V2I Queue Advisory/Warning Applications: Concept and Design

PROJECT MANAGEMENT PLAN (PMP)—FINAL

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Contract #: VTCR 114420
TTI Maestro Project #: M1901702

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Submitted to:
University of Virginia Center for Transportation Studies
Connected Vehicle Pooled Fund Study
Draft: April 30, 2019
Final: June 25, 2019

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DETAILED PROJECT PLAN

	Contract #: VTCR 114420	TTI Project #: 612141-00001	WBS #: 1.2
	Title: V2I Queue Advisory/Warning Applications: Concept and Design Project Management Plan (PMP) —Final		
	Document Date/revision Date: 6/25/2019		
Contract Start Date: 4/3/2019	Contract End Date: 10/2/2020	Appropriation:	

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Document Revision History

Document Version	Document Sections	Description of Changes	Date	Approval
1	All	Initial draft	4/30/2019	
1.1	All	Revised to respond to comments provided by the CV PFS Team on initial draft.	6/9/2019	
1.2	All	Final	6/25/2019	

Prepared by: Kevin Balke — 6/25/2019
Co-Principal Investigator — Date

Approved by: Geza Pesti — 6/25/2019
Principal Investigator — Date

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INTRODUCTION

This project is intended to investigate Vehicle to Infrastructure (V2I) Queue Advisory /Warning Applications: Concept and Design for the Connected Vehicle Pooled Fund Study (CV PFS) entitled *Program to Support the Development and Deployment of Connected Vehicle Applications*. This CV PFS was created by a group of state, local, and international transportation agencies and the Federal Highway Administration (FHWA), with the Virginia Department of Transportation (VDOT) serving as the lead agency. The University of Virginia Center for Transportation Studies (UVA CTS) supports VDOT on the pooled fund study, serving as the technical and administrative lead for the effort, and manages all the projects on behalf of the CV PFS and the United States Department of Transportation (USDOT). The V2I Queue Advisory/Warning Applications: Concept and Design project is another collaborative effort between the CV PFS and USDOT.

Background

The USDOT Intelligent Transportation Systems Joint Program Office (ITS JPO) Vehicle-Infrastructure Program has been engaged in research of connected transportation systems. Part of this effort has focused on researching and prototyping applications to optimize the safety and mobility performance of the transportation network by integrating infrastructure-based technologies into connected systems. Under cooperative agreement with FHWA, the Crash Avoidance Metrics Partners, LLC (CAMP) V2I Consortium is developing and testing a prototype mechanism to enable Event-Driven Configuration Messaging (EDCM) that allows vehicle-based system to provide selective real-time data reports to infrastructure systems (traffic management centers), which can request enhanced details based on dynamic conditions and needs. In the current phase, CAMP is developing and prototyping EDCM applications for work zones, road weather hazards, and queue warning and advisories. USDOT expects this project to complement and interact with the CAMP EDCM project, particularly when dealing with queue warning and advisories. *The CAMP EDCM Project is expected to provide substantive input for this project from the vehicle perspective.*

Organization of Document

This document, the Project Management Plan, defines and describes the approach the TTI will use to successfully delivering the work products for the CV PFS project V2I Queue Warning/Advisory project. This PMP is a living document that governs the conduct of research and is developed, maintained, and updated under Task 1. Project Administration. This PMP establishes and identifies the environment in which the project will operate, and of all the participants in the project including management, responsible teams or organizations for each task, supporting organizations, and stakeholders. It supports the UVA CTS' and the TTI's common goals that all project deliverables are submitted on-time, within project budget, and within acceptable quality.

This document consists of the following plans:

Scope Management Plan—this plan identifies the overall scope of this project and TTI's approach to accomplishing this scope of work. This plan includes a work breakdown structure and list of deliverables for this project.

Project Schedule Management Plan —this plan identifies the process and procedures TTI will follow to monitor and control the schedule for this project. This plan includes the initial schedule for delivering the identified work products by the project team.

Cost Management Plan—this plan identifies the processes and procedures TTI will follow to monitor and control costs by the project team.

Communication Plan—this plan addresses the process and procedures that TTI will use to manage and control communications with the CV PFS team, the project sponsor, and external stakeholders. The plan also identifies how TTI plans to manage communications internal to the project team.

Quality Management Plan—this plan identifies the processes and procedures TTI will use to ensure the quality of deliverables and provides a means of scope verification.

Human Resource Management Plan—this plan identifies the processes and procedures TTI will follow to manage the human resources associated with this project. This plan also identifies a succession plan for key project staff personnel.

Risk Management Plan—this plan outlines the process and procedures TTI will follow to monitor, identify, assess, respond to and otherwise manage project risks. This plan also includes the initial risk register.

TTI will periodically review these plans and update them accordingly throughout this project.

SCOPE MANAGEMENT PLAN

This plan identifies the overall scope of this project and the Team's approach to accomplishing this scope of work.

Scope

The scope of the project is to perform systems engineering resulting in a high-level design for V2I Queue Advisory/Warning Applications using a variety of approaches for both the vehicle side and infrastructure agency [Infrastructure Owner/Operator (IOO)] side. The intent of this high-level design is to enable future development and testing efforts beyond this project. This project builds upon and is related to other prior (e.g., INFLO Q-WARN) and current (e.g., CAMP EDCM) efforts. This project is not intended to duplicate, but rather, enhance, broaden, and update the V2I Queue Advisory/Warning concept to reflect both EDCM variants as well as the rapidly evolving state of vehicle automation and connectivity.

The specific objectives of this project are as follows:

- To gather foundational stakeholder input and assess prior work to identify additional gaps and needs.
- To develop Concept of Operations and Use Cases that reflect the variations for both infrastructure-side and vehicle-side components.
- In conjunction with CAMP EDCM project (which will identify vehicle-side requirements), to develop system requirements for V2I Queue Advisory/Warning systems, and an integrated and validated set of requirements.
- To develop a high-level design that enables other efforts to conduct prototyping and testing activities.
- To coordinate with and review content from the CAMP EDCM project to maximize mutual understanding of vehicle and infrastructure perspectives and needs.

The scope of the project is limited to the conduct of systems engineering services for the development of a prototype V2I Queue Advisory/Warning applications. As part of the effort, TTI does not intend to develop, test, and deploy prototype applications in a controlled test environment or the field.

