


# APPENDIX A: SEMP

# SYSTEMS ENGINEERING MANAGEMENT PLAN

for the

CITY OF OXNARD
ITS Master Plan

***Version 2***

**Submitted to:**

City of Oxnard

**Prepared by:**

ITERIS® Innovation for better mobility

**May 2008**

**Oxnard Contract No. 3825-06-PW**
**Iteris Project No. 17-J06-1725x0001**


## Document History

| Document Name | Submittal Date | Version No. |
|---|---|---|
| First Draft System Engineering Management Plan | August 10, 2006 | Version 1.0 |
| Second Draft System Engineering Management Plan | October 6,2006 | Version 1.1 |
| Final System Engineering Management Plan | May 2008 | Version 2 |
| | | |
| | | |
| | | |




# Table of Contents



# Figures

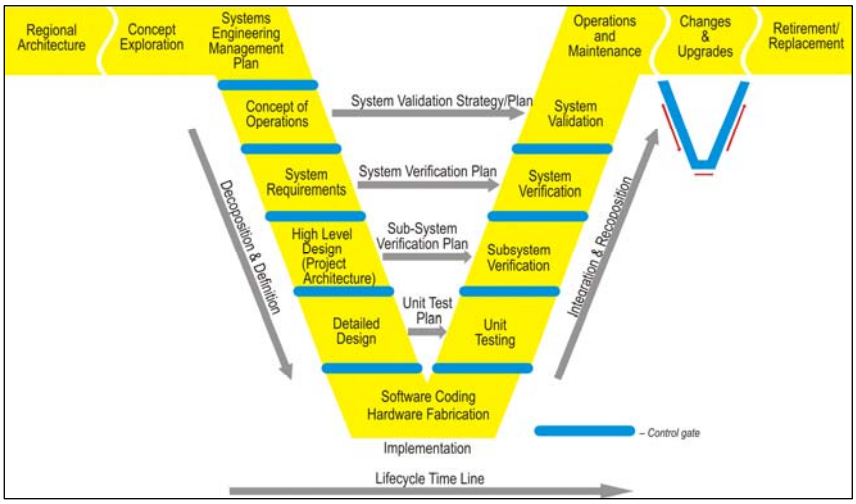

## 1.0 PURPOSE OF DOCUMENT

As part of the first task of this project, this document, the Systems Engineering Management Plan (SEMP), is intended to serve as a guidebook for the City of Oxnard and the system engineer, (Iteris), throughout the course of the project to develop the Oxnard ITS Master Plan, as well as any future vendors who may support the deployment of ITS strategies as detailed in the Oxnard ITS Master Plan. The SEMP will not only identify the tasks to be completed, but also detail out the schedule of the tasks, who is responsible for completing the tasks, and how the final products will be integrated, installed, verified, and supported. The SEMP will enable the Team to manage the project using systems engineering principles and methods to maximize the quality of the system being implemented, while minimizing the budget and schedule required for its completion.

The primary objectives of this document are:

- To provide modern, state-of-the-art, project management requirements for the development of an ITS Master Plan for the City of Oxnard for its design, procurement, construction, integration, testing, and maintenance of technical systems;
- To limit and reduce the proliferation of management documentation and to implement relevant aspects of applicable standards;
- To identify relevant directives and references;
- To provide evidence that control over the development of the ITS Master Plan demonstrates acceptability of material and services will be performed;
- To provide emphasis on a disciplined integrated systems development approach;
- To inform the stakeholders with concepts of systems engineering management and techniques

This SEMP is intended to be a living document; as information is gathered through the life of the project, some tables included in this document can be updated to reflect the most current data. The SEMP follows the systems engineering approach to project completion as illustrated at right in the "Vee Development Model in context of the lifecycle framework[1]".




[1] From the *Systems Engineering Guidebook for ITS*; see Section 8.0 for a wide array of applicable references and reference materials




## 2.0 SCOPE OF PROJECT

Travel in the City of Oxnard and Ventura County is impacted by a variety of forces, and it is projected that in the future the regional mobility problem will be exacerbated. The public policy experience in the Oxnard area, as with most regions, has been an inability to expand existing facilities or build new roads to meet the increasing demand. This is not only infeasible from a monetary perspective, but from a public support perspective; new roads mean more traffic, environmental concerns, etc. Yet, at the same time pressure is mounting to "do something" – to relieve congestion, improve incident management, provide viable alternatives, respond to seasonal variations and weather related conditions, and preserve and enhance mobility for today and years to come.

With a population of approximately 186,000, the City of Oxnard is the largest city in Ventura County, and the 20th largest city in California. Located about 60 miles northwest of Los Angeles and 35 miles south of Santa Barbara, the City is both a coastal getaway and gateway between the greater Los Angeles area and the Central Coast.

Within the last several years, the City has experienced a significant increase in traffic congestion making traffic a major concern. With a majority of the City built-out, the City has initiated this ITS Master Plan effort as a tool to strategically deploy technological solutions to the City and regional transportation needs.

Fortunately, Ventura County stakeholders, including the City of Oxnard, have already begun to take steps to address these issues, particularly with respect to the application of advanced technology and communications systems. This includes the Regional ITS Architecture for the SCAG region, a region that includes Ventura County, as well as the counties of Los Angeles, Orange, Riverside, San Bernardino, and Imperial. The goal of the Regional ITS Architecture is to provide a framework for ensuring institutional agreements and technical integration of technologies for the implementation of projects or groups of projects under a regional ITS strategy. Deployment of ITS in the City of Oxnard is facilitated by having this Regional ITS strategy in place. Adherence to the Regional ITS Architecture, as well as employing the principles of systems engineering, are fundamental requirements of the Oxnard ITS Master Plan project.

The desired outcome of this project is to develop an ITS Master Plan that achieves all of the following goals.

1. Details a long-term ITS deployment strategy
2. Inventories the existing transportation infrastructure to maximize the use of existing resources when deploying future ITS deployments to maximize funding
3. Improves public safety and incident response times
4. Provides the City with the tools to more efficiently and effectively manage the existing transportation network
5. Provides operations and maintenance cost estimates
6. Develops detailed deployment cost estimates for the phased deployment of ITS strategies


7. Employs Systems Engineering Best Practices and the *Systems Engineering Guidebook for ITS*.
8. Provides an evaluation of the City's existing QuicNet/4 traffic signal control system and assess the suitability of this system based upon functional requirements and user needs.
9. Develops a Concept of Operations to ensure the ITS Master Plan meets the City's current and future transportation management needs.
10. Addresses systems integration to support multijurisdictional coordination with additional City and regional stakeholders including Oxnard Police, Ventura County, neighboring cities, as well as other stakeholders including heavy rail, transit rail (Metrolink) and bus transit
11. Complies with and becomes part of the adopted SCAG Regional ITS Architecture
12. Addresses the need for traveler information to the end user, the general public.

