Transportation Systems Management & Operations

PSEMP for Marion County ITS Operational Improvements

Version: 1.0

Approval Date: *TBD*

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DOCUMENT CONTROL PANEL		
File Name:	436361-1 - PSEMP_V1.0	
File Location:	Z:\2015 Projects\10839 (FDOT-5 TSMO)\TWO 20 (Marion County RFP)\Systems Engineering Documents\436361-1 - PSEMP_V1.0.docx	
Version Number:	1.0	
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List of Acronyms and Abbreviations

ATC ..... Advanced Transportation Controller
ATSPM ..... Automated Traffic Signal Performance Measures
CEI ..... Construction Engineering and Inspection
CFR ..... Code of Federal Regulations
CMGC ..... Construction Manager/General Contractor
ConOps ..... Concept of Operations
CPM ..... Critical Path Method
CV ..... Connected Vehicle
ERC ..... Electronic Review Comment
FDOT ..... Florida Department of Transportation
FRAME ..... Florida Regional Advanced Mobility Elements
ITS ..... Intelligent Transportation Systems
ITSFM ..... Intelligent Transportation Systems Facility Management
MOE ..... Measure of Effectiveness
MOP ..... Measure of Performance
MSP ..... Modified Special Provisions
O&M ..... Operations and Maintenance
ORR ..... Operational Readiness Review
OT ..... Operational Test
PERT ..... Project Evaluation and Review Technique
PITSA ..... Project Intelligent Transportation System (ITS) Architecture
PM ..... Project Manager
PSEMP ..... Project Systems Engineering Management Plan
QA ..... Quality Assurance
QC ..... Quality Control
RFP ..... Request for Proposal
RITSA ..... Regional Intelligent Transportation System Architecture
RTMC ..... Regional Transportation Management Center
RTVM ..... Requirements Traceability Verification Matrix
SAT ..... System Acceptance Test
SEMP ..... Systems Engineering Management Plan
SEP ..... Systems Engineering Process
SSR ..... System Requirement Review

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SVP ..... System Validation Plan
TMC ..... Transportation Management Center
TRR ..... Test Readiness Review
TSP ..... Technical Special Provisions
WBS ..... Work Breakdown Structure

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1. Overview

The first section of the Project Systems Engineering Management Plan (PSEMP) document provides seven elements: an overview of the document, need for a PSEMP, project identification, purpose and scope, technical project summary schedule, relationship to other plans, and applicable documents. These elements are described in the following sections.

1.1 Document Overview

This document is the PSEMP for the *Marion County ITS Operational Improvements*. This PSEMP is a plan that helps manage and control the project utilizing systems engineering processes (SEP). The PSEMP identifies what items are to be developed, delivered, integrated, installed, verified, and supported as a part of the project. It documents certain processes and procedures for the technical management, procurement, installation, and acceptance of the project. The document satisfies the requirement for a PSEMP for high-risk Intelligent Transportation System (ITS) projects.

The document is organized as follows:

- Section 1 – Overview of the PSEMP document
- Section 2 – Systems Engineering Processes
- Section 3 – Project Management and Control

1.2 Need for a Project Systems Engineering Management Plan

This PSEMP is developed as required by FDOT Procedure 750-040-003. The PSEMP documents how systems engineering will be used for ITS project management.

1.3 Project Identification

Project Name: *Marion County ITS Operational Improvements*
Financial Project Identification: *436361-1*
Federal Aid Project Number: *D521-028-B*

1.4 Project Purpose and Scope

This project will implement enhancements to Marion County's ITS network that is used to interconnect traffic signals, operations facilities, and ITS devices operated and maintained by the

County. Enhancements will consist of new fiber optic cabling, new wireless communication components, and new network equipment.

The project's objectives include:

1. Enhance Marion County's ITS network's reliability and bandwidth.
2. Expand coverage of Marion County's ITS network.
3. Set the stage, through construction of supporting communication infrastructure, for deployment of future ITS technologies including connected vehicle (CV) equipment and Automated Traffic Signal Performance Measures (ATSPM).

This project will use the Construction Manager/General Contractor (CMGC) procurement method. CMGC is a project delivery method where FDOT holds contracts with the design consultant and the CMGC firm, similar to a traditional design-bid-build. But, unlike design-bid-build, the CMGC is retained early in the design phase and provides input during design—referred to as the preconstruction phase. Consequently, CMGC allows for the contractor, designer, and FDOT to work closely as a team, where each party exercises their unique strengths during the design phase to foster innovative construction approaches that save time and money, develop an accurate and often accelerated construction timeline, solve potential procurement challenges before they cause delays, and mitigate risk. Following the design phase, if FDOT determines that the CMGC has been successful in performing preconstruction services, the CMGC is provided an opportunity to prepare and submit an official price proposal for construction; alternatively, if FDOT determines that the CMGC has not been successful in performing preconstruction services, FDOT may move forward with selection of a contractor using the plans and specifications created during the CMGC preconstruction process through a traditional design-bid-build style bidding and contractor selection.

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1.5 Stakeholders

Table 1 summarizes project stakeholders and their respective roles.

Table 1: Stakeholders

Stakeholder	Project Role
FDOT District 5	- Manage design and construction - Fund design and construction - Provide technical document review - Provide network design support - Acquire a Design Consultant - Acquire a CMGC
Marion County	- Provide technical document review - Maintain and operate the system
FDOT Central Office	- Provide project oversight. - Review and approve ITS products and equipment. List approved products on the FDOT APL
Design Consultant	- Prepare plans and specifications (detailed system design and requirements) - Work with the CMGC during the design phase - Assist the CMGC in development of testing and integration plans
Construction Manager / General Contractor (CMGC)	- Provide preconstruction support during the design phase: design document review, schedule assessment, cost estimating, and procurement assessment - Potentially construct, integrate, and test the system. - Develop testing and integration plans

Figure 1 is an overview showing the system's major components and their connections.

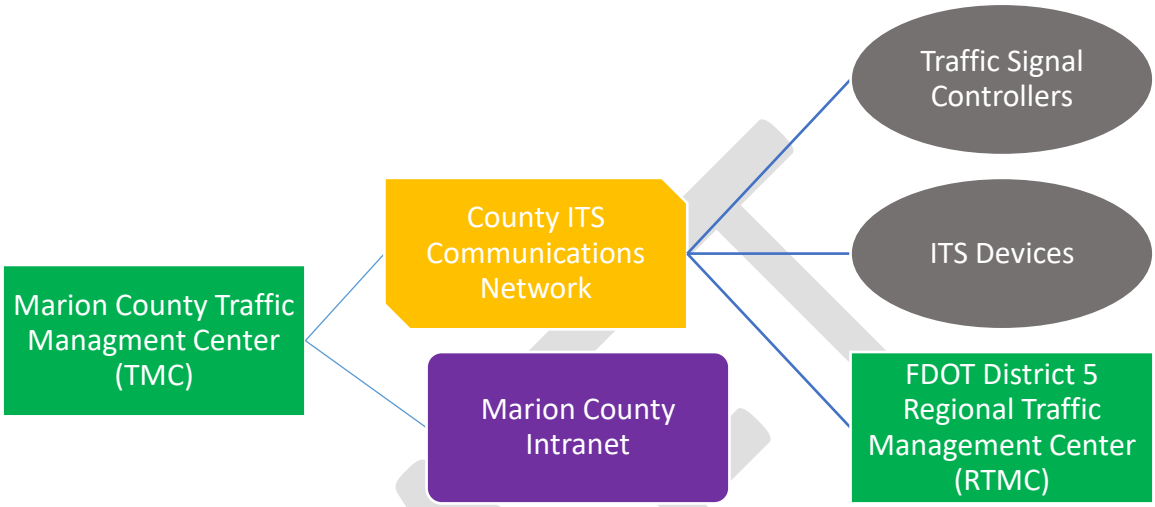

Figure 1: System Overview

1.6 Technical Project Summary Schedule

Below is an overview of the project's major events and schedule:

- CMGC RFP Advertisement ..... August 2021
- CMGC Selection ..... September 2021
- Design & Preconstruction Phase ..... June 2021 to December 2022
- Construction ..... December 2022 to December 2023
- System Verification ..... December 2023 to January 2024
- System Validation ..... January 2024 to February 2024

1.7 Relationship to Other Plans

1.7.1 Relationship to the Regional ITS Architecture (RITSA)

This project is not included in the District 5 RITSA. It will, therefore, have to be added by following the standard RITSA update processing using FDOT's standard architecture update form. Updates to the RITSA are performed by a consultant working for FDOT Central Office.

1.7.2 Relationship to Ocala/Marion TPO 2018 ITS Strategic Plan Update

A strategic plan to guide ITS enhancements within the City of Ocala and Marion County. The plan recommends 18 projects worthy of ITS improvements on various corridors within Marion County—six of the 18 recommend wireless communication equipment that should be considered when designing ITS network enhancement for this project. This strategic plan also provides a useful information about regional stakeholders and their ITS equipment and transportation facilities.

1.7.3 Relationship to FDOT District 5 ITS Master Plan

A Districtwide ITS master plan creates consensus on what items are to be integrated, what ITS strategies are to be implemented, and what standards need to be met—security, maintenance, staffing, etc.—to facilitate future regional ITS goals. The master plan documents Marion County's existing ITS, existing operations resources, and existing maintenance resources; provides staffing guidance for the future; identifies potential ITS strategies for implementation in Marion County; sets forth mandatory regional ITS communication, security, data, common clock, and cabinet locking mechanism standards that must be considered when designing this project's network enhancements for Marion County; and lists recommended ITS security, maintenance, operational, training, system testing and acceptance, and asset management standards that should be considered during development of the Marion County ITS Operational Improvements.