Work Breakdown Structure (WBS)

Figure 1 provides a Level 3 representation of the WBS defining the deliverables from this project. This WBS breaks the project activities down into technical work areas where specific deliverables and responsibilities can be assigned. A WBS Dictionary is included as Appendix A. The WBS and WBS Dictionary represent the required work products to be delivered under the executed the project agreement.

Table of Deliverables

Table 1 summarizes the deliverables for this project. Dates identified for each deliverable correspond to those shown in the detailed project WBS. TTI will update the deliverable table each month as part of the monthly progress reporting.

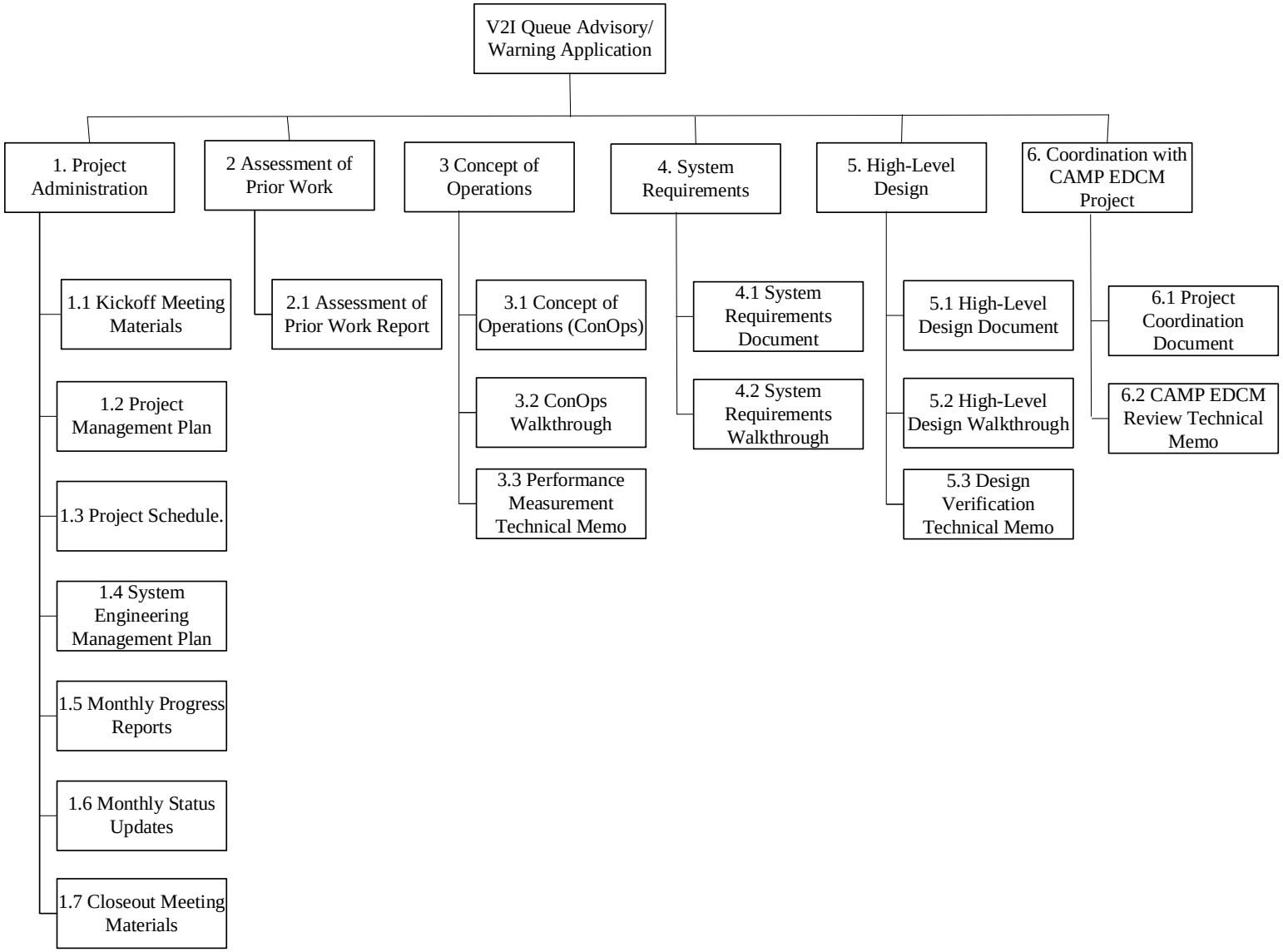

Figure 1. Work Breakdown Structure

Table 1. Deliverable Tables and Schedule

Period of Performance: 4/1/2019 through 9/30/2020						
Task and Deliverable Number	**Task Name and Deliverables**	**Format**	**Original Due Date***		**Actual Submittal Date**	
			Draft	**Final****	**Draft**	**Final****
1.1	Kick-off Meeting, Briefing Materials	PDF, PowerPoint	NA	4/23/2019		
1.2	Project Management Plan (PMP)	MS Word	5/7/2019	6/11/2019		
1.3	Project Schedule	MS Projects	5/7/2019	6/11/2019		
1.4	Systems Engineering Management Plan	MS Word	5/21/2019	6/25/2019		
1.5	Monthly Project Report	MS Word	NA	15th of Each Month		
1.6	Monthly Status Updates (includes meeting notes)	MS Word/OneNote	NA	Monthly		
1.7	Closeout Meeting, Project Closeout Summary	PDF, PowerPoint	NA	9/29/2020		
2.1	Assessment of Prior Work Technical Report	MS Word	7/23/2019	8/27/2019		
3.1	Concept of Operations	MS Word	10/8/2019	1/14/2020		
3.2	Concept of Operations Walkthrough	PDF, PowerPoint	NA	10/29/2019		
3.3	Performance Measurement Technical Memorandum	MS Word	12/24/2019	1/28/2020		
4.1	Systems Requirements Report	MS Word	3/3/2020	5/5/2020		
4.2	System Requirement Walkthrough Support Material	PDF, PowerPoint	NA	3/31/2020		
5.1	High-Level Design Document	MS Word	6/16/2020	8/11/2020		
5.2	High-Level Design Walkthrough Supporting Material	MS Word	NA	7/14/2020		

Period of Performance: 4/1/2019 through 9/30/2020						
Task and Deliverable Number	**Task Name and Deliverables**	**Format**	**Original Due Date***		**Actual Submittal Date**	
			Draft	**Final****	**Draft**	**Final****
5.3	Design Verification Technical Memorandum	MS Word	NA	9/1/2020		
6.1	Project Coordination Document	MS Word	NA	As Required		
6.2	CAMP EDCM Architecture and Data Framework Review Technical Memorandum	MS Word	NA	TBD		

* Assumes a Start Date of April 3, 2019

** Includes Comment Resolution Report, where Draft document was submitted

PROJECT SCHEDULE MANAGEMENT

This plan identifies the process and procedures TTI will follow to monitor and control the schedule for this project. This plan includes the initial schedule for delivering the work products identified in the scope of work.