Below is an initial listing of the project stakeholders, their roles and responsibilities on this project, and key staff identified from each entity. For this version of the SEMP, the list of stakeholders is preliminary based on discussions with City staff. The list of stakeholders will be refined to identify stakeholder contact person and level of involvement for each stakeholder in the project. Once the stakeholder list is formalized, it is recommended that this group meet regularly at critical points of the project. Furthermore, since this ITS Master Plan is intended to be a living document, this stakeholder list will need to be assessed and updated each time the Plan is updated.

| ID | Stakeholder | Key Contacts | Role | Interest in Project |
|---|---|---|---|---|
| 1 | Oxnard Public Works – Traffic | Edgar Hipolito 805.385.7869<br>Jason Samonte 805.385.7872<br>Soher Abdelmalik 805.385.7873 | Traffic management and public safety | • Develop ITS Master Plan<br>• Implement ITS strategies to improve traffic management |
| 2 | Oxnard Public Works – Capital Projects | Dan Rydberg 805.385.8055 | Manage Oxnard Capital Projects | • Coordinate capital projects with ITS deployments<br>• Shared cost of construction<br>• Shared use of communications |
| 3 | Oxnard Public Works – Maintenance | Jim Whiting 805.385.8083 | Maintain City facilities | • Provide input into ITS deployments<br>• Maintain ITS deployments |
| 4 | Oxnard Public Works – Transportation | Martin Erickson 805.385.7870 | Liaison with transit operators | • Coordinate with SCAT for transit applications of Oxnard ITS |
| 5 | Oxnard Police | Tom Cronister 805.385.7756<br>Scott Swenson 805.385.8211 | Public safety | • Emergency signal pre-emption<br>• Access to traffic conditions<br>• Share video surveillance |
| 6 | Oxnard Fire | Gary Sugich 805.385.7720 | Public safety | • Emergency signal pre-emption<br>• Access to traffic conditions |


| ID | Stakeholder | Key Contacts | Role | Interest in Project |
|---|---|---|---|---|
| 7 | Oxnard IS | Tom Clock<br>805.385.7558 | Manage computer technologies (i.e. hardware and software) throughout the City. | • Hardware and software maintenance<br>• Compatibility with City LAN<br>• Shared use of communications |
| 8 | Oxnard GIS | David Endelman<br>805385.8205 | Manage City GIS files | • Ensure GIS work conforms with City standards |
| 9 | Oxnard Public Works – Capital Projects (Water) | Juan Moreno<br>805.385.8141 | Maintain City water system | • Possible shared communications |
| 10 | Oxnard Public Works – Capital Projects (Wastewater) | Thien Ng<br>805.432.3575 | Maintain City wastewater system | • Possible shared communications |
| 11 | Oxnard Public Works – Outreach | Rodrigo Paniagua<br>805.385.8154 | Public Outreach | • Coordinate with general public<br>• Coordinate with local businesses |
| 12 | FHWA | Ed Fok<br>415.744.0113<br>Jesse Glazer<br>213-202-3955 | Project oversight | • Ensure project adheres to Systems Engineering Guidelines<br>• Project oversight<br>• Technical support |
| 13 | VCTC | Steve DeGeorge<br>805.642.1591 x103 | Maintain Regional ITS Architecture | • Incorporate Oxnard ITS into the next revision of the Regional ITS Architecture |
| 14 | Caltrans | Ray Ceriaco<br>213.897.8445<br>Andrew Steel<br>213.897.4562<br>Ali Peykanu<br>213.897.0249 | Traffic management and public safety | • Coordinated operation of Caltrans and City signals<br>• Shared communications<br>• Multijurisdictional traffic management |
| 15 | Ventura County | Nazir Lalani<br>805.654.2080 | Traffic management and public safety | • Coordinated operation of County and City signals<br>• Shared communications<br>• Multijurisdictional traffic management |
| 16 | SCAT (transit) | John Murdoch<br>805.483.3959 | City wide bus service | • Transit signal priority<br>• Transit information dissemination |
| 17 | City of Port Hueneme | Andy Santa Maria<br>805.986.6568 | Traffic management and public safety | • Coordinated operation of Oxnard and Port Hueneme signals<br>• Shared communications<br>• Multijurisdictional traffic management |
| 18 | Union Pacific Railroad | Patrick Kerr<br>916.789.6334 | Railroad operations | • Coordinate rail operations with Oxnard ITS for improved grade crossing safety and operations |


| ID | Stakeholder | Key Contacts | Role | Interest in Project |
|---|---|---|---|---|
| 19 | Ventura County Railroad | Judy Cofer 805.488.3677 | Railroad operations | • Coordinate rail operations with Oxnard ITS for improved grade crossing safety and operations |
| 20 | Ventura County Harbor | (To be named) | Manages Channel Island Harbor | • Homeland Security |
| 21 | Port Authority | Pete Wallace Chris Birkelo 805.488.3677 | Manages Port Hueneme | • Homeland Security |
| 22 | Airport Authority | Tad Dougherty 805.382.3024 | Operates Oxnard Airport | • Traveler information<br>• Homeland Security |
| 23 | Iteris | Scott Carlson 714.780.7109 | SEMP development consultant | • Assisting City of Oxnard in its preparation of a successful ITS Master Plan |

To date, the following meetings have taken place:

| Meeting | Date | Attendees |
|---|---|---|
| Pre kick-off meeting | July 20,2006 | (1.) Edgar Hipolito – Oxnard<br>(1.) Jason Samonte – Oxnard<br>(1.) Soher Abdelmalik - Oxnard<br>(23.) Scott Carlson – Iteris |
| Outreach Meeting 1 | Sept. 12, 2006 | Various project stakeholders |
| Outreach Meeting 2 | Nov. 21, 2006 | Various project stakeholders |
| Caltrans and VCTC Meeting | Mar. 6, 2007 | Oxnard, VCTC, Caltrans and Iteris |
| Deployment Strategy | Jan. 30, 2008 | Oxnard, Iteris |
| | | |

The role of the system engineer, The Iteris Team, on the project will be to assist the City in the development of a SEMP (this document) which will serve as a framework for the development of the Oxnard ITS Master Plan. Once the SEMP is completed and in place, a Concept of Operations, Systems Requirements, Verification Plan, and Strategic Deployment Plan will be developed that will ultimately result in an detailed, long-term ITS deployment plan for the City of Oxnard, as well as a recommended Pilot Project (Phase I) that will be the initial deployment.