1.7.4 Relationship to I-75 Florida Regional Advanced Mobility Elements (FRAME)

I-75 FRAME is an ITS project focused on the I-75 corridor that endeavors to increase safety for I-75 users, improve travel reliability on I-75, reduce trip delay on I-75, accommodate population and economic growth and demand for moving people and freight, and enhance regional emergency evacuation and response. I-75 FRAME, in Sumter and Marion County, is installing

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CV road side units (RSUs) on I-75 and at signalized intersections along I-75 diversion routes; enhancing traffic signal detection and installing Advanced Transportation Controller (ATC) traffic signal controllers at signalized intersections along I-75 diversion routes; and installing fiber optic cable and supporting networking equipment in traffic signal controller cabinets along SR 44, US 301, US 441, and SR 326. The fiber optic cabling and networking equipment installed by I-75 FRAME will be leveraged when designing and implementing the Marion County ITS Operational enhancements.

1.8 Applicable Documents

Table 2: Referenced Documentation

Document Name	ID, Revision, Date, etc.	Link, or Contact Info to Obtain
Systems Engineering and ITS Architecture Procedure 750-040-003	2019	FDOT Forms Management/Procedures https://pdl.fdot.gov/
Florida's Statewide Systems Engineering Mangaement Plan: Deliverable 1-10: Technical Memorandum	March 7, 2005, Version 2	https://www.fdot.gov/traffic/its/projects-deploy/semp.shtm
Ocala/Marion TPO 2018 ITS Strategic Plan Update	2018	2018 ATMS Master Plan – Transportation Planning Organization (ocalamariontpo.org)
FDOT District 5 ITS Master Plan	October 2016, Version 1.3	www.cflsmartroads.com/docs/District 5 ITS Master Plan_FINAL.pdf
I-75 Florida Regional Advanced Mobility Elements (FRAME)	FPID 440900-1-52-01 & 440900-2-52-01; February 2019	FDOT Project Manager: Noemi Rodrigues Bonilla, P.E. (Noemi.RodriguezBonilla@dot.state.fl.us)
FDOT Design Manual	2021	FDOT Design Manual

2. Systems Engineering Processes (SEP)

The SEP is an interdisciplinary approach in which multiple organizations come together to develop, deploy, and maintain a successful ITS System. The SEP process addresses systems planning, engineering, software development, integration testing, documentation development, installation, deployment, and ultimately replacement and retirement of an ITS System.

2.1 Developing the Project ITS Architecture (PITSA)

This project is not included in the District 5 RITSA. It will, therefore, have to be added by following the standard RITSA update processing using FDOT's standard architecture update form.

The following service packages from the District 5 RITSA are expected to be associated with this project:

- TM01 – Infrastructure-Based Traffic Surveillance (County and City TMCs)
- TM03 – Traffic Signal Control (Marion County)
- TM06 – Traffic Information Dissemination (Marion County)
- TM07 – Regional Traffic Management (FDOT and TMCs)
- TM08 – Traffic Incident Management System (Marion County (TM to EM))

2.2 Identifying High-Level Functional Requirements (System)

High-level functional requirements are defined in the project Concept of Operations (ConOps). These requirements are used to develop the System Validation Plan (SVP) and Requirements Traceability Verification Matrix (RTVM). The SVP and RTVM will in turn be used to validate that the realized system fulfils its functional requirements.

2.3 Developing Detailed Requirements

Detailed requirements will be developed during the detailed design phase by the Design Consultant. The Design Consultant will identify the system's detailed requirements necessary for fulfillment of the high-level functional requirements identified.

The Design Consultant will start with the ***Statewide Standard Specifications***, ***FDOT Design Manual***, and ***Standard Plans*** as the basis for system requirements and develop project-specific modifications or enhancements in the form of plan details, modified special provisions (MSP), and technical special provisions (TSP).

2.4 Performing Trade-off Studies and Gap Analyses

2.4.1 Trade-Off Studies

The design consultant will perform Trade-Off Studies during the detailed design phase to identify the optimal solution for fulfilling the high-level system requirements, in the face of

competing features, described in the ConOps. These Trade-Off Studies will consider performance impacts, schedule impacts, cost, and risk identification.

Some situations where more than one alternative exists that require a Trade-Off Study include:

- Using fiber optic cabling or wireless communication or a combination thereof for network links.
- Network topology—ring, mesh, or daisy chain—for intersection-to-intersection communication, corridor (series of interconnected signalized intersections) to aggregation site communication, and backhaul communication links (center to center, aggregation site to center, or aggregation to aggregation site).
- Frequency selection for intersection-to-intersection communication, corridor (series of interconnected signalized intersections) to aggregation site communication, and backhaul communication links (center to center, aggregation site to center, or aggregation to aggregation site). And whether or not licensed or unlicensed frequencies should be used.
- Maintenance options for the wireless equipment: County maintains, the CMGC maintains, or maintenance is performed through a separate contract.
- Mounting alternatives for wireless equipment: use existing towers or construct new towers; use existing signal poles or install new ITS poles.

As the CMGC will be responsible for construction and integration, and will be involved in the design phase, it is recommended that the Design Consultant work with the CMGC on Trade-Off Studies.

2.4.1 Gap Analysis

A gap analysis focuses on determining the gap between the existing system and the desired system. The Design Consultant will prepare a gap analysis that compares the existing system to the desired system as described in the ConOps during the design phase.

2.5 Performing Technical Reviews

Technical reviews for the various documents prepared as part of the SEP will be conducted by the entities included below in the SEP Technical Review Team. The FDOT Design Project Manager will determine which entities from the SEP Technical Review Team are to be included on each specific SEP review step; additionally, the FDOT Design Project Manager is responsible for distribution of the SEP documents intended for review to the appropriate entities.

SEP Technical Review Team:

- FHWA
- FDOT District 5 Departments:

  - FDOT District 5 TSM&O
- Design Consultant
- Marion County

Figure 2 is an organizational chart for the SEP Technical Review Team.

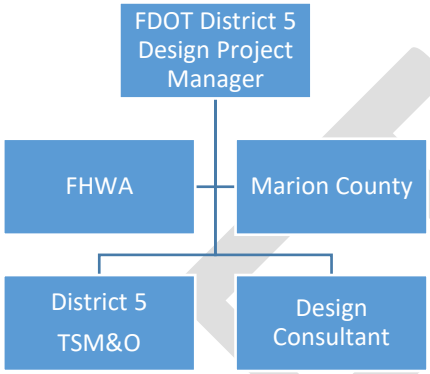

Figure 2: SEP Technical Review Team Organizational Chart

Technical reviews for the various Construction Contract Documents and incidental engineering analysis for this project will be conducted by the entities included below in the Detailed Design Review Team. Construction Contract Documents include the plans and specifications developed during the detailed design phase. The FDOT Design Project Manager will determine which entities from the team are to be included on each specific review step; additionally, the FDOT Design Project Manager is responsible for distribution of the documents intended for review to the appropriate entities.

Detailed Design Review Team:

- FHWA
- FDOT District 5 Departments:
  - FDOT District 5 TSM&O
  - FDOT District 5 Traffic Design
  - FDOT District 5 Construction
  - FDOT District 5 Office of Environmental Management
  - FDOT District 5 Maintenance
  - FDOT District 5 Structural Maintenance
- Marion County
- CMGC

Figure 3 is an organizational chart for the Detailed Design Review Team.

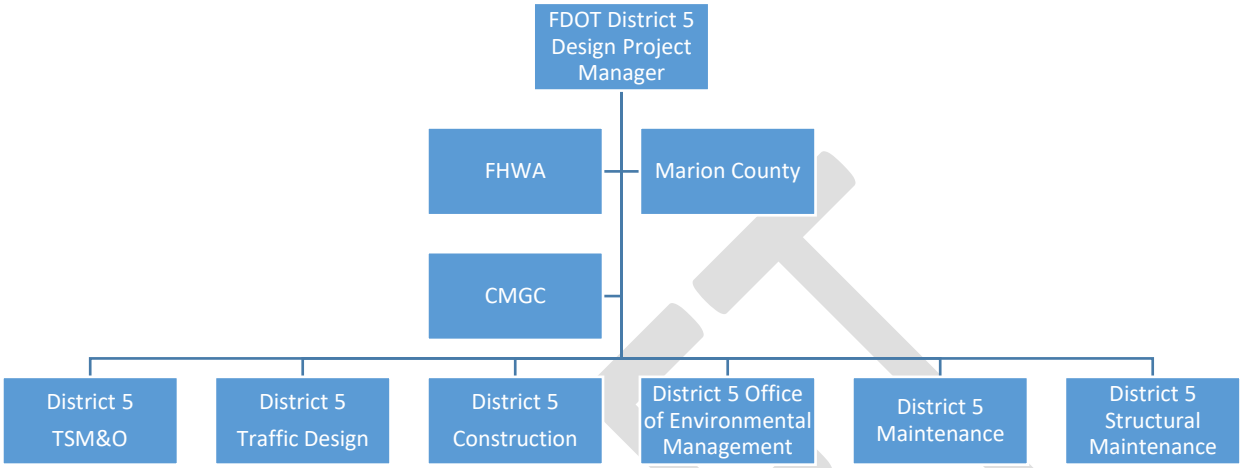

Figure 3: Detailed Design Review Team Organizational Chart

The FDOT's Statewide Electronic Review Comment (ERC) System will be the primary means by which project documents are distributed for review, the primary means in which comments are provided by reviewers, and the primary means by which comments are responded to and resolved. The ERC system allows project managers to track all comments and responses from the various project submittals during the project's development. The Design Consultant will provide the FDOT Design Project Manager with the project submittals in a mutually agreed upon format; subsequently, the FDOT Design Project Manager will upload the documents to the ERC system.

The planned project reviews are provided in the following sections. No Hardware Design Reviews or Software Design Reviews have been included, as the hardware and software sub-systems required are expected to be commercially available or already in place and easily extendable to this project's requirements.

2.5.1 PSEMP Reviews

The members of the SEP Technical Review Team review the initial PSEMP, which focuses on the technical plan and scope of the SEP to be performed. The PSEMP will be written in two

major phases. In the first phase the framework for the document is prepared, and the initial PSEMP review is performed. Enough detail is included to specify the SEP tasks necessary, along with any important constraints on completion of these tasks. In the second phase, the various sections of the PSEMP framework are updated to include more specific detail resulting from completion of tasks outlined in the initial PSEMP. This second phase is an iterative process, and will include multiple updates to the PSEMP during the SEP, with each round of updates requiring a PSEMP review prior to official adoption of the updated PSEMP. The PSEMP is a living document that will be updated throughout the project lifecycle.