Project Schedule

Figure 2 shows the proposed schedule for this project. Blue bar represent the work duration of individual work efforts within each task, while the red bar represent the total duration of Tasks. This schedule provides details concerning subtasks/work packages for this project consistent with the Work Breakdown Structure (WBS). The TTI Team will track the schedule using MS Project Schedule and update it monthly (provided separately). The schedule identifies schedule predecessors and successors, and clearly label and track the project critical path. TTI will provide the UVA CTS with a copy of the MS Project schedule file associated with this project. This schedule represents the baseline schedule for this project. For scheduling purposes, TTI has assumed a 10-working day review period between all draft and final deliverables. The review periods are shown in orange in Figure 2.

Schedule Control

TTI will actively monitor the status of project activities and provide monthly updates of project progress to the project director. As part of the monthly updates, TTI will estimate the percent completion for each work activity. The estimates of the task completion will be tracked compared to the schedule. Figure 3 provides an example of the method that TTI will use to track project completion.

Also, the PI will report the Schedule Variance to the project director. The Schedule Variance is computed by comparing the Earned Value (i.e., the percent estimated project completion multiplied by the allocated budget) to the Planned Value (i.e., the percent planned project completion multiplied by the allocated budget). If the schedule variance is positive, then the project is ahead of schedule. If the schedule variance is negative, then the project is behind schedule. Schedule variance will be reported monthly to the project director.

If the schedule variance shows the project has fallen behind schedule, the TTI PI and Co-PI will work with the project director to identify strategies to construct a schedule recovery plan. Potential strategies to be employed include the following:

- Reallocating resources to work activities behind schedule.
- Revalidate dependencies between work activities.
- Applying additional resources to work activities behind schedule or in the critical path.
- “Fast Track” work activities by executing them in parallel.
- Manage or change the scope of specific work activities.
- Improve or streamline work development processes.