Based on the system requirements developed as part of the ITS Master Plan, the City may elect to procure a new traffic signal system. If appropriate, the System Vendor that is selected for the new traffic signal system, will provide the necessary hardware (i.e. desktop, servers, etc), installation support, and training for the new traffic signal system. The details of this work effort (deployment plan, integration plan, etc) will be dependent on the system that is selected.


# 3.0 TECHNICAL PLANNING AND CONTROL

The following section lays out the plan for the systems engineering activities.

## 3.1 WORK BREAKDOWN STRUCTURE (WBS)

The major activities identified to develop the ITS Master Plan are listed below. It also includes inputs and deliverables required to complete the work. The WBS corresponds with Iteris' scope of work per the contract with the City.

**WBS CITY: Select and Contract with a System Engineer**
The City of Oxnard prepared a Request for Proposals (RFP), which included a description of the required scope of work, for the development of the ITS Master Plan. Iteris, Inc. (system engineer) was selected and a contract negotiated. Work by the system engineer commenced July 17, 2006. This first element of the WBS is completed.

The following WBS activities are associated with the tasks to be completed by Iteris, the City's contracted System Engineer.

**WBS 0: Project Management**
The system engineer will conduct overall project management activities that will consist of preparation of monthly status reports and attendance at required meetings related to the Project. The objective of this task is to ensure an efficient and coordinated project development process, the delivery of a high quality product, and deployment of the project components within budget and on schedule.

**WBS 1: Prepare Systems Engineering Management Plan (SEMP)**
The system engineer will prepare and maintain the Systems Engineering Management Plan – this document. The SEMP will be a living document updated throughout this project (and beyond, as needed); this is Version 1.0 of the SEMP. A final SEMP will be prepared as the last deliverable for this project. City and FHWA staff will provide review of this document.

**WBS 2: Preliminary Data Collection**
The preliminary data collection, to be performed by the system engineer, will develop a database of all existing traffic infrastructure that will serve as the starting point for the preparation of the ITS Master Plan.

**WBS 3: Develop Concept of Operations**
The concept of operations to be developed by the system engineer, needs to answer the following questions: "Who?", "Why?", "What?", and "When?". Key aspects of the Concept of Operations will include the needs assessment, inventory of current systems, roles, operational scenarios, and responsibilities and necessary resources for the operations and maintenance of the elements of Oxnard ITS. There maybe high level functional requirement identified from the operational scenarios. These high level functional requirement should be use to validate systems deployed in Oxnard (answering the question: are these the right systems for Oxnard?).




The Concept of Operation will also serve as the beginning of the traceability process. Stakeholders envisioned to be including in the Concept of Operations including:

1. Oxnard Public Works
2. Oxnard Police
3. Oxnard Fire
4. Caltrans
5. SCAT (South Coast Area Transit)
6. Oxnard IT
7. Ventura County

**WBS 4: System Requirements and Verification Plan**

The system engineer along with City of Oxnard staff will identify and develop a list of essential and/or desirable requirements and functionalities that are preferred to be included in the functionality of the Oxnard ITS, including the traffic signal system. These requirements and functionalities will be determined through discussions, workshops and meetings with City staff and project stakeholders. These requirements and functionalities will not only include features the Oxnard ITS should provide in operating the signals, CCTV cameras, and other field devices, but also the user interface components that allow a user to efficiently utilize and operate the system. The verification plan developed will specify the test plan to prove that the system designed and deployed (the Oxnard ITS or elements thereof) meets the system requirements.

System requirements developed at this stage will be traceable to operational scenarios or any visionary level requirement identified in WBS 3. It should be expected that some level of revisiting WBS 3 maybe needed if amendments are needed to the documented operational scenario.

Noteworthy of the system requirements and functionalities is that this effort will aid in determining whether the City's existing traffic signal system meets the City's system requirements, or the City should select a new traffic signal system.

**WBS 5: Strategic Deployment Plan (SDP)**

All the activities of this project to develop the Oxnard ITS Master Plan will come together in this task. The preliminary data collection, Concept of Operations, and System Requirements and Verification Plan, will all be brought into the Oxnard ITS Master Plan document that details the Strategic Deployment Plan. The system engineer will develop this document that presents design alternatives as well as staging techniques to allow the City to achieve its final goal – deployment of various ITS strategies that meet the City's (and stakeholder's) short-term and long-term ITS needs and requirements. The SDP will include the following elements:

- Pilot Project
- Prioritization and phasing of improvements
- Critical Path Diagram
- Capital improvements and associated costs
- Operations and maintenance costs
- Potential funding sources
- Interagency coordination issues


- Multi-jurisdictional coordination issues
- Interaction with the Regional ITS Architecture

## 3.2 TECHNICAL PLANS

Specific technical plans necessary for the successful deployment of this project will be developed by the system engineer and included as sections of the SEMP and SDP. Each such technical plan will include details about the procedures and tools that will be used throughout the project. These plans include:

- Technical review plan – This plan is including as part of this SEMP. This plan will document the process for the review of each submittal for this project.
- System integration plan – This plan will be prepared in **WBS 5 Strategic Deployment Plan**. This plan will document the integration of the various systems to comprise the Oxnard ITS. This is envisioned to be a high-level plan as no custom software or hardware development is required.
- Verification plan – This plan will be prepared in **WBS 4 System Requirements and Verification Plan**. This plan will be written along with system requirements to prove that the system designed and deployed (the Oxnard ITS or elements thereof) meets the system requirements.
- Deployment plan – This plan will be prepared in **WBS 5 Strategic Deployment Plan**. In essence, this will be the Strategic Deployment Plan (ITS Master Plan) that details the phased deployment of ITS strategies.
- Operation & Maintenance (O&M) plan – This plan will be prepared in **WBS 5 Strategic Deployment Plan**. This plan will define actions to be taken by each stakeholder to ensure proper operation of the ITS system.
- Configuration Management (CM) plan – This plan is included as part of this SEMP. This plan will describe the system engineer's approach and methods to manage the configuration of the system's products and processes.
- **Risk management plan** – This plan is included as part of this SEMP. This plan addresses the processes for identifying, assessing, mitigating and managing the risks expected to encounter during the project's lifecycle, and the roles and responsibilities for risk management

## 3.3 TASK DELIVERABLES

Listed below are the deliverables to be prepared by the system engineer in association with this project. The deliverables are organized by WBS and deliverable number.

**WBS 0: Project Management**

Del 0: Meeting agendas and notes, progress reports, invoices and supplemental material as requested/required by City staff.