2.5.2 Concept of Operations Review

The ConOps helps translate user need to a common vision for how a system will operate from the users' perspectives, and solidifies the look and feel of the system for the technical and non-technical stakeholders. Prior to finalization of system requirements, the system design team writes the draft ConOps following FDOT's accepted ConOps template. This draft ConOps is then reviewed by the SEP Technical Review Team, who will provide comments to be addressed by the system design team—multiple submittal and review iterations of the draft ConOps may be warranted based on the scope of comments provided. Once a common vision for the system is achieved, by the SEP Technical Review Team, the first version of the ConOps is published.

Before the draft ConOps review can be performed, the following entry criteria must be completed:

- Completion of systems needs analysis
- Determination of stakeholder requirements for the ITS deployment
- Draft ConOps must be developed

Items to be reviewed at the ConOps review include:

- Draft ConOps document
- Preliminary project schedule and budget
- Hypothetical system architecture
- Potential risk items

Similar to the PSEMP, the ConOps is a living document that will be updated throughout the SEP. Each time an update to the ConOps is to be performed, the proposed ConOps updates undergo a review process similar to that described previously for the draft ConOps. Once a common vision for the updates is achieved, a new version of the ConOps is issued, and the revision is tracked in the document control panel.

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2.5.3 System Requirements Review

The System Requirements Review (SRR) is held to solidify the functional framework for the system prior to detailed design; it ensures that the requirements align with stakeholder expectations. The SRR is performed by the SEP Technical Review team, and facilitated by the FDOT Design Project Manager.

The following items must be completed prior to this review:

- Completion of the ConOps (current version) where the high-level system requirements are defined
- Completion of the Initial RTVM
- Completion of the Initial System Validation Plan
- Completion of the PITSA
- Risk Management Plan and Risk Assessment

Items to be reviewed include:

- Completed ConOps (current version)
- Initial RTVM
- Initial System Validation Plan
- PITSA
- Risk items from the Risk Assessment

Prior to completion of this review stage the following criteria must be completed:

- Consensus on the current version of the ConOps, and the associated high-level system requirements by the stakeholders
- Consensus on the Project Architecture
- Approved Initial RTVM
- Approved Initial System Validation Plan

2.5.4 Trade-Off Studies and Gap Assessment Review

Prior to commencement of detailed design, Trade-Off Studies and Gap Assessments will be prepared by the Design Consultant and reviewed by the SEP Technical Review Team. A draft version of these documents will be prepared by the Design Consultant and submitted to the SEP Technical Review Team for review. Resulting comments will be provided to the Design Consultant who will update the Trade-Off Studies and Gap Assessments to address the review comments, then resubmit for a pre-final review so the SEP Technical Review Team can confirm that their comments on the draft versions were adequately addressed. Any pre-final review comments will then be provided to the Design Consultant for incorporation into the final studies.

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The conclusions reached in the Trade-Off Studies and Gap Assessments will be used to guide subsequent design phases and, therefore, should be completed beforehand.

2.5.5 Phase II Design Review

The Phase II Review will be conducted in accordance with the ***FDOT Design Manual***. This review is conducted by the Detailed Design Review Team members, and facilitated by the FDOT Design Project Manager.

Entry criteria includes:

- Phase II Plans
- Draft Engineering analysis, calculations, and reports
- Final Gap Assessments
- Final Trade-Off Studies
- Updated Risk Matrix

Products to be reviewed include:

- Phase II Plans
- Draft Engineering analysis, calculations, and reports
- Risk Items

Exit criteria includes:

- Phase II Review comments and responses
- Updated RTVM
- Updated Risk Matrix

2.5.6 Phase III Design Review

The Phase III Review will be conducted in accordance with the ***FDOT Design Manual***. This review is conducted by the Detailed Design Review Team members, and facilitated by the FDOT Design Project Manager.

Entry criteria includes:

- Phase III Plans
- Draft Engineering analysis, calculations, and reports
- Draft Technical Special Provisions
- Draft Modified Special Provisions
- Updated Risk Matrix

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Products to be reviewed include:

- Phase III Plans
- Draft Engineering analysis, calculations, and reports
- Draft Technical Special Provisions
- Draft Modified Special Provisions
- Risk Items

Exit criteria includes:

- Phase III Review comments and responses
- Updated RTVM
- Updated Risk Matrix

2.5.7 Phase IV Design Review

The Phase IV Review will be conducted in accordance with the ***FDOT Design Manual***. This review is conducted by the Detailed Design Review Team members, and facilitated by the FDOT Design Project Manager.

Entry criteria includes:

- Phase IV Plans
- Resolution of Phase III Design Review comments
- Final Engineering analysis, calculations, and reports
- Final Technical Special Provisions
- Final Modified Special Provisions
- Updated Risk Matrix

Products to be reviewed include:

- Phase IV Plans
- Final Engineering analysis, calculations, and reports
- Final Technical Special Provisions
- Final Modified Special Provisions
- Risk Items

Exit criteria includes:

- Phase IV Review comments and responses
- Updated RTVM

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- Updated Risk Matrix

2.5.8 PS&E Review First Submittal

The Plans Specifications and Estimates (PS&E) First Submittal Review will be conducted in accordance with the ***FDOT Design Manual***. This review is conducted by the Detailed Design Review Team members, and facilitated by the FDOT Design Project Manager.

Entry criteria includes:

- Final plans
- Resolution of Phase IV Design Review comments
- Draft Specification Package
- Summary of Pay Items Report

Products to be reviewed include:

- Final plans
- Draft Specification Package
- Summary of Pay Items Report

Exit criteria includes:

- Review comments and responses

2.5.9 PS&E Review Second Submittal

The PS&E Second Submittal Review will be conducted in accordance with the ***FDOT Design Manual***. This review is conducted by the Detailed Design Review Team members, and facilitated by the FDOT Design Project Manager.

Entry criteria includes:

- Signed and Sealed Plans
- Signed and Sealed Specification Package
- Resolution of PS&E Review First Submittal comments
- CAD Files

Products to be reviewed include:

- Signed and sealed Plans
- Signed and Sealed Specification Package

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Exit criteria includes:

- Approved Construction Contract Documents

2.5.10 CMGC Assessment Price Proposal Review

Once the design is complete, FDOT District 5 requests that the CMGC prepare a lump-sum price proposal for construction of the system. The CMGC will prepare a price proposal that includes pricing information such that FDOT can assess CMGC's proposal to ensure competitive pricing—FDOT may employ an independent cost estimator to evaluate the CMGC's price proposal.

In addition to a price proposal review, FDOT District 5 will assess the CMGC's performance during the design phase. If District 5 is satisfied with the price proposal and the CMGC's performance during the design phase, they will choose to accept the CMGC's price proposal and construction of the system by the CMGC will commence.

Entry criteria includes:

- Signed and Sealed Plans
- Signed and Sealed Specification Package
- CMGC lump sum price proposal
- Completion of CMGC preconstruction activities during the design phase

Elements to be reviewed include:

- CMGC's price proposal
- Performance of CMGC during preconstruction phase

Exit criteria includes:

- Accepted or rejected CMGC price proposal
- Decision on whether or not the CMGC will move forward with constructing the system

2.5.11 Cut Sheet and Shop Drawing Reviews

During construction the CMGC is required to submit product cut sheets and/or shop drawings for all devices, equipment, and materials to be used. The CMGC will submit this information to the Construction Engineering and Inspection (CEI) Consultant, who will distribute the submittals to the appropriate Engineer of Record, and the appropriate FDOT project team members for review. The CEI is responsible for consolidation of shop drawing review comments, and providing these

comments to the CMGC for resolution. Once the Engineer of Record and the FDOT project team members approve the equipment, it may be used on the project.

2.5.12 Test Readiness Review

The test readiness review (TRR) is the formal review conducted before starting a formal System Acceptance Test (SAT) of the substantially constructed ITS system. It discusses the objectives and contents of the SAT, when it should be held, and who should attend. The FDOT Construction Project Manager and CEI test director facilitates the TRR. At a minimum, the review should include: the FDOT ITS Project Manager, CEI test director, and any ITS contractors planning to perform the SAT. Each attendee is to review the SAT procedures, and collectively discuss questions and concerns they have, prior to commencement of the SAT.

It is important to consider and discuss the length of time, and the project testing conditions, required to initiate and complete the Operational Test (OT)—often referred to as a "burn-in period". Project final acceptance will not be granted until the OT period is completed. The OT is typically between 30 and 90 days in length, and follows completion of the system acceptance test.

The entry criteria for the TRR includes:

- Approved Test Plan

Products to be reviewed at the TRR include:

- Test Plan
- OT timeline and requirements
- Acceptance criteria and the process by which deficiencies are corrected
- Test equipment needs
- Risk items

Exit Criteria for the TRR Includes:

- Approval to commence SAT
- Consensus of the OT timeline and requirements
- Consensus on the pass/fail criteria and acceptance process
- Agreement on the process by which deficiencies are to be corrected
- Agreement on the schedule for SAT, along with who needs to support and/or witness the testing

2.5.13 Hot Wash-Up Review

The hot wash-up review is held immediately after the SAT is concluded. During this review, consensus is obtained regarding the results of the SAT, and discussions of discrepancies are performed. If necessary, to correct major discrepancies, a corrective action plan should be discussed and agreed upon. This meeting generally will include the CMGC; the CEI test director; the FDOT Construction Project manager; and any other key decision makers that have influence over the system's final acceptance.

2.5.14 Operational Readiness Review

The operational readiness review (ORR) is held prior to full-scale operation of the constructed, integrated, and tested system. The ORR is focused on identifying the elements that must be completed before the system can be placed into full-scale operation. Discussion topics range from training status to operational and maintenance procedures and roles. Discrepancies identified during the SAT and OT are reviewed, and a final determination is made whether or not to proceed with the operation of the system while minor discrepancies are being corrected; the FDOT Construction Project Manager makes this determination.