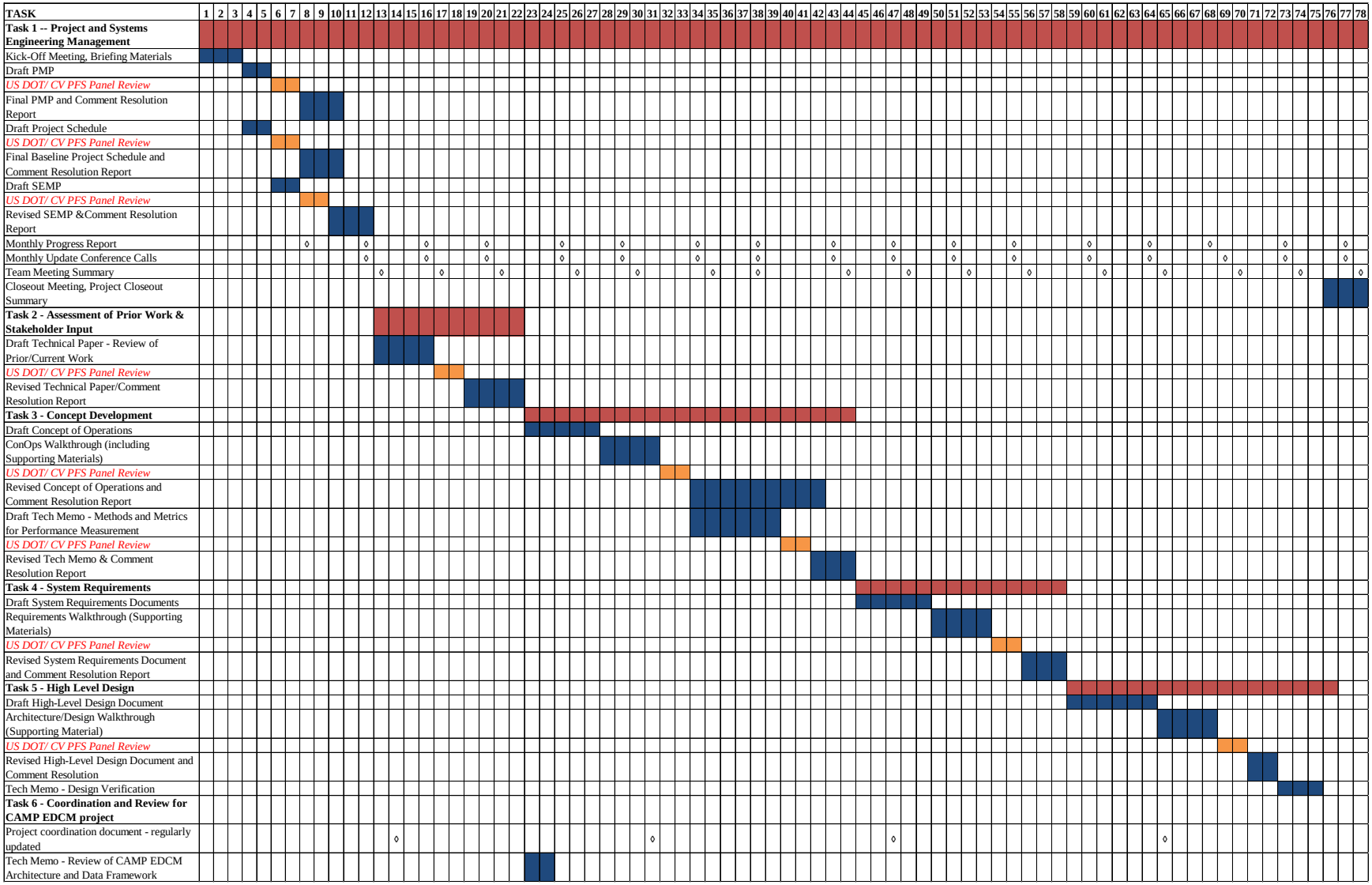

Figure 2. Baseline Project Schedule

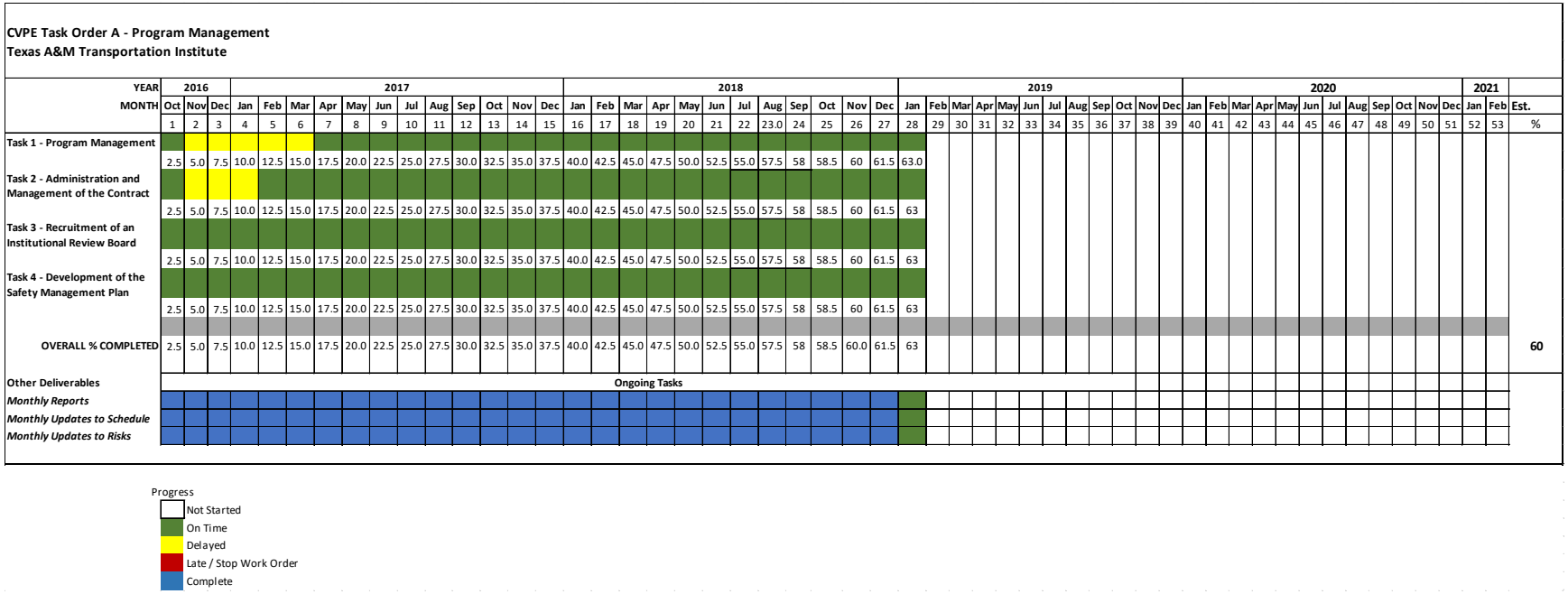

Figure 3. Sample Project Schedule Completion Tracking Chart.

COST MANAGEMENT PLAN

This plan identifies the processes and procedures TTI twill follow to monitor and control costs by the project team.

Monitoring Costs

TTI will use an Earned Value Management (EVM) approach to monitor and control costs. The EVM approach uses a combination of scope, schedule, and resource management to assess project performance and progress. Each month, the TTI project team will provide the project director with a cost management diagram, similar to that shown in Figure 4. This diagram will plot planned project expenditures, actual project expenditures, and earned value estimates. TTI will use the diagram to determine whether the project is over or under budget and ahead or behind schedule. In this example, because actual project expenditures are below planned project expenditures, the project is under budget. Also, because the earned value of the project is above the planned project expenditures, the project is ahead of schedule.