**WBS 1: Prepare Systems Engineering Management Plan**

Del 1.1 Draft Systems Engineering Management Plan
Del 1.2 Final Systems Engineering Management Plan


**WBS 2: Preliminary Data Collection**

- Del 2.1 Draft Existing Traffic Infrastructure Database
- Del 2.2 Final Existing Traffic Infrastructure Database

**WBS 3: Develop Concept of Operations**

- Del 3.1 Draft Stakeholder Needs
- Del 3.2 Final Stakeholder Needs
- Del 3.3 Draft Concept of Operations
- Del 3.4 Final Concept of Operations

**WBS 4: System Requirements and Verification Plan**

- Del 4.1 Draft System Requirements Documentation
- Del 4.2 Final System Requirements Documentation
- Del 4.3 Draft Traceability Matrix
- Del 4.4 Final Traceability Matrix
- Del 4.5 Draft Verification Plan
- Del 4.6 Final Verification Plan

**WBS 5: Strategic Deployment Plan**

- Del 5.1 Draft Oxnard ITS Master Plan that includes the Strategic Deployment Plan
- Del 5.2 Final Oxnard ITS Master Plan that includes the Strategic Deployment Plan

## 3.4 CONTROL GATES

Control gates represent critical activities that must be satisfactorily completed before a task is considered completed. **Table 1** provides a list of those critical activities and which stakeholder can provide its approval.


**Table 1**
**Control Gates**

| Critical Activity | Deliverable | To be Completed By | Approval of Completion | Prerequisite(s) |
|---|---|---|---|---|
| Select and Contract with a System Engineer | Selection of System Engineer | City | City & System Engineer | Funding |
| Prepare Systems Engineering Management Plan | SEMP | System Engineer | City & FHWA | Hiring of SE |
| Preliminary Data Collection | Traffic Infrastructure Database | System Engineer | City | Draft SEMP |
| Develop Concept of Operations | Stakeholder Needs<br>Concept of Operations | System Engineer | City & FHWA | SEMP |
| System Requirements | System Requirements<br>Final Traceability Matrix<br>Final Verification Plan | System Engineer | City & FHWA | Concept of Operations |
| Strategic Deployment Plan | Final Master Plan | System Engineer | City & FHWA | System Requirements and Verification Plan |

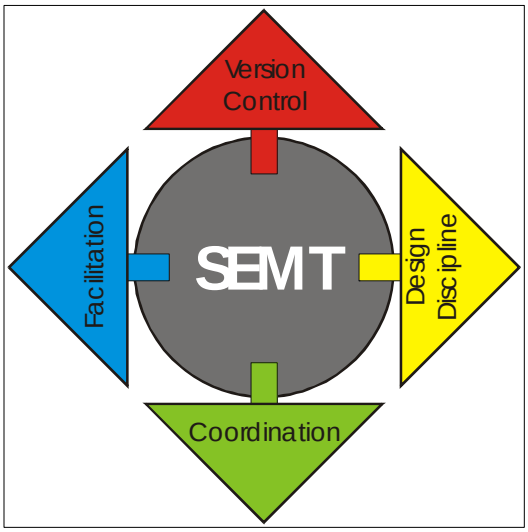

## 3.5 RESOURCES

The following is a summary of the resources needed for each task in the WBS including lead organization, level of effort and the technical expertise required the complete the task.

| Task | Organization | Level of Effort (hours) | Technical Expertise Required |
|---|---|---|---|
| WBS CITY: Select and Contract with System Engineer | City | 50 | City professional services contracting |
| WBS 0: Project Management | System Engineer | 76 | Systems engineering and ITS expertise |
| WBS 1: Prepare Systems Engineering Management Plan | System Engineer | 101 | Systems engineering and ITS expertise |
| WBS 2: Preliminary Data Collection | System Engineer | 235 | Systems engineering and ITS expertise |
| WBS 3: Develop Concept of Operations | System Engineer | 244 | Systems engineering and ITS expertise |
| WBS 4: System Requirements and Verification Plan | System Engineer | 200 | Systems engineering and ITS expertise |
| WBS 5: Strategic Deployment Plan | System Engineer | 287 | Systems engineering and ITS expertise |

In summary, The City of Oxnard is responsible for selecting and hiring the system engineer (the Iteris Team was selected for this work) and the system engineer will be responsible for systems engineering and ITS planning activities identified in this plan to develop the Oxnard ITS Master Plan. This activity, in concert with the City's responsibilities, form the Systems Engineering Management Team (SEMT). The SEMT performs all the system engineering activities required to define and control the ITS requirements and system specifications as defined by the project stakeholders. Activities include:

- Establish, document and maintain documentation standards and provide advice and example model texts for any documentation required during the system life cycle phases;
- Prepare reports on the status of the project systems, subsystems, standards, plans, and procedures;
- Review and audit products and processes as and when necessary for conformance to SEMP and to project requirements;
- Agree upon the user format, content, and standard of the documentation to be prepared for the project;
- Provide information on amendments and change proposals to contractual identified specifications and standards and their impact to the project if accepted or not accepted;
- Identify procedures for statistical methods and techniques required for establishing, controlling and verifying the process and products.




## 3.6 SCHEDULE

The SEMP project has been divided into six tasks. To ensure that the project objectives and requirements are being met, each task requires one or more deliverable submittals. The project schedule was derived based on the time required to complete the various tasks, the relationships between tasks, and Iteris' proposed schedule with the City. The project schedule


will be updated and maintained on a monthly basis. MS Project will be used to develop and maintain the project schedule.

## 3.4 PROJECT SPECIFIC TECHNICAL PLANS

The ITS Master Plan developed pursuant to this project will provide the City with a long-term deployment plan to implement ITS strategies over time as funding becomes available. As part of the initial steps of this project, the system engineer will develop a set of ITS needs and requirements that will aid developing an ITS deployment strategy. This section details the technical plans that will aid in the development of the Oxnard ITS Master Plan.

### *3.4.1 Technical Review Plan*

The development of the Oxnard ITS Master Plan will require the review of a number of technical documents. **Table 1** in **Section 3.2, Control Gates**, provides a summary of the deliverables and the entity responsible for conducting the review.

In support of the development of the technical documents, the system engineer will develop the technical documents, the City and FHWA (as appropriate) will provide comments, and the system engineer will be responsible for responding to and incorporating appropriate changes arising from the comments on the following technical submittals:

- Draft Systems Engineering Management Plan
- Draft Existing Traffic Infrastructure Database
- Draft Stakeholder Needs Technical Memorandum
- Draft Concept of Operations
- Draft System Requirements Documentation
- Draft Traceability Matrix
- Draft Verification Plan
- Draft Oxnard ITS Master Plan that includes the Strategic Deployment Plan

### *3.4.2 Systems Integration Plan*

As previously mentioned, the Oxnard ITS Master Plan will detail the staged deployment of ITS strategies over the long-term. It is envisioned that several ITS strategies may be employed, such as a replacement or upgraded traffic signal system (central software and controllers), CCTV cameras, and dynamic message signs (DMS). Additionally, it is envisioned that the Oxnard ITS will be multijurisdictional in nature, such as shared operation of traffic signal controllers and shared incident and traveler information data.