2.5.15 Completion of Systems Engineering Project Checklist

For high-risk ITS projects, FDOT's ***System Engineering and ITS Architecture Procedure*** requires the completion of the Systems Engineering Project Checklist. Completion of this checklist helps to ensure that ITS projects adhere to 23 CFR 940.11. Said checklist has been included in Section 4.2 and will be updated as the various SEP steps are completed.

2.6 Identifying, Assessing and Mitigating Risk

Application of a systematic risk management strategy helps to prevent uncertainties with negative consequences, known as risks, from diverting a project away from achieving its objectives. Potential negative impacts caused by project risks include schedule delay, cost overruns, technical gaps, and incompatibilities. The following section describes the risk management strategy developed for this project, and provides a framework by which risks are to be identified, analyzed, prioritized, mitigated, and monitored.

2.6.1 Risk Management Cycle

The risk management cycle for this project will run through the entire project lifecycle, and be updated continuously. A graphical representation of the risk management cycle to be applied is provided in Figure 4, the steps of which include:

- Risk Identification
- Risk Analysis
- Risk Prioritization
- Risk Mitigation
- Risk Monitoring

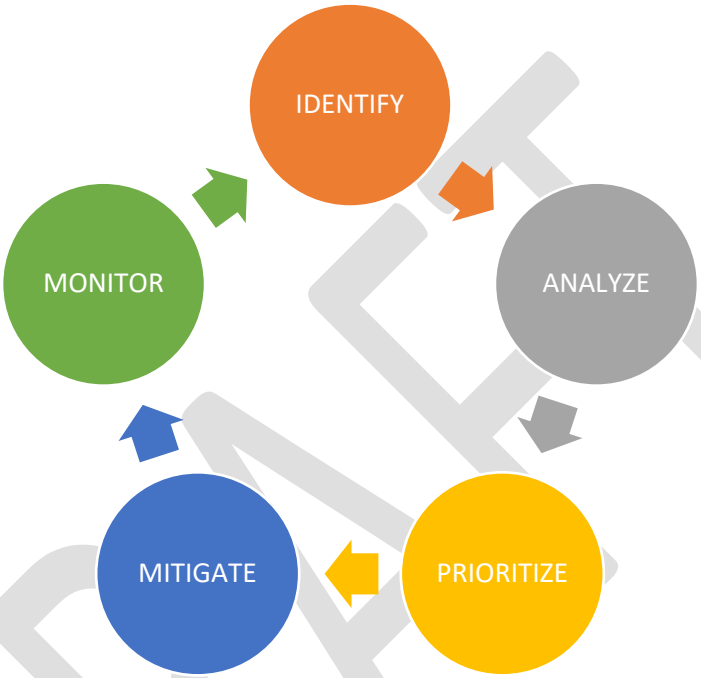

Figure 4: Risk Management Cycle

2.6.2 Risk Identification

While risks will be identified throughout the project lifecycle, it is most impactful on the project success to identify risks at the beginning of the project; requiring that project managers, stakeholders, and domain experts brainstorm about areas where risks are present. All areas of potential risks should be considered, from initial project developing through to operations and maintenance (O&M) and eventually system retirement. Many areas of risk may affect the project, including:

- Technical
- Institutional
- Funding and Cost
- Schedule
- Staffing Levels
- Environmental

- Product lead-times

Two steps will occur to help identify risks at the beginning of the project:

- **Completion of the Project Risk Assessment and Regulatory Compliance Checklist** – this checklist has been completed and included in Section 4.1. The purpose of this checklist is to determine if this project is "high-risk". High-risk ITS projects require more detailed and robust SEP as compared to "low-risk" projects. This project was determined to be high-risk.
- **Initial Risk Assessment Meeting with Project Stakeholders –** a meeting to brainstorm potential project risks. The meeting will include various stakeholders as identified by the FDOT Design Project Manager. The result of this meeting will be an initial list of identified risks to include in the project Risk Matrix.

As this project will use the CMGC procurement method, the CMGC will be involved during the design phase and will use their construction and procurement knowledge to help identify risks associated with construction schedule, procurement, and constructability during the design phase while performing their review of the Phase II, Phase III, and Phase IV plans.

2.6.3 Risk Analysis

After risks are identified, each will be analyzed and placed into three categories based on the level of potential impact to the project:

- **Low Risk –** A risk that if realized will only marginally impact the project, and for which existing resource contingency reserves are sufficient to absorb without causing significant drain.
- **Medium Risk –** A risk that if realized will impact the project. Existing resource contingency reserves are sufficient to absorb the realized risk; however, significant draining to the contingency reserves will occur.
- **High Risk -** A risk that if realized will significantly impact the project. Existing resource contingency reserves are not adequate to absorb the realized risk.

The project manager, or designated representative, is responsible for analyzing the risk and determining the level of potential impact they represent, and the probability of its occurrence. This is somewhat of an abstract task, and assessment of potential level of impact is not always simple. When necessary, the project manager is to reach out to persons with specialized knowledge of the domain in which the risk exists, and leverage this person's knowledge to better define the potential impact level and occurrence probability of the risk. The Design Consultant and CMGC should be contacted to assist with risk analysis.

A quantitative scale for risk probability is to be used:

- **Low Probability** – less than 10% occurrence probability
- **Medium Probability** – between 10% and 40% occurrence probability
- **High Probability** – greater than 40% occurrence probability

2.6.4 Risk Prioritization

Upon analysis of each risk, the next step is to prioritize the risks according to probability of occurrence and potential impact severity. Risks which have both a high occurrence probability and high potential impact severity should be prioritized for mitigation—mitigation of these risks is likely to provide the best return on investment of resources. If adequate resources exist, risks which represent a medium level of potential impact severity, and either a medium or low probability occurrence should be mitigated for next; followed finally by mitigation of low impact risks.

2.6.5 Risk Mitigation

Risk mitigation is the process used to identify and evaluate alternatives for treatment of risks that have been previously identified, analyzed, and prioritized. Several potential risk mitigation strategies exist, and include:

- **Risk avoidance**: changing the design or system requirements.
- **Risk acceptance**: accept the risk and do nothing; often appropriate for low impact and low occurrence probability risks.
- **Risk probability or severity reduction**: take steps to reduce the probability and/or impact severity of the risk (break the task into smaller more manageable steps, or develop new technological solutions).

The FDOT Design or Construction Project Manager (depending on when the risk is identified) is responsible for facilitating the development of a risk mitigation strategy for each risk—the CMGC should be involved in all risk mitigation activities during design and construction and the Design Consultant should be involved in all risk mitigation activities during design. Care should be taken to consider the schedule, cost, or other resources required to implement the risk mitigation strategy. Once a strategy is agreed upon, update the Risk Matrix to include it; for complicated risk management strategies, a separate plan may need to be developed, in such a case, refer to the plan in the Risk Matrix.

2.6.6 Risk Monitoring

Risks will be monitored throughout the project lifecycle and the Risk Matrix will be updated accordingly. The effectiveness of the selected mitigation strategy should be reviewed. The occurrence probability and impact severity should also be reviewed for each risk, as project

developments could impact these parameters. Once there is no longer a chance of a risk occurring the risk status will be changed to "closed" in the Risk Matrix.

2.7 Creating the Requirements Traceability Verification Matrix (RTVM)

The RTVM provides a way to track the various system requirements, and the means by which each requirement is to be verified (testing, demonstration, etc.). Once stakeholder needs and requirements have been identified and refined, the RTVM is created. The requirements, and the method of verification, will be entered into the initial RTVM following the completion of the ConOps and reviewed as part of the SRR. The initial RTVM will be reviewed and updated during the Phase II, Phase III, Phase IV, and PS&E reviews. The RTVM is a living document that is updated throughout the project lifecycle, as system requirements are identified or demonstrated. During system validation, the RTVM will be used to help systematically verify fulfillment of system requirements.

2.7.1 Creating Performance Measure Metrics

Two methods of evaluation will be used to determine how well the project meets its design requirements:

- **Measures of Effectiveness (MOE)**: used to measure how well a system meets the original design intent as provided in the ConOps. MOEs are commonly decomposed into several Measures of Performance. MOEs assess the level of satisfaction achieved by the project, in relation to the stakeholder's original requirements.
- **Measures of Performance (MOP)**: used to quantify the systems performance as a distinctly quantifiable performance feature—an example is sensor accuracy. To show that a particular MOE is achieved, several MOPs may be required to show satisfactory system performance. MOPs are directly testable requirements, that can be traced to stakeholder requirements and their MOEs.

MOEs are developed alongside and documented in the ConOps. The System Validation Plan then provides a structure for system validation using the MOEs. MOPs will be included with the project specifications developed by the Design Consultant during detailed design.

2.7.2 System Verification

The CMGC, using the testing criteria defined in the project specifications developed by the Design Consultant and reviewed by the CMGC during the design phase, will be responsible for preparation of a Test Plan that will be used for System Verification.

2.8 Conducting System Testing, Integration, Verification, and Acceptance Planning

System testing will be performed by the CMGC during construction to verify that the MOPs described in the project specifications are met; the CEI will oversee testing. Testing will be performed in accordance with the testing requirements defined in the project specifications and the CMGC's Test Plan. Test results will be systematically recorded in test forms, which are part of the CMGC-developed Test Plan. These results will be reviewed by the CEI and FDOT Project Manager who will verify the test results.

Project testing involves a series of test phases that progress in sequential order, where approval of the previous testing phase is required before moving to the next. The test phases are:

- **Factory Acceptance Test** – test performed by the manufacturer to demonstrate each component is functioning as intended at the manufacturing facility. In most cases, devices are provided with a testing report from the factory, or labeled as having passed the manufacturers quality assurance and quality control process.
- **Field Acceptance Test** – individual test of each device in the field to demonstrate proper calibration and configuration have occurred, and that the device functions in the field as intended and in accordance with the project specifications. This test is performed by the Contractor and witnessed by the CEI.
- **System Acceptance Test** – test of the entire installed and integrated system to demonstrate that the sub-systems work together as intended, and that the system is accessible and functional from the TMC or other similar remote management facility. This test is performed by the Contractor and witnessed by the CEI; additionally, the TMC operators will access the system to assess device function remotely.
- **Operational Test Period** – a period of time (typically 30-90 days), following a successful system acceptance test, where the entire system is fully functional. This test is meant to "burn-in" the entire system, and identify faulty components that do not function properly for extended periods. During this period, the CMGC and FDOT monitor the system to identify any system failures. If a failure of a predetermined level of significance occurs, the Operational Test Period may be reset—this significance level will be determined in project specifications.