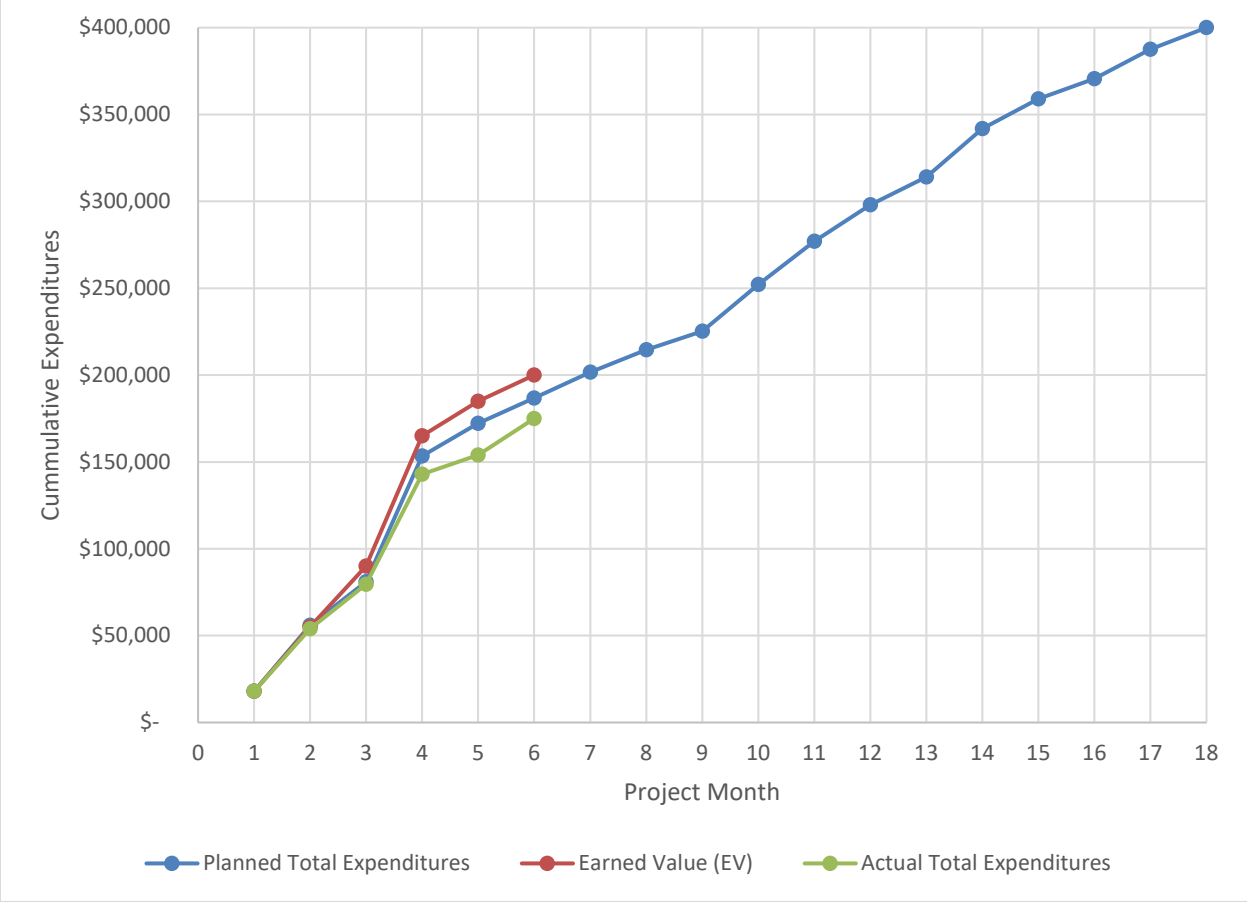

Figure 4. Example of Method for Monitoring Project Costs.

Controlling Costs

To control costs, the PI will employ the following strategies:

- Provide regular estimate at completion (EAC) forecasts. This effort involves forecasting the total amount of funds required to complete the project based at the current expenditure rate. This forecast assumes that future work is likely to be performed at the current rate, rather than the budgeted rate.
- Identify potential reduction in work scope.
- Reallocate work activities to individuals with lower rates.

Before taking any action, the PI and Co-PI will discuss potential cost-saving activities with the Project Director.

COMMUNICATIONS MANAGEMENT PLAN

This plan addresses the process and procedures that TTI will use to manage and control communications with the CV PFS team, the project sponsor, and external stakeholders. The plan also identifies how TTI plans to manage communications internal to the project team.

Communications with the CV PFS Project Team

The TTI Project Team will maintain good lines of communications with the CV PFS project team and the USDOT ITS JPO throughout the project. Figure 5 shows the lines of communications between the TTI, UVA, the CV PFS Project Advisory Panel, and the Crash Avoidance Metrics Partnership (CAMP) Event-Driven Configurable Messaging (EDCM) Project Team.

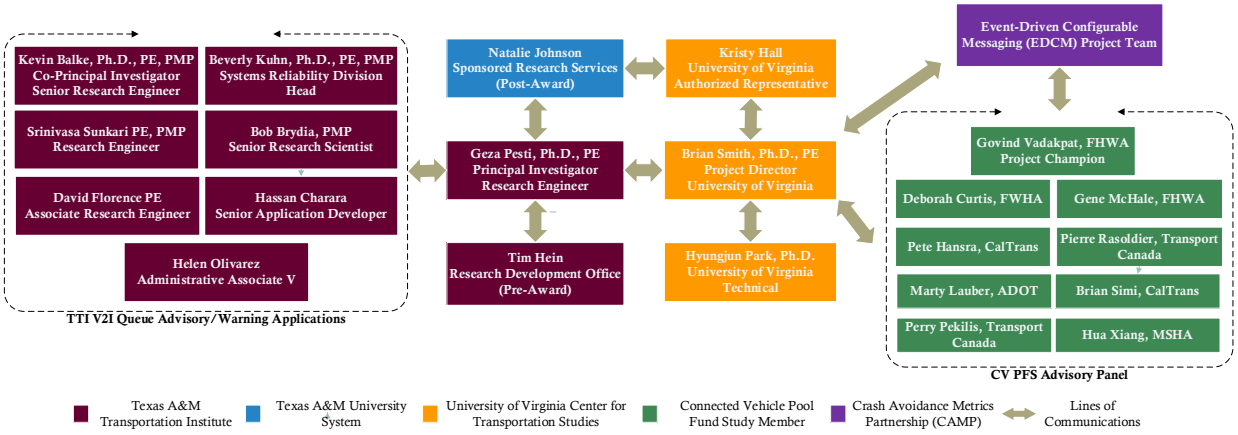

Figure 5. Internal Project Lines of Communications

TTI will submit monthly progress reports to the project director by the fifteenth working day of each month. The monthly progress reports will include cost, schedule, and performance information. The monthly progress reports will also include an update on the status of the deliverables (not initiated, in progress x% complete, draft delivered, in revision X% complete, final delivered, accepted), accomplishments, current risk register, and planned activities for the next month. Appendix B provides a template that TTI will use to submit monthly progress reports.

The project team will also meet monthly with the project director to discuss the status of the project and discuss findings of work activities. Other team members will also participate on an as-needed basis to discuss their ongoing work activities. The project team will conduct these monthly status report meetings via web-conferencing technology. The PI will be responsible for scheduling and disseminating information about the web-conference prior to the meeting and for initiating the web-conference at the agreed upon time. The PI will be responsible for preparing agendas, and presentation materials for the monthly meetings. The PI will distribute these items to the Pooled Fund Study team at least 1-day in advance of the meeting. The PI will also be responsible for disseminating notes from the meeting at least five working days after the meeting.

The project team will also participate in joint meetings and workshops with the CAMP EDCM project team to discuss and present interrelated portions of both projects, as needed and/or at the request of the Pooled Fund Study coordinator. Opportunities for coordination and collaboration with the CAMP EDCM project team include the following:

- System engineering walkthroughs in Task 3-5, locations to be determined.
- Three in-person meetings at CAMP in Novi, MI.
- One in-person meeting in Washington DC.
- Three in-person meetings at CV PFS regular meetings.

The PI and Co-PI will travel to all in-person meetings. Other project team members may attend in-person or via web-conference, depending on the availability of funds and the topics of discussion at these meetings.