The Systems Integration Plan, prepared by the System Engineer as part of the Strategic Deployment Plan in **WBS 5 Strategic Deployment Plan**, will detail how the various ITS strategies, both City of Oxnard elements as well as other stakeholder elements, will be integrated to compose the Oxnard ITS.


### *3.4.3 Verification Plan*

A key element of the ITS systems engineering process is requirements traceability, ensuring that the functionality and operation of the Oxnard ITS, and the components thereof, meet the City's needs, objectives, requirements and project constraints. The requirements traceability matrix is the primary tool that will be used to map requirements to subsystems, configuration items, and functional areas. The requirements traceability matrix will at a minimum contain the user requirements, system components that fulfill the user requirements, budget status, system and requirements analysis, and a description of the resulting deliverables.

Once the system requirements are developed, the system engineer will develop a verification plan, as part of **WBS 4 System Requirements and Verification Plan**, to review and accept the deployment of the ITS strategies. This plan will include the verification of the ITS strategies.

***Requirements Baseline Validation***
Validating the requirements established from the requirements analysis will vary depending on the ITS strategies deployed. Because the systems being selected will be deployed in phases, the requirements baseline validation will be conducted as the ITS strategies are deployed when each phase's funding becomes available. The requirements baseline validation will address what, how well, and under what conditions the ITS strategy will perform a given outcome. ,

***Functional Verification***
The functional verification will be conducted in the same manner as the requirements baseline validation. Because the systems being selected will be deployed in phases, the functional verification will be conducted (with validation following) as the ITS strategies are deployed when each phase's funding becomes available. The functional verification process will confirm if the system (ITS deployment) does what it is supposed to do.

After the user needs and requirements have been developed, the system engineer will prepare the Verification Plan, which identifies acceptable procedures for verification (acceptance testing) of each system requirement. The four methods of verification will be inspection, demonstration, analysis, or test. Test cases will be identified based on the concept of operations. The stakeholders will review the Verification Plan. Based on the Verification Plan, a detailed acceptance plan will have to be prepared as part of a future project to deploy systems as detailed in the Oxnard ITS Master Plan.

### *3.4.4 Deployment Plan*

The Deployment Plan will be the main focus of the Oxnard ITS Master Plan, as developed in **WBS 5 Strategic Deployment Plan**. It is envisioned that the deployment of ITS strategies will occur in phases as incremental funding becomes available. The details of the ITS deployments, including what will be deployed (scheduling, training, stakeholders, etc.), will be developed based on user needs and requirements, construction costs, etc. The City can then use the deployment plan to program future ITS projects.


*ITS Field Elements*

The deployment plan will detail the type, location and quantity of field elements (traffic signal controllers, CCTV cameras, system detection, DMS, etc.), to be deployed. The deployment plan will order the improvements in priority order of needed ITS elements and systems, suitable for developing a multi-step implementation that logically builds improvements by phases.

*Communication System(s)*

Another important aspect of the Oxnard ITS Master Plan will be the data communication system or systems that will support the ITS field elements, and possibly other City-facilities. These communication systems, which includes the conduit, pull boxes, cable, communications hardware, typically represent the single most expensive component of any ITS. It is critical to reuse and integrate any existing infrastructure into the final communications systems to the maximum extent possible. The System Engineer will collect the existing conditions as part of WBS 2. The deployment plan will identify the detailed deployment of the communication systems including typical conditions of existing infrastructure (conduit, pull boxes, etc.) that can be utilized as a construction cost-savings and/or time-savings measure.

*Stakeholders and Multijurisdictional Requirements*

The Oxnard ITS is envisioned to be a multijurisdictional system that provides an interface between the Oxnard ITS field elements and elements owned and/or operated by other stakeholder agencies. For example, it is envisioned that the Oxnard and Caltrans will coordinate operation of each agency's respective signalized intersections in the Oxnard region. This type of coordinated operation of ITS field elements will require specific coordination activities such as the preparation of Cooperation Agreements or Memorandums of Understanding (MOUs) to ensure details of the coordinated operations, roles and responsibilities, etc. The Deployment Plan will identify the stakeholders and required supporting activities for each such multijurisdictional deployment.

*Pilot Project*

Currently, the City's traffic management capabilities include a QuicNet/4 traffic signal system that supports some but not all of the City's traffic signal controllers via dial-up telephone drop communications. The Oxnard ITS Master Plan will detail the phased deployment of new technologies that will include CCTV cameras, system detectors, coordination with stakeholder agencies, and may include a new or upgraded traffic signal system. This will represent a dynamic change in the City's traffic management capabilities. This will also require a significant financial commitment by the City, both for capital equipment expenditures and for adequate staffing to appropriately operate and manage the traffic management resource.

In an effort to manage the transition to the operations and maintenance of the ITS strategies envisioned for the Oxnard ITS, one output of the ITS Strategic Plan will likely be a Pilot Project that details a small-scale initial deployment. The purpose of the Pilot Project would be to pick a corridor or corridors to deploy new ITS strategies and evaluate the effectiveness of the deployments prior to conducting a more wide-scale deployment.

It is important to note that the pilot project will be separate and distinct from the ITS Strategic Plan and that the requirements of the Pilot Project will be separate from those of the ITS Strategic Plan.


### *3.4.5 Operations and Maintenance Plan*

The City currently has a number of field devices (traffic signal controllers) deployed throughout the City, some of which are supported by the City's QuicNet/4 traffic signal system. It is envisioned that additional field elements will be deployed to supplement and/or replace the existing elements. Any new systems to be deployed will be COTS hardware and software, and ideally, the additional equipment will be compatible with the existing elements and City staff will be familiar with their operation and maintenance.

The Operations and Maintenance Plan, prepared by the System Engineer as part of the Strategic Deployment Plan in **WBS 5 Strategic Deployment Plan**, will detail the necessary operations and maintenance requirements to support the ITS strategies deployed as part of the ITS Master Plan.