2.9 System Validation

System validation will be performed by Marion County by following the System Validation Plan. Validation will occur after system testing, with the RTVM used to trace fulfilment of MOEs. If the system satisfies all MOEs, it is considered validated.

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3. Project Management and Control

Completion of the SEP, as described in this PSEMP, forms the backbone for project success. Figure 5 depicts the typical SEP stages of a high-risk ITS project. This section focuses on project management and control used during the SEP.

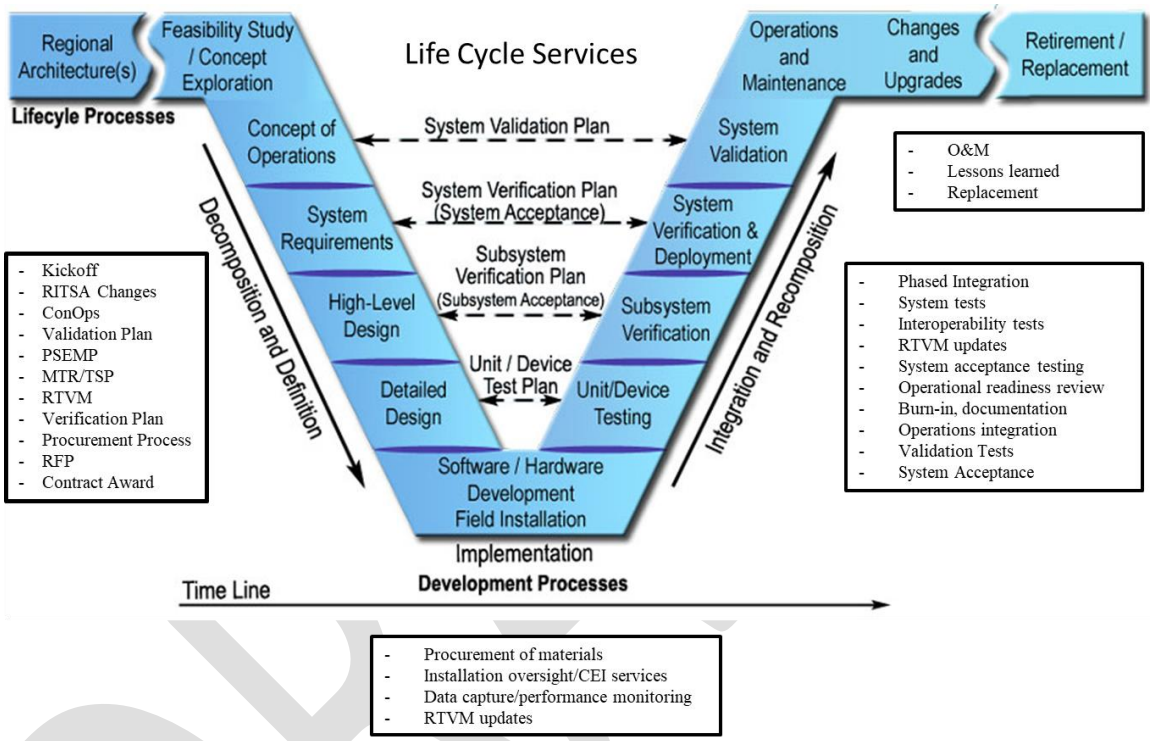

Figure 5: ITS Project Stages

3.1 Organization Structure

The FDOT Design Project Manager, or their representative, is responsible for ensuring that the project tasks prior to the start of construction are completed on schedule and within budget. Once the design phase is complete, a hand-off of the project by the FDOT Design Project Manager to the FDOT Construction Project Manager is performed. The FDOT Construction Project Manager, and the CEI Consultant, are responsible for monitoring the project tasks performed during construction, integration, and testing phases performed by the Contractor; culminating in issuance of final project acceptance and transition to System Validation and O&M.

The FDOT Construction Project Manager is also responsible for coordinating review and ultimately approval of plans, specifications, calculations, and other engineering analysis

produced by the Design Consultant. FDOT District 5 engineers of various disciplines will perform these reviews and they may employ the expertise of in-house consultants to assist.

The FDOT District 5 Procurement Office is responsible for the procurement process of Design Consultants, who will perform the Detailed Design, and the CMGC, who will participate in the design phase (preconstruction services), construct, integrate, and test the system. Project acceptance will be supervised by FDOT District 5, and/or an independent verification team if deemed appropriate.

The Design Consultant Project Manager will work closely with the FDOT Design Project Manager and CGMC Project Manager, working together to complete: design submittal reviews; risk management activities; cost estimate and budget updates and assessments; and schedule updates and assessments. Figure 6 provides an organizational chart for the design phase.

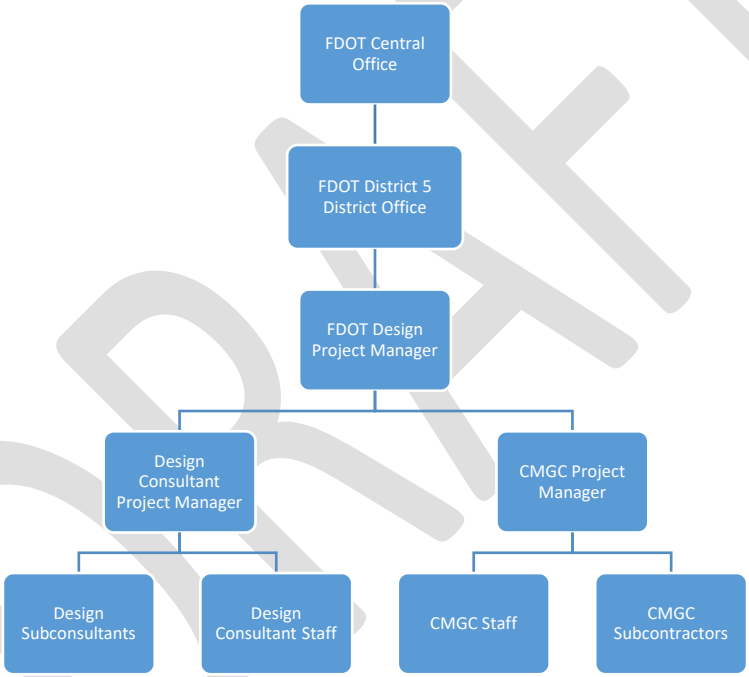

Figure 6: Design Phase Organizational Chart

3.1.1 The Project Team

Table 3 provides an overview of the organizational responsibilities of the various project entities. This table should be updated throughout project development, as more detailed information is produced and the requirements sharpen—it is difficult to fully assess all parties that will need to be involved and their total list of responsibilities in the early stages of a project.

Table 3: Project Team Responsibilities

Entity	Responsibilities
FDOT District 5 Design Project Manager	• Oversee design activities • Oversee CMGC selection • Ensure design tasks are completed on schedule and at cost • Manage Design Consultant • Manage CMGC • Facilitate document review on ERC • Risk management activities during design • Update project budget based on design changes • Update the project design schedule • Project hand-off to the FDOT District 5 Construction Project Manager • Coordination with local governments and regulatory agencies
FDOT District 5 District Office (all offices and personnel not explicitly mentioned separately)	• Review and approval plans, specifications, and engineering analysis prepared by the Design Consultants • Review and approval of SEP documents • Design services procurement and contract administration • Construction procurement and contract administration • CMGC preconstruction phase procurement • Construction administration activities • Issuance of final acceptance upon completion of construction
Marion County	• Review of plans, specifications, and engineering analysis prepared by the Design Consultants • Review of SEP documents • System validation • Post construction system operation and maintenance
FDOT Central Office	• Review and approval of the Contract Documents • Development and maintenance of Statewide Design Standards and Standard Specifications • General project oversight
Design Consultants	• Production and updating of SEP documents • Production of plans, specifications, and all associated engineering analysis • Assisting the FDOT Design Project Manager with risk management activities • Project cost estimate updates (Long Range Estimate, etc.) • Coordinating closely with the FDOT District 5 Design Project Manager to provide updates on the progress of design tasks • Coordination of Public Meetings and Public Involvement • All other services provided in the project design Scope of Services not listed above • Utility coordination • Permit assessment and acquisition • Prepare CMGC RFP

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Entity	Responsibilities
FDOT District 5 Construction Project Manager and/or CEI Consultant	• Oversee and administer construction, integration, and testing activities • Ensure that construction, integration, and testing activities are completed on schedule and on budget • Construction inspection and witnessing of testing activities
CMGC	• Provide a proposal in response to the CMGC RFP • Review of plans and specifications during design phase • Assessment and mitigation of potential procurement and construction schedule risks • Preparation of a lump sum price proposal for construction • Completion of all construction services defined in the Construction Contract Documents • Management of sub-contractors • Construction scheduling and resource allocation • Completion of testing (verification) and integration activities • Completion and submittal of as-built information and asset management data as required by the Contract Documents

3.2 Work Breakdown Structure (WBS) and Work Plan

Design project management will generally follow FDOT's ***Project Management Handbook,*** but will need to include steps for coordination with the CGMC during design to perform technical reviews, as described in Section 2.5, and obtaining a lump sum price proposal from the CGMC for construction with subsequent determination on whether or not FDOT decides to move forward with accepting the CGMC's proposal and requesting that they move forward with construction. Construction project management will follow FDOT's ***Construction Project Administration Manual***, where the CGMC will act as the Contractor unless FDOT decides that the CGMC's performance during preconstruction was insufficient.

