each strategy are divided by the total cost/time scores for each strategy to derive a value index. The value indices for the VA Strategy(s) are then compared against the value index of the Baseline Concept and the difference is expressed as a percent ($\pm\%$) deviation.

**Figure A1-10 Sample Value Matrix
Comparing Baseline Concept with VA Strategies**

Strategies	Performance Score	Change in Performance	Cost/Time Score	Net Change	Value Index	Change in Value
Baseline Concept	0.438	---	0.287	---	1.526	---
VA Strategy 1	0.516	+18 %	0.270	-6 %	1.910	+25 %
VA Strategy 2	0.648	+48 %	0.218	-24 %	2.966	+94 %
VA Strategy 3	0.620	+41 %	0.224	-22 %	2.761	+81 %

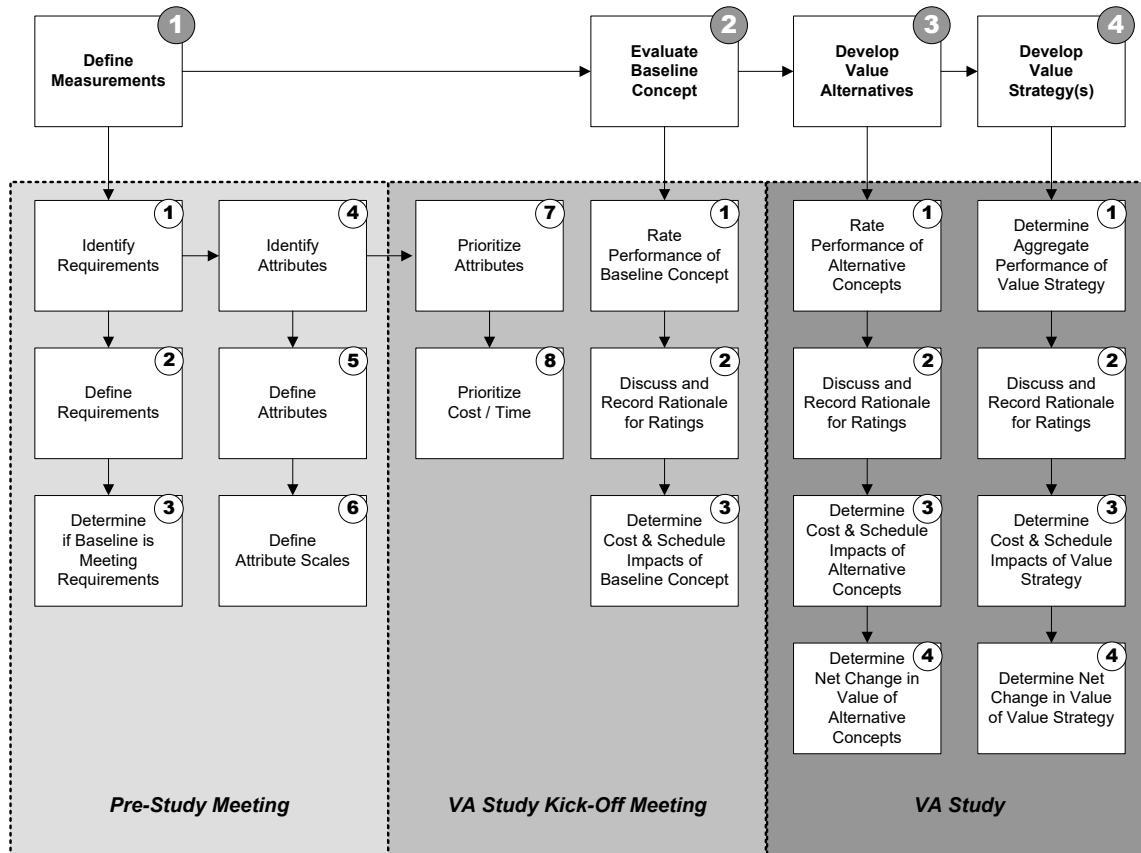
**Figure A1-11 Sample Comparison of Value Chart Based on Value Matrix
Comparing Baseline Concept with VA Strategies**



SECTION 4 – Tools for Conducting Value Metrics

The method used at Caltrans to capture performance measures can be easily summarized. On the HQ VA website, VA Team Leaders can download a simple spreadsheet (Caltrans Value Metrics Template v6.xlsx) to capture performance benefits throughout the study. Figure A1-12 is a flowchart of the process.