### *3.4.7 Configuration Management Plan*

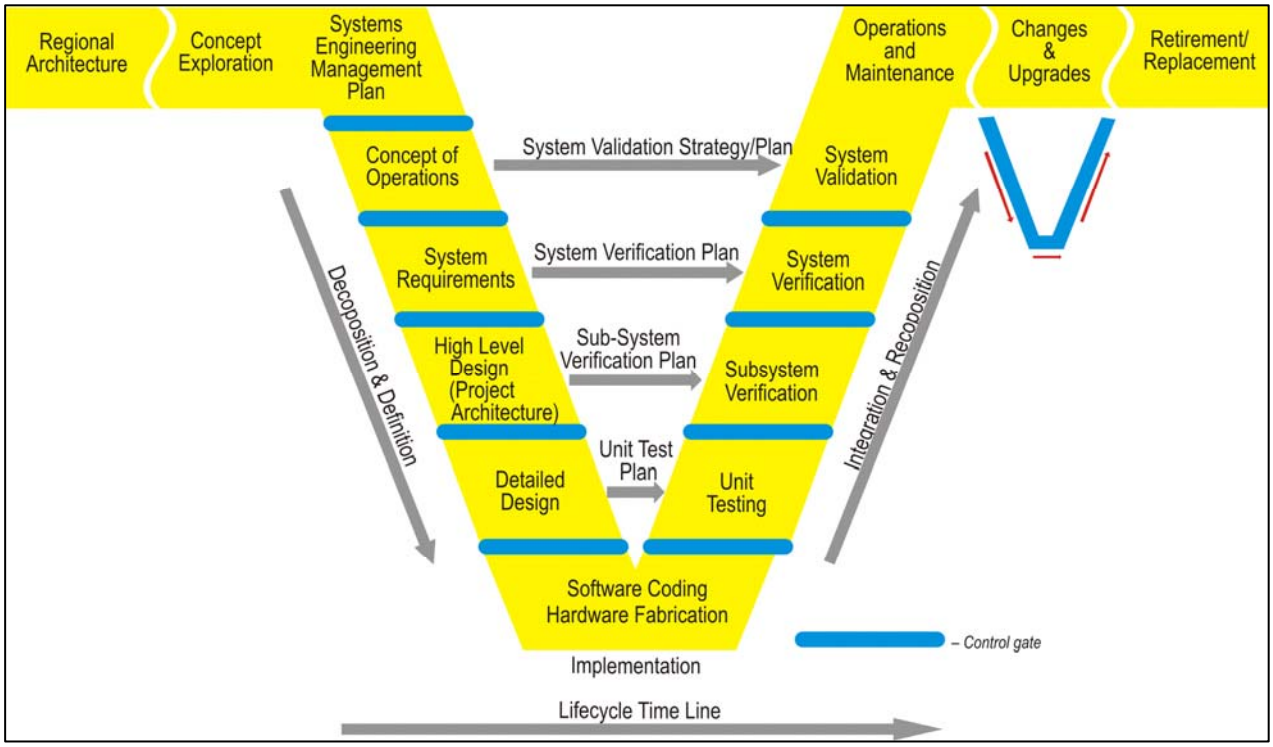
Through the course of the project, the amount of information collected and analyzed will require an information repository to ensure no data are lost. This project will have an electronic repository with scanned documents in PDF form for both documents prepared as part of this project as well as any information provided by the involved agencies. Any analysis conducted will also be filed in the repository for quick reference and back traceability.

### *3.4.8 Risk Management Plan*

There are no safety risks foreseen associated with planning the deployment of new ITS strategies in the Oxnard region. This project will detail the phased deployment of ITS strategies based on the City's traffic management needs and requirements. The City will use the Oxnard ITS Master Plan as a tool to secure funding for projects and coordinate the deployment of ITS strategies with other City projects as a cost savings measure. For example, the Oxnard ITS Master Plan is envisioned to include routing of new fiber optic cable and conduit along key arterial corridors. The Oxnard Capital Projects department maintains a 5-year plan for capital project that may include roadway improvement projects that parallel the routing of new fiber optic cable and conduit. Early identification of this overlap in projects would allow the City to possibly include the new conduit and fiber as part of the capital project, allowing the City to reduce construction costs compared with conducting the projects separately. No RMP is therefore needed, and this task is complete without content in this technical plan item.

## 4.0 SYSTEMS ENGINEERING PROCESS

The most significant objective of the systems engineering process is to ensure that the ITS Master Plan details a deployment strategy that meets the City's long-term needs while adhering the ITS Regional Architecture principles of Systems Engineering. To meet this objective, the systems engineering process, as noted in the Vee diagram below, is utilized to minimize changes to the Master Plan once it has been completed. As an example, the Concept of Operations will identify the overall operational features of the Oxnard ITS, followed by development of the system requirements and detailed design, and implementation. This goal is accomplished by ensuring that all relevant concerns have been included in the overall design process and at the right time.




The system engineer's approach to the application of the SEP is to identify ITS deployment stakeholders, determine their needs, and follow a logical process in defining a system architecture and functional design that can be reviewed and verified to meet stakeholder needs. The key concept in this approach is to identify system requirements, track the requirements to ensure they link to the stakeholder needs, and then verify that the requirements have been satisfied by the installed system.

### 4.1 CONCEPT OF OPERATIONS

In developing the Concept of Operations, it is imperative that all activities are focused on the views from the stakeholders' perspectives. This is the most critical step in developing a successful ITS Master Plan for the City of Oxnard as it establishes the blueprint for everything




that will be deployed. The Oxnard ITS Concept of Operations needs to answer the following questions: "Who?", "Why?", "What?", and "When?". The answer to "How?" is addressed in the subsequent steps to the development process (System Requirements and Strategic Deployment Plan). Arriving at these answers might require several iterations through the process as new stakeholders and operational scenarios are developed.

Key aspects of the Concept of Operations will include the needs assessment, inventory of current systems, roles and responsibilities and necessary resources for the operations and maintenance of the elements of Oxnard ITS. Each of these aspects is discussed further below.

*Identify Project Stakeholders ("Who")*

The Concept of Operations process needs to begin by identifying who will be the project stakeholders. This process needs to identify the various City departments and other agencies who will become system stakeholders, and potential roles and representatives for each stakeholder. For a City such as Oxnard, participants in the system may include Police, Fire, Information Services, GIS, transportation planners, commuters, emergency responders, and transit users to name a few, in addition to outside agencies including Ventura County and Caltrans. The system engineer will work with the City to update the stakeholder list to include the potential stakeholders, which will be used to develop workshops and outreach activities to promote stakeholder participation. The system engineer will use the ITS Regional Architecture along with our extensive knowledge of the ITS systems in the area to complete this identification process.