The preliminary WBS, which should be updated as system design progresses, consists of the following tasks:

3.2.1 SEP Kick-Off Meeting

- Inputs: Notice to proceed, Contract with Design Consultant preparing SEP and CMGC RFP
- Activities: Prepare agenda, conduct meeting, and publish minutes.
- Outputs: Meeting minutes.

3.2.2 Design Consultant Acquisition

- Inputs: Contract with Design Consultant preparing plans and specifications

- Activities: Acquire Design Consultant
- Outputs: Notice to proceed

3.2.3 CMGC Acquisition

- Inputs: CMGC RFP, CGMC RFP advertisement
- Activities: Acquire CMGC
- Outputs: Notice to proceed for CGMC preconstruction phase

3.2.4 Design Project Management

- Inputs: Notice to proceed
- Activities: Management of project design phase
- Outputs: See subtasks

3.2.4.1 PSEMP

- Inputs: Notice to proceed, SEP Kick-Off Meeting Minutes
- Activities: Prepare draft PSEMP and submit for comments, address comments in updated PSEMP, PSEMP approval
- Outputs: Approved PSEMP

3.2.4.2 Initial Risk Assessment Meeting

- Inputs: Risk Matrix Template, Meeting Agenda
- Activities: Brainstorm project risks with stakeholders and Design Consultant
- Outputs: Initial Risk Matrix, Meeting Minutes

3.2.4.3 Project Design Schedule

- Inputs: Funding timelines, Draft Design Schedule
- Activities: Plan and schedule the design phase and CGMC preconstruction phase to align with construction and design funding allocations.
- Outputs: Project Design Schedule

3.2.4.4 Design Phase Management

- Inputs: PSEMP, Design Schedule, CMGC Acquisition, Design Consultant Notice to Proceed

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- Activities: Monitoring of design phase by FDOT Design Project Manager and Design Consultant
- Outputs: Final contract documents.

3.2.5 Design

3.2.5.1 Requirements Analysis

- Inputs: PSEMP, SEP Kick-Off Meeting
- Activities: Solidify project requirements and stakeholder expectations.
- Outputs: ConOps, System Validation Plan, RTVM

3.2.5.2 High-Level Design (Phase II Submittal)

- Inputs: ConOps, System Validation Plan, RTVM
- Activities: Design Consultant prepares high-level design following the project requirements set forth in the ConOps; includes preparation of Trade-Off Studies and Gap Analysis. Phase II design review.
- Outputs: Phase II Design, Trade-Off Studies, Gap Analysis, comments from reviewers (including CMGC)

3.2.5.3 Detailed Design (Phase III Submittal)

- Inputs: Phase II Design comments
- Activities: Design Consultant prepares detailed design (Phase III). Phase III design review. Prepare technical special provisions and modified special provisions.
- Outputs: Phase III Design, comments from reviewers (including CMGC)

3.2.5.4 Final Design (Phase IV Submittal)

- Inputs: Phase III Design comments
- Activities: Design Consultant prepares detailed design (Phase IV), also known as "final plans". Phase IV design review. Finalize specifications package with approved technical special provisions and modified special provisions.
- Outputs: Final Plans, comments from reviewers (including CMGC)

3.2.5.5 Plans, Specification, and Estimates (PS&E)

- Inputs: Phase IV Design comments

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- Activities: Design Consultant prepares PS&E package for review and approval by FDOT District 5. Following approval, package is submitted to FDOT Central Office for final approval.
- Outputs: Approved construction contract documents.

3.2.6 FCC Licensing

- Inputs: Detailed Design
- Activities: Submit for and obtain FCC licenses for any wireless equipment operating in licensed frequency band. Perform any frequency coordination required. Licensing effort is led by Design Consultant in coordination with FDOT Central Office and Marion County.
- Outputs: Approved FCC licenses.

3.2.7 CMGC Price Proposal and Evaluation

- Inputs: Final Design
- Activities: CMGC prepares a lump sum price proposal for construction. FDOT District 5 reviews the proposal and determines whether or not to accept.
- Outputs: Accepted/Rejected CGMC Price Proposal

3.2.8 Construction

3.2.8.1CEI Acquisition

- Inputs: Final Design
- Activities: FDOT procures a CEI to oversee construction
- Outputs: CEI acquired

3.2.8.2 Notice To Proceed

- Inputs: Accepted CGMC Price Proposal
- Activities: FDOT issues Notice To Proceed to CGMC based on the accepted CGMC's price proposal
- Outputs: Notice to Proceed

3.2.8.3 Construction Kick Off Meeting

- Inputs: Notice To Proceed, Meeting Agenda

- Activities: FDOT Design Project Manager handoff to FDOT Construction Project Manager and discuss construction activities.
- Outputs: Construction starts, Meeting Minutes

3.2.8.4 Construction Phase Management

- Inputs: Notice to Proceed
- Activities: Monitoring of construction by CGMC, FDOT Construction Project Manager, and CEI
- Outputs: Project constructed and integrated.

3.2.9 Verification

3.2.9.1Test Plan

- Inputs: Construction and integration complete
- Activities: CGMC prepared Test Plan based on the project specification requirements.
- Outputs: Approved Test Plan

3.2.9.2 Test Readiness Review

- Inputs: Test Plan, Meeting Agenda
- Activities: Meeting between FDOT Construction Project Manager, CEI, and CGMC to discuss test readiness and go over Test Plan.
- Outputs: Meeting minutes, start of testing

3.2.9.3 System Testing

- Inputs: Test Plan, Constructed System
- Activities: Field Acceptance Test, System Acceptance Test, Operational Test
- Outputs: Completed test forms

3.2.9.4 Hot Wash-Up Review

- Inputs: Test results, Meeting Agenda
- Activities: Discuss testing results and develop a corrective action plan for problems identified during testing
- Outputs: Corrective action plan, Meeting Minutes

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3.2.9.5 Operational Readiness Review

- Inputs: Test results, Hot Wash-Up Review Minutes, Corrective action plan
- Activities: Identify tasks that must be completed before the system can be place into full-scale operation.
- Outputs: Determination on whether or not to proceed with operation of the system

3.2.9.6 Final Acceptance

- Inputs: Constructed system, completed system verification
- Activities: Issue final acceptance to the CMGC after confirming that all construction contract requirements are met.
- Outputs: Issuing final acceptance, lessons learned report

3.2.10 Validation

- Inputs: Complete and accepted system, System Validation Plan
- Activities: Marion County performs validation following the System Validation Plan.
- Outputs: System validation or report of unfulfilled system MOEs

3.2.11 Operations and Maintenance

- Inputs: Complete and validated system
- Activities: Operations and maintenance of the system.
- Outputs: Operation and maintenance of the system over its lifecycle.

3.3 Managing the Schedule with the Project Evaluation and Review Technique (PERT) / Critical Path Method (CPM)

Detailed schedules for the design and construction phases will be maintained as separate deliverables by the FDOT Design Project Manager and FDOT Construction Project Manager.

3.4 Procurement Management

The CMGC project delivery method has been selected for this project. Acquisition of professional consultant services (the Design Consultant) will be performed by FDOT District 5 for preparation of the plans and specifications. FDOT District 5 will also acquire a CGMC through advertisement of an RFP soliciting technical proposals from interested CGMC firms—

selection will be based on the technical proposal with the best score where scoring is performed as described in the RFP.

FDOT District 5, at the end of the design phase, will request a price proposal from the CGMC to provide construction service. If accepted, the CGMC will move forward with construction.

The selected CMGC is responsible for completion of all furnishing, installation, integration, testing, and other construction activities as required in the Contract Documents. All ITS devices must meet the project specifications and be listed on the FDOT's Approved Products List (APL) where applicable.

3.5 Communications Management

3.5.1 Communication Channel

During design the Consultant Project Manager and the FDOT Design Project Manager will be the primary communication channel; they will collectively manage design phase communication.

During construction, the Contractor's Project Manager, CEI Consultant, and FDOT Construction Project Manager will be the primary communications channel for the project; they will collectively manage construction phase communication.

The project managers provide direction, clarification, or tuning of communication patterns and protocols used. This includes things like who is copied on emails or provided with meeting minutes.

3.5.2 Meetings

Meeting minutes must be developed for all stakeholder meetings during design and construction phases and distributed to all attendees.

3.5.3 Design Review

All review comments made during design, and their associated responses, will be stored in FDOT's ERC system.

3.5.4 Central Project Documentation Repository

All project documentation will be stored in FDOT's Electronic Document Management System (EDMS) following that system's standard policies and procedures.

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3.6 Cost Management

The design contract method of compensation is Lump Sum. The Design Consultant will invoice FDOT monthly following the design contract requirements. The Design Consultant will monitor design costs but not report actual costs incurred to the Department. Throughout the design phase, the Design Consultant will estimate the cost of constructing the system following FDOT's standard practices (long-range estimating system, Transport, etc.) to ensure that the system design remains in line with the allocated construction funding.

The construction contract method of compensation will be defined in the Contract Documents. Invoicing will follow standard FDOT practices for Design-Bid-Build construction contracts. The CMGC will be responsible for management of its subcontractors and monitoring of actual construction costs. Given the CGMC's role in developing the price proposal and involvement in the design phase, the risk of cost increases during construction should be less than a traditional Design-Bid-Build.

3.7 Risk Management

Project risks will be managed as described in Section 2.6. During the design phase, the FDOT Design Project Manager will be primarily responsible for risk management, whereas during construction the FDOT Construction Project Manager will be.

3.8 Subcontractor Management

During design the Design Consultant will manage all of their specialized subconsultant engineers.

During construction the CMGC will manage of their specialized subcontractors.

3.9 Engineering Specialty Integration

Document the project's engineering specialty activities in this section and identify who will manage the specialty activities. This section will be updated upon ConOps approval.

3.10 Integrated Logistics Support and Maintenance Engineering

Identify the support requirements, considerations, and needed resources in this section over the project's life cycle. This section will be updated upon ConOps approval.