Internal Communications

The PI and Co-PI will also hold internal bi-weekly status meeting with the project team. The purpose of the meetings is to discuss the status, results and findings of ongoing work activities and the plan the work activities and assignments for the following two-week period. The project team will use Agile Sprint concepts to manage work activities. The team will develop and track activities use a Trello board.

External Communications

The project team plans to pursue publishing papers dealing with the results and findings of this project. The project team agrees not to knowingly disclose proprietary information without the express written consent of the owner of that information. The project team agrees not to disclose, in whole or in part, any Proprietary Information to any third party for three years following termination of the project. TTI agrees to send a copy of any proposed publication thirty days in advance of submittal for presentation. The project team also agrees to delete proprietary information at the request of the CV PFS team, USDOT ITS JPO, or CAMP. The team also agrees to provide appropriate recognition to the project sponsors in any published article.

Coordination with and Review for CAMP EDCM Project

Communications and coordination with the CAMP EDCM project is a critical element of this project. To facilitate this coordination, the TTI Project Team will meet regularly with CAMP EDCM project representatives to discuss the projects' timelines and planned activities. Since there may be factors that result in variation from planned schedules, TTI will work with the CAMP EDCM to develop a project coordination document hat identifies upcoming planned interactions between the projects once the CAMP EDCM project begins. The TTI Team will regularly update this plan as needed to ensure that both projects have a common understanding of timelines.

The TTI Team also plans to participate in joint meetings and workshops with the CAMP EDCM project to discuss and present information and findings related to both projects. In

addition to the systems engineering walkthroughs in Tasks 3-5 (locations TBD), the TTI Team plans to participate in 3 in-person meetings at CAMP (in Metro Detroit Area – Novi, Michigan), 1 in-person meeting in Washington, DC, and 3 in-person meetings at CV PFS regular meetings. The TTI Team and the CAMP EDCM Project Team will also hold regularly discussions via teleconference/web conference to facilitate coordination between the two projects.

TTI will also review CAMP EDCM Project draft deliverables that relate to V2I Queue Advisory/Warning (i.e., EDCM Architecture and Data Framework) and develop a set of written comments (non-editorial). TTTI will participate in discussions relating to the comments as necessary.

Stakeholder Engagement and Walkthroughs

Stakeholder engagement is a critical component to the successful completion of this project. Potential stakeholder groups include the following.

- CAMP, and automotive OEMs.
- US Department of Transportation, Federal Highway Administration.
- Infrastructure Owner/Operators (IOO), such as state departments for transportation.
- The Cooperative Automated Transportation (CAT) Coalition.
- The American Association of State Highway and Transportation Officials (AASHTO.
- The Institute of Transportation Engineer (ITE).
- The Society of Automotive Engineers (SAE) Infrastructure Applications Working Group.

The primary mechanism that TTI will use to engage stakeholders (other than USDOT and the CV PFS Advisory Panel) will be through periodic walkthroughs of specific deliverables. The TTI Team will coordinate with the CV PFS Advisory Panel and USDOT to conduct walkthroughs of the draft Concept of Operations, the draft System Requirements, and the draft High-Level documents for the V2I Queue Advisory/Warning application. One walkthrough will be conducted for each document. The purpose of these walkthroughs is to solicit input from stakeholders on the completeness and correctness of the documents. TTI will conduct these walkthroughs in person with representatives from the CAMP EDCM project team, the CV PFS Advisory Panel and USDOT. TTI will also invite other stakeholder groups, such as the work group members from the Cooperative Automated Transportation (CAT) Coalition, the Society of Automotive Engineers (SAE) Infrastructure Applications Technical Committee, and others, to participate in the walkthroughs. TTI will also provide web-conferencing capabilities to allow stakeholders who cannot attend in person to provide their input as well.

In these walkthroughs, the TTI Team will lead the participants through the major element of the each document. To facilitate the discussion in the walkthroughs, TTI will develop a Microsoft PowerPoint® presentations and walkthrough workbooks highlighting the major concepts and ideas in each document. The TTI Team will distribute these documents to the stakeholders at least 5 working days prior to each walkthrough.

QUALITY MANAGEMENT

The objective of the quality management plan is to establish controls and reviews of major project deliverables, including reviews of initial, interim and final document drafts, before submitting to the CV PFS team and USDOT ITS JPO for review.

All program deliverables require the review and approval of the PI and another member of the project team. For key deliverables, the TTI Team may perform additional internal peer reviews of the technical content, accuracy, and adherence to PWS requirements before delivery to the USDOT. The PI and Co-PI will be responsible for reviewing all draft reports, documents, and presentations prepared by the team technical staff responsible before being submitted to the CV PFS team for review. Once all comments have been incorporated, the PI will be responsible for transmitting the deliverables to the USDOT. Regardless of the author, at least the PI or the Co-PI will review and approve each deliverable before submittal.

For major deliverables, TTI Communications staff will provide a full edit and format of project documentation.

Once a document is delivered to the CV PFS team, TTI requests that the Project Director or designee coordinate comments and consolidate them into a single version of the submitted initial Microsoft Word document using Track Changes. TTI requests that, at a minimum, the project director be available by phone within two days of providing the comments for a comment discussion conference call if needed. TTI will complete the revisions to the document within 5 to 10 business days, and then submit the revised document along with a comment resolution document if appropriate. This will complete the review and submission cycle for a given document developed in this project.

HUMAN RESOURCE MANAGEMENT

This plan identifies the processes and procedures TTI will follow to ensure the timely and effective management of human resources assigned to the project.

Staffing Plan

The PI for this project is Dr. Geza Pesti, Ph.D., PE. Dr. Pesti is a Research Engineer with over 27 years of research, 6 years of teaching, and 2 years of consulting experience. Dr. Kevin Balke, Ph.D., PE, PMP will be the Co-PI for this project. Dr. Balke is a Senior Research Engineer and has over 32 years of experience conducting research for the Texas A&M Transportation Institute. Key researchers on the TTI project team include:

- Mr. Robert Brydia, PMP, Senior Research Scientist.
- Mr. Srinivasa Sunkari, PE, PMP, Research Engineer.
- Dr. Beverly Kuhn, Ph.D., PE, PMP, Senior Research Engineer.
- Mr. Hassan Charara, Software Application Developer.
- Mr. David Florence, PE, Assistant Transportation Researcher.
- Ms. Helen Olivarez, Administrative Associate V.

Table 2 defines the roles and responsibilities of each team member assigned to this project.

The team may bring in additional staff throughout the project to assist in particular aspects of the project. The team may also bring in additional technical experts where needed to address or augment the team's technical expertise. If the team uses technical expertise outside the current staffing plan, the PI will adjust the hours of the budgeted project staff to ensure that the project remains within budget.

Succession Planning

TTI is a relatively stable environment for those individuals interested in conducting leading-edge research on transportation. The following outlines the succession plan if, in the unlikely event, key individuals leave or are unable to fulfill their assigned duties to the project:

- In the event that the PI, Dr. Pesti, leaves TTI or is unable to fulfill his duties as the PI, then Dr. Balke will step in to become PI, and another Co-PI will be named to take his place from the project team.
- In the event that the Co-PI, Dr. Balke leaves TTI or is unable to fulfill his duties as Co-PI, another project team member will be named to take his place.

The project director has approval authority over all changes in project leadership positions (PI and Co-PI).

Table 2. Roles and Responsibilities of TTI Project Team Members.

Role	Identity	Responsibility	Interfaces
Principal Investigator	Geza Pesti	• Provide overall leadership and management of the research project. • Lead system engineering concept development, design, and system requirements. • Provide technical support related to third-party data integration and hybrid queue warning system. • Provide expertise related to queue warning system design. • Ensure overall quality of work by the project team	• Coordinate with the UVA CTS Project director and the CV PFS Team • Coordination with CAMP EDCM Project • External stakeholder groups
Co-Principal Investigator	Kevin Balke	• Assist the PI in providing overall management of the project. • Provide technical expertise related to the INFLO prototype system • Assist in system engineering concept development, design, and system requirements. • Provide Project Management support	• Coordinate with the UVA CTS Project director and the CV PFS Team • Coordination with CAMP EDCM Project • External stakeholder groups
Infrastructure Field Deployment Expert	Srinivasa Sunkari	• Provide technical expertise on the integration of infrastructure and connected vehicle systems. • Technical background on the development and implementation of INFLO algorithm approaches • Assist in system engineering concept development, design, and system requirements. • Conduct assessment of prior work on infrastructure-based queue detection and warning.	• External stakeholder groups • Coordination with CAMP EDCM Project

Software /Applications Developer	Hassan Charara	• Provide technical expertise in software development requirements. • Provide technical expertise on the integration of infrastructure and connected vehicle systems. • Assist in system engineering concept development, design, and system requirements.	• Coordination with CAMP EDCM Project
System Engineering Expert	Bob Brydia	• Provide technical expertise related to work zone and freeway infrastructure-based queue warning systems. • Assist in the development of Concept of Operations and System Requirements	• Coordination with CAMP EDCM Project • External stakeholder groups
Active Transportation Management Expert	Beverly Kuhn	• Provide technical expertise on the state-of-the-practice of active traffic management and queue warning. • Review technical documentation	• External stakeholder groups • Coordination with CAMP EDCM Project
Junior Research Engineer	David Florence	• Provide technical insight into the value and use of third-party data • Assist in system engineering concept development, design, and system requirements. • Conduct assessment of prior work on CV-based queue detection and warning.	• Coordination with CAMP EDCM Project • Project Team
Administrative Support	Helen Olivarez	• Provide administrative support to the project team.	• Project PI/Co-PI • Project Team

In the event that one or more of the key technical personnel assigned to the project leave or are unable to fulfill their duties to the project, the PI and Co-PI will find additional personnel within TTI that have the technical expertise and experience similar to the team member. If this occurs, the PI will provide the project director with the resume of the individual(s) being proposed to fill the vacancy to validate that the proposed individual(s) has the technical expertise and qualifications necessary to complete the work assignment.

RISK MANAGEMENT PLAN

This plan outlines the process and procedures TTI will follow to monitor, identify, assess, respond to and otherwise manage project risks. This plan also includes the initial risk register.

Risk Management

A key to effective project execution is a process to identify and mitigate risks to success. TTI recognizes that there are risks as the sole organization on this project and has procedures in place to manage risks at both levels.

The PI, with support from the entire project team, is responsible for managing team risks. The PI will maintain a risk register based upon the USDOT ITS-JPO Risk Register template. The risk register identifies various internal risks such as change orders, schedule and cost overruns, staff turnover, and non-performance by subcontractors. The register will also include planned and actual risk responses. The risk register is a living document and will be updated bi-weekly in coordination with the project team. The triggers of the TTI risk register are linked to the management tools described below, which will feed into the monthly updates to provide the ITS-JPO quick and transparent performance metrics regarding schedule and budget.

The PI will implement a coordination plan that will include regular internal team meetings (e.g., bi-weekly) and briefings to the project director (e.g., monthly). Concerns raised during these meetings will be appropriately documented to ensure that they are addressed. Team members will closely monitor any indication of scope creep and cost overruns indicated in team meetings and briefings.

Risk Register

Table 3 below shows a snapshot of the Risk Register as of the date this version of the PMP. TTI will maintain the full Risk Register in a separate file with this PMP. The Risk Register will be provided to the project director with each monthly update if changed relative to the prior provided version and within 1 day of the identification of a new significant risk.