*Define Vision Statement ("Why")*

The Concept of Operations process continues with the development of the Vision Statement for the Oxnard ITS. Simply put, the vision statement should serve as the key guideline(s) for why an ITS is required for the City of Oxnard. The Vision Statement will clearly link the ITS deployment strategies with transportation policies. The system engineer will conduct a workshop with the stakeholders to formally define the Vision Statement for the Oxnard ITS and to begin defining the principal goals for realizing this vision. These goals will be the foundation upon which the Concept of Operation is structured.

*Develop User Scenarios ("What")*

The Concept of Operations process continues with the development of the User Scenarios for the Oxnard ITS. The User Scenarios are constructed to map how stakeholders might be involved in the Oxnard ITS, essentially forming the needs assessment. For example, a scenario will likely be developed that demonstrates how a commuter might use the Oxnard ITS to access real-time traffic conditions in order to improve (shorten) a commute. To support this User Scenario, the Oxnard ITS will be *required* to collect traffic conditions (speed, accidents, construction), which may include not only the City's arterials but also freeway conditions, and then process that information into the type of data requested by the Police. The user scenario will also define how the Police receive this information. In this case it might be via a dedicated workstation at the Police station. These types of scenarios will have an impact on the ultimate requirements of the Oxnard ITS. Therefore, it is critical to define the features / functionality early on in the development process to allow for applications and investments to be leveraged to benefit the greatest number of users. Different concepts for achieving the vision and




satisfying the user needs based on the user scenarios will be developed. It is extremely important to document these Scenarios from the view point of the ***User***. In the example of the commuter cited above, the relevant scenario needs to be described as viewed by the commuter. I would not be afraid to use the first person in such scenarios.

*Specify Roles and Responsibilities ("Who")*

The Concept of Operations process continues with the specification of roles and responsibilities for the various stakeholders in the Oxnard ITS. The User Scenarios will demonstrate what information and resources are required. This portion of the Concept of Operations will translate those needs into specific roles and responsibilities for stakeholders. This will include the provision of specific information, staffing and funding requirements, configuration management requirements, marketing needs, and infrastructure maintenance requirements to name a few.

In addition to being highlighted in the User Scenarios, the Regional ITS Architecture may already have identified the various agreements that would be required to support and continue maintenance of such an operation. These agreements will be identified in the Concept of Operations and required implementation steps to finalize these agreements will be included.

*Determine Implementation Schedule ("When")*

The Concept of Operations should conclude with a high level implementation schedule that identifies what capabilities are needed to support the user scenarios and the timeframe for these enhancements. The system engineer will work with the City and identified stakeholders to identify current implementation plans as well as specific plans associated with the development of the various phases of the Oxnard ITS, as will be detailed in the ITS Master Plan. The Concept of Operations will identify logical deployment increments and the timing of those deployments to support the various operational scenarios, which will feed into the phases of the ITS Master Plan.

The system engineer will conduct a series of workshops to support the development of the Concept of Operations, and the overall project, as well as maintain a project website for posting of project information. This will be essential to encouraging participation by the project stakeholders. It is envisioned that some key stakeholders involved in these workshops will include the City's traffic engineering staff, Caltrans, and Ventura County, as well as other City departments including Oxnard Police, Fire, IS and Public Works. These other City departments have key resources that may be made available to support the Oxnard ITS. Additionally, these City departments will likely become stakeholders of the Oxnard ITS, making use of (among other things) the vital, real time traffic information that will be collected by the Oxnard ITS.

Also needs to be identified during the ConOps development process are **what, if any, limits to the vision**. This can be tricky to do in the stakeholder meeting since on one hand we want them to stretch the limit of their imagination while at the same time identifying the 'edges of the cliff'. But if successful, this will help with: Early Identification of legacy issues, identify community and institutional limits on the level of risk acceptable, identification of any other intangibles that affects the limits of the Strategic Plan. Guidance to what the boundary conditions are will be very important when developing the requirement to reflect institutional limits and/or legacy issues.


## 4.2 SYSTEM REQUIREMENTS ANALYSIS

Upon approval of the Concept of Operations, the system engineer will begin the preparation of the System Requirements for the Oxnard ITS. In support of this task, Iteris will conduct individual telephone / videoconferencing interviews with the stakeholders. Prior to each interview, Iteris will provide the stakeholders with reading materials to prepare them and maximize their input. The information obtained from the interviews will be compiled into a technical memorandum to promote further discussion (workshop) as well as support the preparation of the system requirements.

In developing the requirements document, it is important to keep in mind that the requirements will not define how the system is to be built, but will describe what the system is to do (functionally), how well it is to perform (performance), and under what conditions (environmental and non-functional). Although the system requirements should be technology neutral, they must be consistent with policy elements. In essence, the systems requirements document will provide the technical scope of how the Oxnard ITS is to be built.

The Systems Analysis effort will be initiated with a review of the user needs that have been developed as part of the Concept of Operations. The system engineer will then develop the user requirements. This analysis will identify the system users' desired system operations and functions. The Concept of Operations will then be updated if additional needs are found that can be mapped to a scenario and user. This will ensure the traceability with the requirements. The user requirements will, at a minimum, address the following information:

- Data collection
- Future ITS elements
- Information exchange
- Level of control
- Modes of operation
- Security/access
- Inter-jurisdictional requirements
- O&M requirements
- Staffing and training requirements
- Cost requirements
- Data dissemination/public outreach

Based on the user requirements, the system engineer will develop the System Functional Requirements document, based on Section 7.5.6 of the Systems Engineering Guidebook. This will identify the system functional requirements as related to the user needs and requirements. The system functional requirements will address, at a minimum, the following requirements:

- Needs/requirements of existing systems
- System performance
- Equipment and technology
- Availability of technology
- Technology constrains
- Interoperability
- Expandability to provide additional ITS elements
- ITS Regional Architecture
- Implementation costs
- Operations
- Maintenance
- System Interface
- Existing infrastructure
- Reliability
- National and International Standards, such as National Transportation Communications for ITS Protocol (NTCIP) as required
- Scalability




A traceability matrix will also be developed to map the user needs and requirements to the system requirements. The system engineer will utilize a matrix that employs a common numbering method used throughout all project deliverables. The traceability matrix will trace requirements and the corresponding verification plan development in a format that will be readily utilized by the stakeholders for their reviews. Various softwares are available to develop and manage a traceability matrix, including *System Architect* by Popkin Software, *Access*, *Excel* and *SourceSafe*, all by Microsoft, and *Rose* by Rational. The System Manager proposes to use Excel for the Oxnard ITS Master Plan project.

As part of the development of the System Requirements, a Configuration Management (CM) Plan will be developed. It will be developed in conjunction with the system requirements and will document the CM Plan to be initiated at this stage. The CM Plan will establish the basic processes and methods to manage the configuration of the various elements of the system and sub-systems. Some of these elements include the identification, documentation and control of changes that occur throughout the life of the system. This CM Plan will be utilized as an input to the Verification Plan mainly as it relates to changing requirements and test plans accordingly. By setting the procedures for managing change control, the requirements and associated verifications can be approved and documented effectively to ensure that the stakeholder expectations are continuously checked and that the risks (non envisioned) are properly minimized for Oxnard ITS, from its initial deployment through its long-term use and eventual retirement and replacement.

***Verification Plan***

The verification plan is a critical element in ensuring that the system built meets the requirements specified and developed for the Oxnard ITS. The verification plan will specify the test plan to prove that the system designed and deployed (the Oxnard ITS or elements thereof) meets the system requirements. The verification plan will identify or define:

- How each of the requirements will be tested within the system and sub-systems, who will perform the testing, where the test will be performed, and what required items to perform as part of the test.
- What to do if the test fails.
- Verification the elements deployed for the ITS Strategic Plan are delivering the required benefits.

The verification plan will ensure traceability such that each system and sub-system requirement will have an associated test or tests, and each test will have an associated requirement or set of requirements. In addition, the verification plan will be developed such that realistic and doable tests are defined.

***System Analysis***

The system analysis will include both a trade-off analysis and a system/cost effectiveness analysis.

The trade-off analyses of various ITS strategies will be completed by the City and the system engineer and will be undertaken when developing the deployment plan. For example, several communication systems are available for ITS including fiber optics, twisted pair, spread


spectrum, WI-FI, etc. Based up on specific ITS strategies to be deployed, one or more alternatives may be viable, each with a set of benefits and risks, with the more suitable alternatives being recommended.

A system/cost effectiveness analysis will be developed for each deployment of the Oxnard ITS Master Plan, which will be based on a high-level cost estimate, to be used for planning purposes.


## 5.0 TRANSITIONING CRITICAL TECHNOLOGIES

The Oxnard ITS Master Plan will define ITS strategies to deploy based on the needs and requirements of the City of Oxnard and the other stakeholders. The ITS Master Plan will evaluate and make recommendations regarding hardware and systems to deploy. Additionally, it will be recommended that any future deployments will utilize COTS hardware and software that are compliant with industry accepted standards, and that no new or untested technologies for operation and maintenance (O&M) will be used for this system. However, the ITS Master Plan project itself will not involve the procurement or deployment of any hardware or software as part of this project.

## 6.0 INTEGRATION OF THE SYSTEM

The Oxnard ITS Master Plan will detail the deployment of various ITS strategies into one integrated (Oxnard ITS) system for an improved capacity for proactive and reactive management of traffic flow in and around the City of Oxnard. As noted in **Section 2**, numerous City departments and outside agencies have been identified as stakeholders in this project. It is envisioned that some stakeholders will be intimately involved in this project while others may have little (or no) involvement. Accordingly, it is intended that the Oxnard ITS Master Plan system be evaluated for future integration with other agencies.


## 7.0 INTEGRATION OF THE SYSTEMS ENGINEERING EFFORT

To ensure an efficient and coordinated project development process, and the delivery of a high quality product within budget and on schedule, Iteris has assembled a Systems Engineering Management Team (SEMT). The SEMT will be comprised of Iteris staff.

The project will be headed by Scott Carlson serving as Project Manager. Abbas Mohaddes and Marc Porter will serve as Senior Advisors on the project. Scott,. Abbas and Marc will be supported by other experienced engineers from Iteris who will assist in the development of the Oxnard ITS Master Plan. **Table 5** provides the proposed staffing table for the major tasks of the project.

**Table 5. Project Organization Chart**

| Task | Responsible Entity | Task Lead |
|---|---|---|
| Select and Contract with a System Engineer | City | City |
| Prepare Systems Engineering Management Plan | System Engineer | Scott Carlson |
| Preliminary Data Collection | System Engineer | Abi Mogharabi |
| Develop Concept of Operations | System Engineer | Ramin Massoumi |
| System Requirements | System Engineer | Marc Porter |
| Strategic Deployment Plan | System Engineer | Scott Carlson |


## 8.0 APPLICABLE DOCUMENTS AND REFERENCES

With any project, the success of the system is often dependant on following the correct standards and procedures (directive documents). A number of directive documents were used to create this document. The following documents and reference have been identified and will be utilized to aid in the development of the Oxnard ITS Master Plan and this SEMP:

- "Systems Engineering Guidebook for ITS" (PowerPoint Presentation)
  Frank Cechini – Federal Highway Administration

- Systems Engineering Guidebook for ITS, Version 1.1, February 14, 2005;
  Federal Highway Administration California Division
  California Department of Transportation Division of Research & Innovation

- IEEE Standard 1220-2005, Standard for Application and Management of the Systems Engineering Process;
  IEEE Computer Society; Approved December 8, 1998; revised September 9, 2005

- Ventura County Congestion Management Program, VCTC 1004/1005

- NTCIP – National Transportation Communications for ITS Protocol

- Caltrans Transportation Electrical Equipment Specifications (TEES)

- Caltrans TMC Standards and Specifications

- Caltrans Information Technology (IT) Deployment Plans and Standards

- Fiber Optics Communication System Design Guidelines

- City of Oxnard Design Standards

- City of Oxnard IT/IS Standards

- Caltrans CADD Users Manual

- Work Area Traffic Control Handbook ("WATCH manual");
  American Public Works Association (updated 2006).


## 9.0 ACRONYMS AND ABBREVIATION

| | |
|---|---|
| CADD | Computer Aided Design & Drafting |
| Caltrans | California Department of Transportation |
| CCTV | Closed Circuit Television Camera |
| CM | Configuration Management |
| COOP | Cooperation Agreement |
| COTS | Commercial off-the-shelf |
| DMS | Dynamic Message Sign |
| FHWA | Federal Highway Administration |
| IS | Information Services |
| IT | Information Technology |
| ITS | Intelligent Transportation System |
| MOU | Memorandum of Understanding |
| MS | Microsoft |
| NTCIP | National Transportation Communications for ITS Protocol |
| O&M | Operations and Maintenance |
| RFP | Request for Proposal |
| SCAT | South Coast Area Transit |
| SE | System Engineer |
| SEMP | Systems Engineering Management Plan |
| SEMT | Systems Engineering Management Team |
| SEP | Systems Engineering Process |
| TEES | Transportation Electrical Equipment Specifications (Caltrans) |
| TMC | Traffic Management Center |
| WATCH | Work Area Traffic Control Handbook |
| WBS | Work Breakdown Structure |