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3.11 Project Status Reviews

During design, the FDOT Design Project Manager will determine health of the project considering the design progress, design schedule progress, and a review of the active risk items during monthly project status reviews. The Design Consultant Project Manager is to be involved in these monthly reviews, at a minimum, with other project team members included as determined by the FDOT Design Project Manager and Design Consultant Project Manager. Upon completion of each monthly review, the schedule is to be updated to reflect the project's current status; meeting minutes are to be recorded and kept in a separate document from the schedule. Various issues may be discussed at these meetings, but the following items must be discussed in detail:

- Review of action items and resolutions from the last monthly meeting
- Critical path tasks status reviews
- Review of major risk items
- Action items for the subsequent month

During the construction phase the CMGC will meet with the FDOT Construction Project Manager and/or the CEI Consultant on a weekly basis and provide a one-week look ahead schedule for activities to be performed during the coming week. At the weekly meeting a variety of issues may be discussed, and meeting minutes are to be recorded, but the following items must be discussed at a minimum:

- Review of action items and resolutions from the last weekly meeting
- Critical path tasks status reviews
- Review of major risk items
- Action items for the subsequent week

On a monthly basis the CMGC is to provide a written progress report that describes the items of concern and the work performed on each task during the previous month.

3.12 Change Management

The FDOT Design or Construction Project Manager, depending on the current phase of the project, addresses changes in schedule and the subsequent impacts by adjusting the schedule and cost metrics. Sometimes changes in task durations give rise to a new critical path for the project, which must be monitored as the project proceeds.

Changes in basic system requirements need careful review; in such cases, the FDOT Design or Construction Project Manager informs stakeholders of the changes and the resultant outcomes expected. The FDOT Design Project Manager decides if design changes will be accepted and the FDOT Construction Project Manager, or CEI Consultant acting as their representative, makes

decisions regarding construction changes. All changes must be well documented, and the anticipated effects of such changes distributed to impacted stakeholders.

All design changes made during construction must be documented in the as-built records—follow the FDOT ***Construction Project Administration Manual*** and ***Statewide Standard Specifications*** which provide a detailed set of procedures and requirements for creating as-built records.

For amendments to the construction contract—due to unforeseen field conditions, plan deficiencies (errors or omissions), extra/unanticipated necessary work, or design criteria changes—follow the FDOT's standard change order process. These procedures may be obtained by contacting the District 5 Construction Office. A change order is a bilateral amendment to the Construction Contract agreed upon between both the FDOT and CMGC.

3.13 Quality Management

Development and application of effective Quality Assurance/Quality Control (QA/QC) processes are important to project success, and must be followed during both design and construction.

The Design Consultant develops a design QA/QC Plan; this QA/QC Plan is submitted to FDOT District 5 for review and approval prior to commencement of the consultant's activities.

The CMGC develops a construction QA/QC Plan that is submitted to FDOT District 5 for review and approval prior to commencement of construction.

The Design Consultants and CMGC are responsible for ensuring that the processes described in their QA/QC plans are implemented. At any time, during project design or construction, FDOT may audit the QA/QC process, at which time proof of adherence to the QA/QC Plan must be furnished for review.

3.14 Systems Acceptance

The systems acceptance process is critical—this is where FDOT becomes responsible for the continued maintenance and management of the systems, products, and processes delivered by the Contractor. The FDOT Construction Project Manager will assign the FDOT personnel, the CEI Consultant staff, or a specialty test engineering representative to oversee and witness the project testing. The assigned project team members must familiarize themselves with the approved Test Plan provided by the CMGC; be familiar with the system being tested and the test being performed; be familiar with the system MOPs and MOEs; and be contractually authorized to accept the results of the test. The parameters which warrant a passed or failed test will be provided in the Test Plan, and will have been mutually agreed upon by the FDOT and CMGC prior to commencement of testing. Upon completion of each test, the test result information will

be entered into the appropriate test form provided in the Test Plan, from which the test results will be reviewed to determine if each test has been successfully completed.

Prior to final system acceptance the following tasks must be completed:

- Construction and integration must be substantially or fully complete, as determined by the FDOT Construction Project Manager.
- All testing phases must be completed and the results for each test must demonstrate satisfactory system performance.
- The OT period must be successfully completed.
- All as-built plans must be signed and sealed by the appropriate engineers and submitted to the FDOT Construction Project Manager.
- All asset management information (including fulfillment of ITSFM[1] requirements) must be compiled and submitted in the appropriate format to the FDOT.
- Final inspections of the entire system, by the FDOT Construction Project Manager and/or their CEI Consultant in the presence of the CMGC, must be complete and any noted deficiencies addressed and re-inspected.

Upon receipt and detailed review of the items described above, the FDOT Construction Project Manager, who may delegate review of certain items, will determine if the Contractor has met all obligations of the Construction Contract Documents. If all such obligations are met, final system acceptance will be granted and written notice will be provided to the CMGC by the FDOT Project Manager or CEI Consultant.

3.15 Operations and Maintenance, Upgrade, and Retirement

Marion County will be responsible for operations, maintenance, upgrade, and retirement of the system.

Marion County's funding for system operations, maintenance, upgrade, and retirement will be provided in the same manner used to fund their existing maintenance operations, which includes reimbursement for maintenance of traffic signals on the State Highway System—additional compensation is provided for network connected traffic signals—as described in the ***Traffic Signal Maintenance and Compensation Agreement*** between Marion County and FDOT.

[1] ITSFM is FDOT's GIS-based facility management system used to assist in management of their ITS infrastructure.

Maintenance will be completed primarily by Marion County personnel. The scope of anticipated impacts to maintenance and operation processes will be assessed in the ConOps. System component upgrades and retirement will be performed under separate contracts, with funding sources consistent with standard County practices.

3.16 Lessons Learned

In every project, there are lessons to be learned. This section will be updated throughout project development, and will be used to provide improved guidance for future projects or, if feasible, for future phases of this project. Lessons learned are to either be included in this section, or added to a lessons learned depository created for this project and referenced herein.

At a minimum the following meetings to discuss lessons learned are to be held:

- Upon completion of the design stage, the FDOT Design Project Manager and Design Consultants will meet discuss and record lessons learned during design.
- Upon completion of construction, the Contractor and FDOT Construction and ITS personnel will meet to discuss and record lessons learned during construction.

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4. Appendix

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4.1 Risk Assessment and Compliance Checklist

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PROJECT RISK ASSESSMENT AND REGULATORY COMPLIANCE CHECKLIST

(Required for federally funded ITS project; may also be required for state funded ITS project as determined by the FDOT District ITS Program Engineer)

Instructions for submitting checklist:

Project manager (individual responsible for the execution and completion of ITS Project, i.e. FDOT PM or local agency PM depending on project ownership) must submit completed form electronically as follows:

To Whom	By When	Under What Conditions
• FHWA Florida Division ITS Engineer	• Prior to authorization of federal funds, and • Within 90 calendar days prior to FDOT final acceptance (complete checklist)	• Project under full FHWA oversight
• FDOT District TSM&O Program Engineer • FDOT State Traffic Engineering and Operations Office, TSM&O Division • TSM&O Program State ITS Software Engineer (sysandarch@dot.state.fl.us)	• Prior to authorization of federal funds, and • Within 30 calendar days following FDOT final acceptance (complete checklist)	• Federally funded project • State funded project if required by the FDOT District TSM&O Program Engineer
• FDOT District Local Programs Administrator	• Prior to authorization of federal funds, and • Prior to FDOT final acceptance (complete checklist)	• Local agency project under FDOT delegated oversight

SECTION 1 – Project Information

1.1 Financial Project ID (If Available): 436361-1

1.2 Agency: FDOT District 5 & Marion County

1.3 Agency contact's name, phone and e-mail:

Noemí S Rodríguez Bonilla, P.E. - FDOT Project Manager
Noemi.RodriguezBonilla@dot.state.fl.us
386-943-5327

1.4 Project title, description, and location:

Title: Marion County ITS Operational Improvements
Location: Marion County, FL
Description: Design and construction of ITS network improvements in Marion County to enhance the County's existing ITS network that interconnects traffic signals, operations facilities, and ITS devices maintained and operated by the County.

1.5 Nature of work (Check all that apply):

☐ Software development ☒ ITS implementation ☒ Traditional construction with ITS
☐ Operations ☐ Maintenance (Equipment replacement) ☐ Other

If Other, explain:

PROJECT RISK ASSESSMENT AND REGULATORY COMPLIANCE CHECKLIST

(Required for federally funded ITS project; may also be required for state funded ITS project as determined by the District ITS Program Engineer)

1.6 Questions:

Instructions for answering questions: If you are unsure about a question, be conservative. If all "Yes" are selected, that is a preliminary indication of a low-risk project. If there is even one "No" selected," the project is high-risk. Use Table 1: Risk Assessment for Intelligent Transportation System (ITS) Projects within the procedure for additional details regarding each question.

	Yes	No
a. Will the project depend on only your agency to implement and operate or is there an existing multi-agency agreement in place?	☒	☐
b. Will the project use only software proven elsewhere, with no new software writing or no software at all?	☒	☐
c. Will the project use only hardware and communications proven elsewhere or no hardware at all?	☒	☐
d. Will the project use only existing interfaces (no new interfaces to other systems)?	☒	☐
e. Will the project use only existing system requirements that are defined in writing (can reuse requirements from other projects)?	☐	☒
f. Will the project use only existing operating procedures that are defined in writing?	☒	☐
g. Will the project use only technologies with service life longer than 2-4 years?	☒	☐

SECTION 2 – Regulatory Compliance Information

Answering regulatory compliance items: Ensure each item is fully addressed and documented before project completion as these items are required in 23 CFR 940.11. If the preliminary indication shows a low-risk project and you are able to address all seven items in section 2 completely and with certainty, then self-certify the project as low-risk. You may reference existing documents if they are being reused for this project. Otherwise, the project must be classified as high-risk and the System Engineering Project Checklist (Topic Number 750-040-06) and supporting documents required by section 2.2 of the System Engineering and ITS Architecture Procedure (Topic Number 750-040-003) must be completed. If you feel this is not justified, you may request a review of this information by FHWA. Information for items 2.1, 2.2 and 2.7 is required upon first submittal. If any of the other items below cannot be fully addressed now, but will be answered during the project implementation, please indicate the step at which the items will be answered and resubmit in accordance with instructions for submitting checklist, once all items are fully answered.