Figure A1-12 Value Metrics Flowchart



The Spreadsheet is a systematic tool for deriving the needed charts used in the VA Study Report. The VA Team Leader can input the data through multiple tabs in the spreadsheet. Below is the list of tabs:

1. Performance Requirements
2. Performance Attributes
3. Priorities
4. Alternative Performance
5. Alternative Value
6. Strategy Performance
7. Strategy Value

Once completed, the following charts are automatically generated for the reports.

- Performance Priorities
- Alternative Performance Ratings

- Alternative Performance Profile
- Alternative Value Profile
- Strategy Performance Profile
- Strategy Value Profile

Much of the material included in this appendix was taken from the book, *Value Optimization for Project and Performance Management*, by Robert B. Stewart, published by John R. Wiley & Sons, Inc. in 2010.

APPENDIX 2 – Writing the Value Analysis Alternative For Caltrans

The VA Alternatives are developed by the VA Team Members with the help of the VA Team Leader. The VA Alternative form (found on the Caltrans VA website) shown on the following pages is used to document the important information needed to back-up the recommendation so project decision makers can make an informed decision on the changes of the project. This form is included in the *Final VA Study Report*.

VA ALTERNATIVE NO. 1.0

This will be determined by the VA Study Team Leader.

Alternative Title

The title can be modified if further research or refinement uncovers necessary changes or clarifications. Do not use this area to describe the reason(s) for the alternative.

Initial Cost Savings:

LCC Savings:

Change in Schedule:

Performance Change:

Value Change:

This information will be filled in by the VA Study Team Leader.

Description of Baseline Concept: *What is currently planned?* Describe the project element(s) as presented in the Kick-Off Meeting and available drawings and cost estimates. Be as descriptive and specific as possible, but only include those elements that are relevant to the alternative concept being proposed below.

Description of Alternative Concept: *What is the change(s) proposed by the VA Study Team?*

Describe the proposed change(s) to the baseline concept described above. Be as descriptive and specific as possible, but do not discuss the rationale for the change or its benefits.

Advantages: *Why is the Alternative Concept better?*

- Benefits (“Pros”) of implementing the Alternative Concept
- Use concise statements (one per line), not full sentences

Disadvantages: *What challenges or disadvantages does the Alternative Concept introduce?*

- Detriments (“Cons”) of implementing the Alternative Concept
- Use concise statements (one per line), not full sentences

Discussion: *Describe IN DETAIL why the Alternative Concept should be implemented.* Provide an in-depth narrative about the Baseline and Alternative Concepts and thorough analysis of the Alternative’s advantages and disadvantages, etc. For instance, if you listed “Reduces required retaining wall maintenance” in the Advantages above, it is critical to describe why and how in this section. The Discussion section is intended to PROVE to project stakeholders, owners, and Project Team that this alternative should be implemented.

Technical Review Comments: *Highlight issues/concerns for the Project Team or technical personnel considerations.* If there is a Technical Review session during the VA Study, use this space to relate the comments of the reviewers as to the technical feasibility of the Alternative Concept. It is acceptable to paraphrase reviewer comments, and it is not necessary to identify the commenter.

Project Management Considerations: *What will the PM have to do to implement this alternate concept?* Also, how are the PM’s continuing responsibilities affected by implementing this alternative?

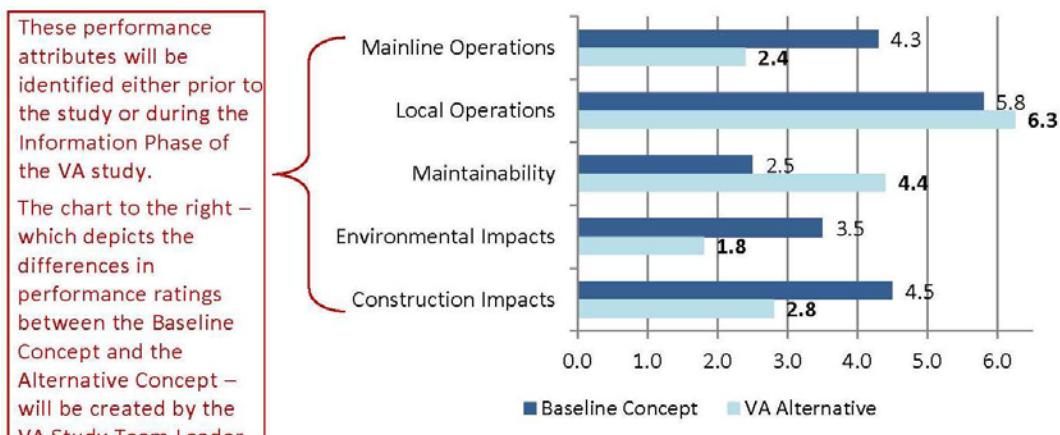
Discussion of Schedule Impacts: *Describe how implementing the Alternative Concept will impact the project schedule.* Be specific as to the phases, activities, etc., to be impacted. While you are welcome to provide exact durations for every potential impact, it is not always possible. Therefore, if necessary, estimate lengths of time based on your best judgment and expertise.

VA ALTERNATIVE NO. 1.0

Alternative Title

Discussion of Risk Impacts: *Describe how the Alternative Concept will address existing risks and/or opportunities, as well as any new risks/opportunities introduced by implementing this Alternative.*
It is possible for an alternative to simultaneously address an existing risk and introduce a new one. In this case, discuss the trade-offs and demonstrate why it is still good practice to implement the Alternative Concept.

Comparison of Performance



Performance Assessment

Performance Attribute	Rationale for Change in Performance
Mainline Operations	<i>How will the alternative impact each of the various performance attributes?</i> Is performance better or worse? Explain why. At times, this information is captured from discussions during group Idea Evaluation; elaborate on this information.
Maintainability	Is performance better or worse? Explain why.
Environmental Impacts	Is performance better or worse? Explain why.
Construction Impacts	Is performance better or worse? Explain why.

VA ALTERNATIVE NO. 1.0

Alternative Title

Baseline Concept Sketch

Provide a visual depiction of the Baseline Concept. This could include plans/drawings, hand-drawn sketches, photos, or figures. Scale and precision are not required, though it is encouraged if it is available. Please limit the area to that which is relevant to the Alternative Concept.

VA Alternative Concept Sketch

Provide a visual depiction of the Alternative Concept. This could include marked-up plans/drawings, hand-drawn sketches, photos, or figures. Scale and precision are not required, though it is encouraged if it is available.

Assumptions and Calculations: *What was assumed in order to develop the cost impact of this VA alternative?* Provide assumed quantities, unit costs, calculations, and/or activities that must be (or must not be) performed. This enables development alternative and the cost estimate/comparison, as shown on the “Initial Cost Estimate” on the following page.

VA ALTERNATIVE NO. 1.0

Alternative Title

Initial Cost Estimates

Once the VA Alternative information is captured, initial and life-cycle cost estimates and order-of-magnitude comparisons can be made in the MS Excel templates provided by the VA Study Team Leader, shown below.

CONSTRUCTION ELEMENT		BASELINE CONCEPT			ALTERNATIVE CONCEPT		
Description	Unit	Qty	Cost/Unit	Total	Qty	Cost/Unit	Total
ROADWAY ITEMS			\$	\$		\$	\$
			\$	\$		\$	\$
			\$	\$		\$	\$
			\$	\$		\$	\$
ROADWAY SUBTOTAL			\$	\$		\$	\$
ROADWAY MARK-UP			\$	\$		\$	\$
ROADWAY TOTAL			\$	\$		\$	\$
STRUCTURE ITEMS			\$	\$		\$	\$
			\$	\$		\$	\$
			\$	\$		\$	\$
			\$	\$		\$	\$
			\$	\$		\$	\$
STRUCTURE SUBTOTAL			\$	\$		\$	\$
STRUCTURE MARK-UP			\$	\$		\$	\$
STRUCTURE TOTAL			\$	\$		\$	\$
RIGHT-OF-WAY ITEMS			\$	\$		\$	\$
Right-of-Way Acquisition			\$	\$		\$	\$
Utility Relocation			\$	\$		\$	\$
Relocation Assistance			\$	\$		\$	\$
Demolition			\$	\$		\$	\$
Title and Escrow Fees			\$	\$		\$	\$
RIGHT-OF-WAY TOTAL			\$	\$		\$	\$
ENVIRONMENTAL MITIGATION ITEMS			\$	\$		\$	\$
			\$	\$		\$	\$
CAPITAL OUTLAY SUPPORT ITEMS			\$	\$		\$	\$
Reengineering and Redesign			\$	\$		\$	\$
Project Engineering			\$	\$		\$	\$
TOTAL			\$0	\$0		\$0	\$0
TOTAL (Rounded)			\$0	\$0		\$0	\$0
					SAVINGS		\$0

VA ALTERNATIVE NO. 1.0

Alternative Title

Life-Cycle Cost Estimates

Based on the initial cost estimates previously developed, the VA Study Team Leader will work with the team to perform a life-cycle cost analysis, if the relevant information is available and there is a high likelihood that life-cycle cost savings can be realized by implementing the VA alternative. The form used to perform this analysis is shown below.

Life-Cycle Period	Years	Real Discount Rate	BASELINE	ALTERNATIVE
A. INITIAL COST				
Service Life - Baseline	Years		INITIAL COST SAVINGS:	\$ -
Service Life - Alternative	Years			
B. SUBSEQUENT ANNUAL COSTS				
1. Maintenance and Inspection				
2. Operating				
3. Energy				
Total Subsequent Annual Costs:			\$ -	\$ -
Present Value Factor (P/A):			0.000	0.000
PRESENT VALUE OF SUBSEQUENT ANNUAL COSTS (Rounded):				
C. SUBSEQUENT SINGLE COSTS		Year	Amount	PV Factor
			1.00000	\$ -
			1.00000	\$ -
			1.00000	\$ -
			1.00000	\$ -
			1.00000	\$ -
			1.00000	\$ -
			1.00000	\$ -
			1.00000	\$ -
PRESENT VALUE OF SUBSEQUENT SINGLE COSTS (Rounded):			\$ -	\$ -
D. TOTAL SUBSEQUENT ANNUAL AND SINGLE COSTS (B+C)			\$ -	\$ -
E. TOTAL SUBSEQUENT COSTS SAVINGS:			\$ -	\$ -
F. TOTAL PRESENT VALUE COST (A+D)			\$ -	\$ -
TOTAL LIFE-CYCLE SAVINGS:				\$ -

APPENDIX 3 – Caltrans VA Report Requirements and Process Guidance

To streamline the implementation of VA Alternatives, the HQ VA program has supplied the necessary documents for a typical VA Study on the VA internet site:

<http://www.dot.ca.gov/hq/oppd/value/guides.htm>

The following is a list of documents that will guide the VA Team Leader through a well-documented VA Study to meet Caltrans policy and federal guidelines.

- Caltrans VA Study Activity Chart 2013
- Caltrans Value Metrics Template (spreadsheet)
- Writing A VA Alternative for Caltrans (template)
- Life Cycle Cost Estimate (spreadsheet)
- Preliminary VA Study Report (template)
- VA Alternative Implementation Action Recommendation (template)
- Implementation Action Memo (template)
- Implementation Plan Authorization Memo (template)
- Final VA Study Report (template)
- VA Study Summary Report (VASSR) (template)
- Two-Page Study Results Summary (template)
- Modified Job Plan Proposal (template)