Table 3. Risk Register

RISK NUMBER	TASK	RISK OWNER	RISK IDENTIFICATION	PROBABILITY	IMPACT	SEVERITY (Pxl)*	RISK RESPONSE	RISK MITIGATION STRATEGY	CLOSING RISK DATE
	Title or description of task.	Owner of risk.	Brief description of risk.	1 - Low 5 - High	1 - Low 5 - High	Formula calculated risk (Probability * Impact)	Avoid, Mitigate, Accept, Contingency, Transfer the risk.	Overall approach to reduce risk impact severity and or probability of occurrence.	
1	1. Project Management	TTI	Key staff leaves TTI	1-Low	1-Low	***1***	Mitigate	Project does not depend solely on single staff member. Active participation by key staff throughout project lifespan helps ensure continuity in case of departure.	
2	1. Project Management	TTI	Ineffective communication between regular project update cycles.	1-Low	4-Significant	***4***	Mitigate	Email communication with CC: to entire project leadership is encouraged at all phases of the project by all parties of the project.	
3	1. Project Management	TTI	Ineffective internal communication with project task leaders	1-Low	5-High	***5***	Mitigate	Schedule and hold bi-weekly internal meetings with core staff to review recent progress, identify problems, and scope upcoming work efforts.	
4	1. Project Management	TTI / CV-PFS / USDOT	Delayed contractor (TTI) communications and submissions to USDOT	2-Minor	2-Minor	***4***	Contingency	TTI to provide adequate review time. Suggested one week for major deliverables, two days for minor deliverables such as monthly reports. CV-PFS members and USDOT to provide timely response to review requests to ensure submission deadlines can be met.	
5	1. Project Management	TTI / CV-PFS / USDOT	Delayed sponsor communication or approval on deliverables.	3-Moderate	2-Minor	***6***	Contingency	The use of simultaneous reviews and/or agreements to proceed with work prior to official acceptance of deliverables should be examined in the case of potential lengthy delays.	
6	6. Coordination with CAMP EDCM Project	TTI / CAMP	Potential delay in some Tasks and delivarables in the EDCM project can make coordination difficult.	2-Minor	4-Significant	***8***	Mitigate	TTI team will develop a project coordination document that identifies upcoming planned interactions between the two projects and regularly update it as needed to ensure that both projects have a common understanding of timelines.	

APPENDIX A – V2I QUEUE ADVISORY/WARNING APPLICATIONS WBS DICTIONARY

WBS	Activity	Description	Completion Criteria
1.1	Kickoff Meeting	Conduct an in-person meeting to begin the project. In this meeting, the Team will provide an overview of the scope, schedule, and deliverable associated with the project.	Delivery of meeting materials and meeting notes
1.2	Project Management Plan	Develop a project management plan (draft & final) define the processes and procedures the team will use to manage the project.	Delivery of final report and comment resolution report
1.3	Project Schedule	Develop a schedule showing the duration of work activities and milestones for deliverables.	Delivery of final schedule in MS Projects and comment resolution report
1.4	System Engineering Management Plan	Develop document the covers the approach being used to develop system engineering documents (Concept of Operations, System Requirements, and High-Level Design)	Delivery of final report and comment resolution report
1.5	Monthly Progress Reports	Develop monthly reports documenting the process of the work activities	Delivery of MPR by 15th of each month.
1.6	Monthly Status Updates	Attend team meetings and teleconferences as requested to report on progress, schedules, scope issues, budget, and results of team activities	Delivery of meeting summary notes.
1.7	Closeout Meeting	Prepare and present closeout summary including work performed under each task, the status of each deliverable, and identify pending or incomplete deliverables and the total funds expended.	Delivery of closeout meeting materials and summary notes.
2.1	Assessment of Prior Work Report	Develop technical report (draft & final) documenting the results of an assessment of the prior queue warning and advisory work.	Delivery of final report and comment resolution report
3.1	Concept of Operations	Develop Concept of Operations document in IEEE 1362 format describing for the V2I Queue Advisory/Warning Application.	Delivery of final report and comment resolution report
3.2	ConOps Walkthrough	Conduct an in-person meeting to gather stakeholder input and feedback on Concept of Operations.	Delivery of meeting materials and summary notes.
3.3	Performance Measure Technical Memorandum	Prepare a technical memorandum detailing expected methods and metrics, both for the functionality of V2I Queue Advisory/Warning Applications and components affecting application and system performance	Delivery of technical memorandum
4.1	System Requirement Document	Prepare a document (draft & final) indicating the system requirements of the V2I Queue Advisory/Warning Applications	Delivery of final report and comment resolution report
4.2	System Requirements Walkthrough	Conduct an in-person meeting to gather stakeholder input and feedback on System Requirements	Delivery of meeting materials and summary notes.
5.1	High-Level Design Document	Prepare a document (draft & final) describing a high-level design of a V2I Queue Advisory/Warning Application.	Delivery of final report and comment resolution report

APPENDIX A – V2I QUEUE ADVISORY/WARNING APPLICATIONS WBS DICTIONARY

WBS	Activity	Description	Completion Criteria
5.2	High-Level Design Walkthrough	Conduct an in-person meeting to gather stakeholder input and feedback on the High-Level System Design of a V2I Queue Advisory/Warning Application.	Delivery of meeting materials and summary notes.
5.3	Design Verification Technical Memorandum	Prepare a technical memorandum detailing the traceability of the high-level design to the system requirements.	Delivery of technical memorandum
6.1	Project Coordination	Participate in coordination activities to ensure project alignment with CAMP EDCM effort	Delivery of meeting materials and summary notes.
6.2	CAMP EDCM Review	Prepare a technical memorandum provident written comments (non-editorial) on CAMP EDCM documents	Delivery of technical memorandum

MONTHLY STATUS REPORT

CONTRACT INFORMATION

Contract Name	Contract #	Prime Contractor

STATUS INFORMATION

Date Submitted	Submitted To	Month

PROJECT SCOPE

Scope Statement

FINANCIAL STATUS

Task Name	Task Number	Funds Obligated	Funds Expended To Date	Funds Remaining
Task A		$	$	$
Task B		$	$	$
Task C		$	$	$

INVOICES SUBMITTED

Invoice #	$ Amount	Date	Notes/Comments

APPENDIX B – MONTHLY PROGRESS REPORT TEMPLATE

SCHEDULE UPDATE

KEY TASKS/ MILESTONES COMPLETED THIS MONTH

Task: Milestone	Baseline Start	Actual Start	Baseline Finish	Actual Finish

KEY TASKS/ MILESTONES SCHEDULED FOR NEXT MONTH

Task: Milestone	Baseline Start	Actual Start	Baseline Finish	Actual Finish

KEY ACTIVITIES / ACCOMPLISHMENTS

TASK A - TASK NAME

Support Provided
1)
2)
3)

TASK B - TASK NAME

Support Provided
1)
2)
3)

TASK C - TASK NAME

Support Provided
1)
2)
3)

APPENDIX B – MONTHLY PROGRESS REPORT TEMPLATE

RISK STATUS

RISK LOG

Risk Rating	Risk Statement	Mitigation Strategy

ISSUES/CONCERNS/ OTHER

- Add any applicable