2.1 Identification of portions of the Regional ITS Architecture (RITSA) being implemented (23 CFR 940.11 (c)(1)):

Instructions: Locate RITSA. In the RITSA, the project might be identified specifically by name and agency, or by a more generic description (e.g. "Arterial Traffic Management"). For high-risk projects, indicate where the architecture information can be found in the Concept of Operations. If listed in the RITSA, document which inventory elements, service packages, subsystems, and/or information flows are being completed in this project, either below or in an attached document. If there is no information in your RITSA, arrange with your District TSM&O Program Engineer to provide this information when your project is designed; the Central Office TSM&O Program will use it in the next update of the RITSA.

Project will be added to the RITSA using FDOT's standard update procedure.

2.2 Identification of participating agencies roles and responsibilities (23 CR 940.11 (c)(2)):

Instructions: Can you identify all stakeholders that must participate in the implementation phase of this project? What are their roles/responsibilities? Have they committed to the responsibilities? Some of this information might appear in your RITSA (e.g., "Operational Concepts" or other sections). If this will be defined in a later phase of the project (e.g., Concept of Operations), the RITSA may be a good source to start definition.

FDOT District 5 will manage design and construction of the system. Design consultant will prepare the systems engineering documents, create the plans and specifications, and write the Construction Manager/General Contractor (CMGC) RFP. A CMGC will be selected to perform construction, integrating, and testing of the system. Marion County will perform system validation following construction.

2.3 Procedures and resources necessary for operations and management of the system (23 CFR 940.11 (c)(7)):

Instructions: Can you identify all stakeholders that must participate in operations, management, and maintenance of the system throughout its life cycle? What are the roles, responsibilities, and resources required from each stakeholder? Examples include: money, special equipment, staff time, special expertise, provision of data, and many more. You should also consider hardware, software, and communications issues.

PROJECT RISK ASSESSMENT AND REGULATORY COMPLIANCE CHECKLIST

(Required for federally funded ITS project; may also be required for state funded ITS project as determined by the District ITS Program Engineer)

Marion County will operate, manage, and maintain the system. Further detail is provided in the ConOps. A maintenance agreement between FDOT and Marion County will be required to solidify maintenance responsibilities for portions of this project installed off of the State Highway System. Marion County will be solely responsible for operations and maintenance of all elements of the project installed outside of the State Highway System right-of-way.

2.4 Requirements definitions (23 CFR 940.11 (c)(3)):

Instructions: Are the system requirements (functional and performance) already well-defined in writing? If yes, indicate where they can be found (e.g., Std. Specs). If they will be defined in a later phase of the project, the applicable high-level functional requirements in the RITSA may be a good starting point for writing them. The focus is on "what" functions must be performed – not on "how" the technology will be used to perform them.

Yes; Refer to ConOps.

2.5 Identification of applicable ITS standards and testing procedures (23 CFR 940.11 (c)(6)):

Instructions: Do you know yet if any ITS Communications Standards are applicable to this project? If they are applicable, will you use them? Some of this information might appear in your RITSA. If your RITSA identifies specific Architecture Flows, ITS Standards to consider should also be identified within it.

Refer to project entry into RITSA. Project will be added to RITSA on next update following FDOT's standard procedure. FDOT Standard Specifications will be used for most of the project components.

2.6 Analysis of alternative system configurations and technology options to meet requirements (23 CFR 940.11 (c)(4)):

Instructions: Have you considered alternative designs yet? This could include system configurations; different organizational roles; and alternative hardware, software, or communications technology. If you cannot yet make a choice of available alternatives, this analysis will occur in a later phase of the project (High-Level Design).

Will be performed by Design Consultant during design phase.

2.7 Procurement options (23 CFR 940.11 (c)(5)):

Instructions: Have you considered different procurement options for each of the project phases (design, implementation, operation, and management)? These options could include: off-the-shelf vs. custom, lease vs. buy, fixed-price vs. cost-reimbursable, etc. Procurement options must consider the level of staff technical expertise, existing agency procurement practices, who will be the project manager, and whether you need a systems engineer and/or system integrator.

Central office has instructed use of Construction Manager/General Contractor procurement (design and implementation).

Comments or additional information (if needed):

List of attachments:

[Source: Caltrans Local Assistance Procedures Manual, Chapter 7, Systems Engineering Review Form]
http://www.dot.ca.gov/hq/LocalPrograms/lam/lapm.htm

4.2 System Engineering Project Checklist

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SYSTEMS ENGINEERING PROJECT CHECKLIST

(Required for federally funded high-risk ITS project; may also be required for state-funded high-risk ITS project as determined by the FDOT District TSM&O Program Engineer)

Instructions for submitting checklist:

Project manager (individual responsible for the execution and completion of ITS Project, i.e. FDOT PM or local agency PM depending on project ownership) must submit completed form electronically as follows:

To Whom	By When	Under What Conditions
• FHWA Florida Division ITS Engineer	• Within 90 calendar days prior to FDOT final acceptance (complete checklist)	• Project under full FHWA oversight
• FDOT District TSM&O Program Engineer • FDOT State Traffic Engineering and Operations Office, TSM&O Division • TSM&O Program State ITS Software Engineer (sysandarch@dot.state.fl.us)	• Within 30 calendar days following FDOT final acceptance (complete checklist)	• Federally funded project • State funded project if required by the FDOT District TSM&O Program Engineer
• FDOT District Local Programs Administrator	• Prior to FDOT final acceptance (complete checklist)	• Local agency project under FDOT delegated oversight

SECTION 1 – Project Information

1.1 Financial Project ID (If Available): 436361-1

1.2 Agency: FDOT District 5

1.3 Agency Project Manager's name, phone and e-mail:

Noemí S Rodríguez Bonilla, P.E. - FDOT Project Manager
Noemi.RodriguezBonilla@dot.state.fl.us
386-943-5327

1.4 Project title, description, and location:

Title: Marion County ITS Operational Improvements
Location: Marion County, FL
Description: Design and construction of ITS network improvements in Marion County to enhance the County's existing ITS network that interconnects traffic signals, operations facilities, and ITS devices maintained and operated by the County.

SECTION 2 – Systems Engineering Management Plan

2.1 Is there a Project Systems Engineering Management Plan (PSEMP), as required in FDOT procedure 750-040-003?

☒ Yes. Please provide document

SECTION 3 – Architecture Assessment

3.1 Portions of architecture(s) implemented by project:

☐ Statewide ☐ District 1 ☐ District 2 ☐ District 3 ☐ Districts 4 & 6
☒ District 5 ☐ District 7 ☐ Florida's Turnpike Enterprise ☐ None

SYSTEMS ENGINEERING PROJECT CHECKLIST

(Required for federally funded high-risk ITS project; may also be required for state-funded high-risk ITS project as determined by the FDOT District TSM&O Program Engineer)

3.2 Is the project included in the architecture? ☒ No ☐ Yes

If "Yes" was selected, please provide the corresponding service package diagram and, as needed, include revisions to diagram. If "No" was selected, please specify reason:

Project will be added to the District 5 RITSA following the FDOT-standard architecture update process.

3.3 Are changes needed to the architecture(s)? ☐ No ☒ Yes

If "Yes" was selected, please specify changes (including service package diagram), indicate reason for changes, and include any additional stakeholder(s) that may be affected by the changes and prepare and submit an ITS Architecture Change Request Form: (750-040-04):

Project will be added to the District 5 RITSA following the FDOT-standard architecture update process. Refer to PSEMP and ConOps for more information.

SECTION 4 – Alternative Analysis

4.1 Is there an analysis of alternative system configurations and technology options to meet requirements, as required in FDOT procedure 750-040-003?

☐ Yes. Please provide document.

SECTION 5 – Concept of Operations

5.1 Is there a Concept of Operations, as required in FDOT procedure 750-040-003?

☒ Yes. Please provide document.

SECTION 6 – Requirements Definitions (High-Level and Detailed)

6.1 Are high-level requirements determined, as required in FDOT procedure 750-040-003?

☒ Yes. Please provide document.

6.2 Are detailed requirements determined?

☒ No ☐ Yes

6.3 Is there a requirements traceability verification matrix, as required in FDOT procedure 750-040-003?

☒ Yes. Please provide document.

SECTION 7 – High Level and Detailed Design

7.1 Is there a high-level design available? ☒ No ☐ Yes

7.2 Is there a detailed design available? ☒ No ☐ Yes

7.3 Are ITS standards (national and/or FDOT) identified, as required in FDOT procedure 750-040-003?

☒ Yes. Please provide document.

SYSTEMS ENGINEERING PROJECT CHECKLIST

(Required for federally funded high-risk ITS project; may also be required for state-funded high-risk ITS project as determined by the FDOT District TSM&O Program Engineer)

SECTION 8 – Implementation

8.1 Procurement methods

☐ Task Work Order ☐ Low Bid Contractor with Consultant Design ☐ Design-Build
☐ Systems Manager ☐ Systems Integrator ☐ Invitation to Negotiate ☒ Other

If "Other" was selected, please specify:

Construction Manager/General Contractor

8.2 Are there any agreements that must be implemented between users/agencies in order to implement the project?

☒ No ☐ Yes

If "Yes" was selected, please list agreements:

SECTION 9 – Integration and Verification

9.1 Is there an integration plan? ☒ No ☐ Yes

9.2 Is there a system verification plan, as required in FDOT procedure 750-040-003?

☐ Yes. Please provide document.

SECTION 10 – System Validation and Acceptance

10.1 Is there a system validation plan, as required in FDOT procedure 750-040-003?

☒ Yes. Please provide document.

SECTION 11 – Operations and Management

11.1 Is there an operations and management plan, as required in FDOT procedure 750-040-003?

☐ Yes. Please provide document.

Comments or additional information (if needed):

The system verification plan for this project will be the Test Plan created by the CMGC. The Test Plan will follow the project specifications, which include detailed testing requirements. System integration will be performed by the CMGC, who will work closely with Marion County and District 5 TSM&O staff, in accordance with the project speficiations.

List of attachments: