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INTEGRATED CORRIDOR MANAGEMENT (ICM)

FINAL Regional Traffic Signal Optimization Concept of Operations

July 31, 2019

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1 Introduction

This document details the Concept of Operations (ConOps) for Regional Traffic Signal Optimization developed as part of the Des Moines Metropolitan Area Integrated Corridor Management (ICM) Program. The ICM Program was developed to proactively address current and anticipated instances of congestion along transportation corridors. The Iowa Department of Transportation (DOT), in cooperation with regional stakeholders, has identified arterial-level traffic signal operations and specifically the need to optimize signal timing as a priority strategy within the context of ICM.

1.1 PROJECT BACKGROUND AND UNDERSTANDING

During the development of the Des Moines Metropolitan Area ICM Program, stakeholders prioritized a number of strategies that could be implemented to support the ICM vision and goals of the ICM Program, including safety, mobility, reliability and accessibility. Traffic signal timing is of critical importance to an agency and the traveling public as poor or outdated signal configurations can adversely impact safety and create unnecessary delay, queuing, conflicts, and environmental impacts. While this is the case at any individual signalized intersection, it becomes more evident within an ICM corridor where multiple agencies are focused on moving the greatest number of people.

1.1.1 Traffic Signal Operations

Traffic signal operations is the application of traffic engineering principals at signalized intersections to manage specific performance measures. In the most basic sense, the function of a traffic signal is to alternate signal phases to assign vehicle right-of-way and prevent crashes at an at-grade intersection. However, the efficiency at which the traffic signal can perform that singular task is measured through vehicle delays, queuing, and the concept of intersection level of service.

The operation of a traffic signal is governed by intersection geometry, traffic volume, and signal timing. In Phase 1 of the Des Moines ICM Program, there are no plans to reconstruct intersections and modify capacity or operations through changes in geometry. The most immediate way to improve the operation of traffic signals is through optimizing signal phasing and timing.

Traffic volume is a function of land use, regional roadway networks, and time-of-day. While volumes can vary significantly throughout a given timeframe, there are patterns that can be identified by time of day, day of week, and conditions such as weather or events. Traffic signals are typically designed and operated to accommodate a range of volume through separate timing plans for different times of day, most typically peak-periods. In addition to peak-periods, other conditions that generate unique volumes, such as special events or traffic incidents, can be identified for development of timing plans.

While agency staff cannot directly control traffic volume, traffic signal timing is one feature that is flexible and can be controlled. Signalized intersections require two main components to control traffic – the signal controller and detection equipment. The signal controller is the computer equipment that governs the on-site processing of signal changes and can operate in a variety of modes – pre-timed, actuated, or semi-actuated. The difference in these modes is related to the availability of detection on approaches to the intersection. Pre-timed operation does not rely on detection and runs a fixed sequence and phase duration. Actuated operation relies on vehicle detection on each approach and can respond to changes in traffic volume by changing the sequence and length of each signal phase. Semi-actuated is similar to actuated but with detection present only on some approaches, usually the minor street.

Phasing, split timing, and cycle length are the primary variables in signal timing. The phasing refers to the pattern or sequence or order in which different traffic movements are assigned right-of-way. Split

timing refers to the length of time the phases are allowed to operate. Split timing are fixed durations for pre-timed operations and are governed by minimum and maximum times for actuated control. The cycle length is the time duration for a single completion of the entire phase sequence.

1.1.2 Importance of Traffic Signal Operations

Traffic signal operation is typically the key component in arterial traffic management as signalized at-grade intersections introduce delay and act as bottlenecks along a corridor. While reconstruction and other capital-intensive projects and intersection improvements, such as adding turn lanes or changing the allowable movements from a given lane, can improve intersection operations, adjustments to traffic signal timing are typically the quickest and least expensive method to improve operations at an intersection or along an entire corridor. Routine traffic signal maintenance and evaluation is required to maintain acceptable (or optimal) operation.

Traffic signal timing is typically analyzed by engineers or agency staff when traffic signal equipment is initially installed or upgraded. Signal timing should be analyzed and updated periodically after installation. However, a lack of resources can limit an agency's ability to routinely evaluate traffic signal operations for AM and PM peak and off-peak operations let alone other times of day that have significantly different traffic conditions, weekends, or for incident scenarios. Staff observation or public complaints are the primary triggers for agencies to re-evaluate signal timing and address shortcomings in level of service. Changes in traffic patterns, via short-term variations or long-term growth, are the common variables that create operational issues associated with traffic signals.

1.2 PROJECT SCOPE AND UNDERSTANDING

Efficient traffic flow on regionally significant arterials is important to the overall operation of the Des Moines ICM Program. Efficient arterial operations are particularly important when there are incidents, work zones, or special events that affect other facilities in the corridor, especially the freeways. Optimizing traffic signal operations on arterials that cross jurisdictional boundaries requires additional coordination. Traffic signal timing is a function of individual agencies that own and operate signalized intersections. Addressing signal timing and optimizing performance along corridors that cross political boundaries adds a level of complexity because of the interagency collaboration that is required. In addition, some agencies do not have adequate resources or capacity to address all their needs, making coordinating operations with neighboring jurisdictions even more challenging. This project-level ConOps highlights the process for identifying high priority signal optimization needs on arterials that are regionally significant and provide agencies with assistance in optimizing traffic signal operations on those arterials.

1.2.1 Project Timeline

As part of the ICM effort, stakeholders and the public have been engaged in a series of activities that began in October 2018. The following is a list of the activities undergone as part of this effort and which provided input for this document:

- Stakeholder Kick-off Meeting (October 2018)
- Stakeholder Visioning Workshop (November 2018)
- Public Scoping Meeting (January 2019)
- Stakeholder ConOps Workshop (March 2019)

A stakeholder working group comprised of agency staff focused on traffic signal operations was identified during the development of this ConOps and met to provide guidance, answer technical questions, and review proposed approaches to improving signal operations on regionally significant arterials.

1.2.2 Project Boundaries

The Des Moines Metropolitan Area ICM Program is a regional effort focusing on key corridors within Des Moines region. The Regional Traffic Signal Optimization Project is an element of the overall ICM Program. It is focused on arterials that are key to providing safe and reliable transportation in the Region. The project area is shown in Figure 1.

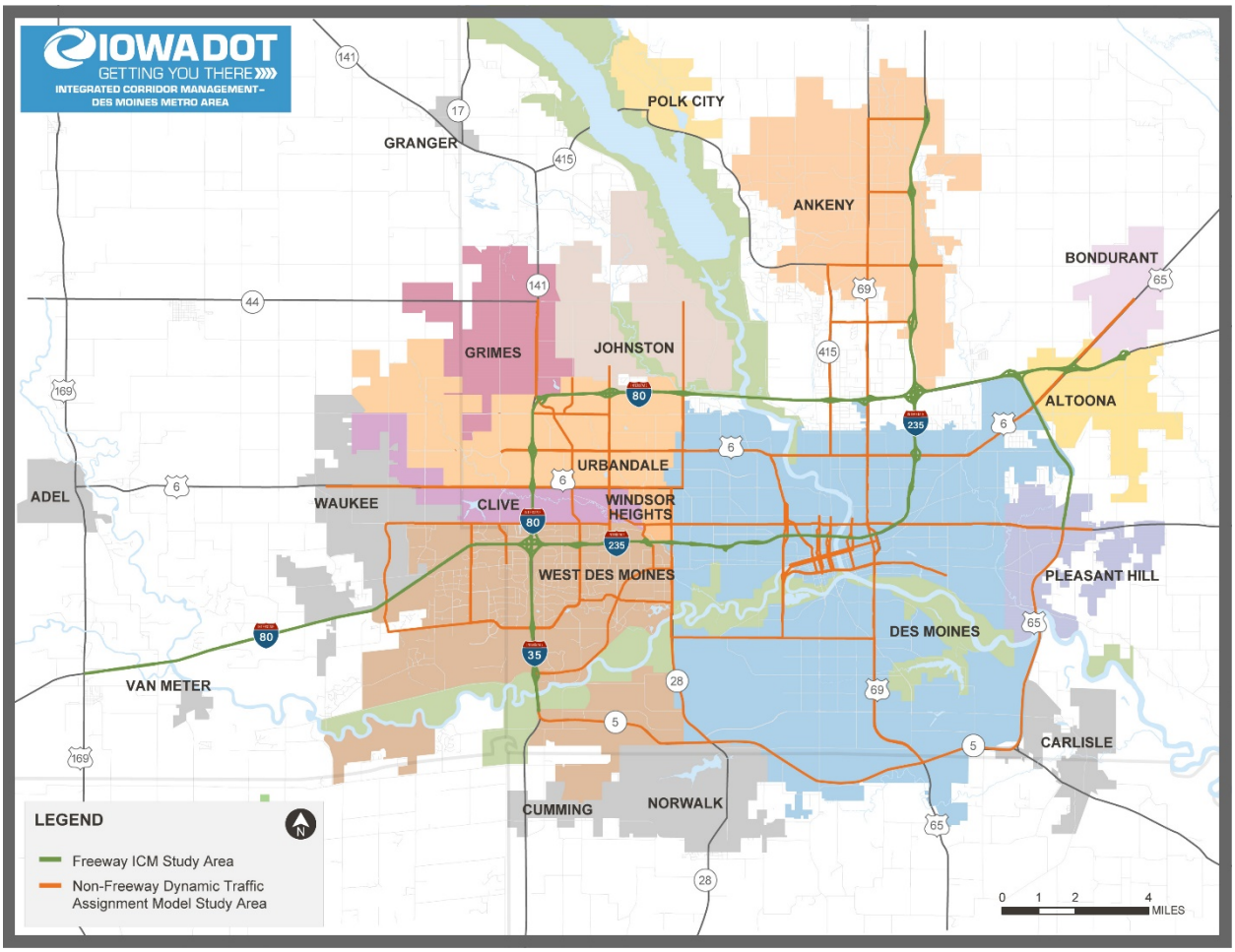

Figure 1: Des Moines Metropolitan Area ICM Program Area

1.3 DOCUMENT SCOPE AND UNDERSTANDING

The Regional Traffic Signal Optimization ConOps for the Des Moines ICM Program provides the guidance and structure for agencies operating regionally significant signalized arterial roadways to obtain assistance in optimizing signal timing along those arterials. The document is written so that all stakeholders, regardless of their background, can easily understand where in the framework they fit and what general responsibilities they have in the activity. The ConOps is written in a non-technical manner so that each stakeholder has the opportunity to understand the signal optimization concept and the ability to provide feedback on this concept. The ConOps fosters an environment where stakeholders can collaborate to exchange ideas and gain consensus on how to proceed with implementing the regional traffic signal optimization concept.

1.3.1 What is a Concept of Operations?

Ultimately, this project-level ConOps answers the who, what, when, where, why, and how questions regarding regional traffic signal optimization efforts.

- Who? — Identifies the various agencies or people involved in the process.
- What? — Identifies the known system components/elements and high-level capabilities required. Note this is with respect to all elements of the system—whether human or machine (hardware/software).
- When? — Identifies the activities and tasks of the process, including any required time sequence (precedence, concurrence), and operations under various conditions.
- Where? — Describes the physical and geographic location and environment.
- Why? — Explains the reasoning behind specific sequences or partitioning of tasks (e.g., policies, skill sets).
- How? — Wraps together all the above to explain how the process is to function.

Project Level Concept of Operations

This document serves as a project-level ConOps, describing how an individual ICM strategy will work to meet the high-level ICM vision and its corresponding goals and objectives.

This project-level ConOps focuses on the specific operational needs for regional traffic signal optimization and identifies roles and responsibilities for planning, implementing, operating, and maintaining the strategy. It is important to note that this ConOps defines the process for making decisions about what arterials should be part of an ICM Program signal timing optimization effort based on stakeholder input. The ConOps is not static and will need to be updated as new information arises during the life of the ICM Program.

Program Level and Project Level Concept of Operations Relationship

A program-level ConOps was prepared for the overarching ICM effort and serves as the framework for future projects and efforts. The Program-Level ConOps focuses on the overall vision and objectives of the ICM Program, provides an area-wide perspective, describes how various strategies will work together, and describes how the ICM Program will be managed. The Program Level ConOps is designed to reduce agency burden in developing ICM projects by providing information and understanding common to most or all ICM projects.

The project level ConOps identifies project specific details not found in the program level ConOps. As project champions use this regional traffic signal optimization project ConOps, they will need to refer to the Program-Level ConOps to verify the larger goals and objectives are being met and to determine how other strategies can be integrated. While each Project-Level ConOps is a standalone document, the program-level ICM ConOps will assist in connecting the different ICM strategies and efforts.

1.3.2 Development Process and Approach

Stakeholder involvement was essential in the development of the ConOps as consensus is needed related to goals, objectives, and responsibilities of the project and its members.

The Regional Traffic Signal Optimization ConOps was developed using a disciplined systems engineering approach. Systems engineering is a method to facilitate the development, maintenance, refinement, and

retirement of dynamic systems comprising both technological components (machines, information systems, etc.) and human components (users, stakeholders, etc.). Within the systems engineering approach, the ConOps is typically one of the earlier stages and serves as the principal guidance document for future steps within the design process.

Stakeholder Outreach

Stakeholder involvement is key to developing consensus on the operation of a system or subsystem. As part of the program-level ConOps process, a Stakeholder and Public Engagement Plan was developed that outlined specific steps, methods, and timeframes for outreach with the goal to actively identify and engage key stakeholder audiences and the general public throughout the ICM development process.

As part of the project-level ConOps, stakeholder involvement focused on a smaller subset of groups or individuals who are focused on traffic signal operations. A traffic signal operations working group was identified to facilitate development and review of the ConOps and will continue to be engaged as the ICM Regional Traffic Signal Optimization project is implemented. An initial kick-off meeting with this working group was held on June 11, 2019 to discuss current agency capabilities and to solicit input into this proposed process. Meeting minutes are provided in the Appendix.

1.3.3 Audience

The following groups or categories of audience members have been identified for this document:

- Elected officials
- Transportation agencies
- Metropolitan planning organizations
- Law enforcement
- Emergency responders (fire, medical)
- Transit providers
- Engineering firms
- Professional organizations
- Commercial vehicle operators and organizations
- Road users/general public

Within each of the above groups or categories, there are multiple types of audiences such as policy-makers, managers, engineers or designers, operators, maintenance workers, construction workers, manufacturers or suppliers, and others. While this list is fairly exhaustive, it is important to consider all potential users to capture input or consider perspective in the early stages of the systems engineering process. Specific stakeholders who play a more active role in the program development are listed in Section 5.3.

1.3.4 Document Contents and Organization

This document generally follows the high-level outline structure that has been developed for ConOps efforts. A brief description of each section is provided below.

Section 2: Reference Documents - This section lists the references used in the development of this document and serves as a source that readers may use to obtain additional details on aspects of the project.

Section 3: Situational Background - This section describes how agencies currently optimize traffic signal operations and what limitations agencies experience. It provides the underlying argument in support of the regional traffic signal optimization project and how it can meet identified goals.

Section 4: Operational Needs - This section identifies and summarizes agency needs and issues with respect to regional traffic signal optimization. Each need and issue includes background information obtained from stakeholder outreach, literature review, and field reviews. Needs and Issues identified here will provide the basis for developing the regional traffic signal optimization concept.

Section 5: System Concept Operational Context and Understanding – This section describes how the regional traffic signal optimization concept is expected to operate at a high-level. It explains how the regional traffic signal optimization concept will improve the operation of the Des Moines corridor overall. and how it addresses stakeholder operational needs. Included are descriptions of the project purpose, goals & objectives, operational stakeholders, interfaces, information flows and ideal operations.

Section 6: Operational Environment - This section discusses the physical operational environment, such as traffic signal control equipment, computing hardware, software, personnel, and other items involved in optimizing traffic signal operations. Within the project-level ConOps, the focus will be those items specific to traffic signal timing and operations. Items discussed here are generally considered mandatory for operating and optimizing traffic signals.

Section 7: Support Environment - This section discusses other non-physical assets that may be leveraged in support of regional traffic signal optimization, such as standard operating procedures, policies, funding, legislation, education and training, memorandum of understanding, maintenance procedures, etc.

Section 8: Operational Scenarios - This section describes how regional traffic signal optimization will occur given a number of operational scenarios. The scenarios discussed include: normal operations, incident operations, weather events, construction events, and maintenance events.

Section 9: Analysis of Proposed System - This section describes the anticipated impacts that may result from the project's implementation. Impacts will be organized by type to include operational, organizational, and other impacts.

2 Referenced Documents

The following resources have been referenced in development of this document:

- Congestion Management Process, Des Moines Area Metropolitan Planning Organization, January 2016
- Des Moines Area Regional Intelligent Transportation Systems (ITS) Architecture Update, Des Moines Area Metropolitan Planning Organization, August 2009
- Transportation Systems Management and Operations (TSMO) Intelligent Transportation Systems (ITS) and Communications Systems Service Layer Plan, Iowa Department of Transportation, January 2018
- Transportation Systems Management and Operations (TSMO) Work Zone Management Service Layer, Iowa Department of Transportation, June 2018
- Iowa Transportation Systems Management and Operations (TSMO) Strategic Plan, Iowa Department of Transportation, February 2016
- Iowa Transportation Systems Management and Operations (TSMO) Program Plan, Iowa Department of Transportation, February 2016
- Integrated Corridor Management Plan: Existing Conditions Report, Iowa Department of Transportation
- Integrated Corridor Management Plan: Vision, Goals, Objectives and Performance Measures Report, Iowa Department of Transportation
- Integrated Corridor Management Plan: Range of Potential ICM Strategies Report, Iowa Department of Transportation

3 Situational Background

The Des Moines Metropolitan ICM Study includes many individual agencies and jurisdictions that each have independent methods and resources for operating traffic signals. Separately, these agencies maintain and operate the traffic signals within their jurisdiction according to their individual needs and priorities. The following is an overview of the current state of traffic signal operations within the study area.

3.1 DESCRIPTION OF CURRENT SITUATION

In order to determine the current practices and resources of each agency within the ICM program area, an initial questionnaire was developed and sent to all participating stakeholders. The questionnaire focused on existing processes and included the following:

1 Who evaluates traffic signal timing for your agency? Do you have internal expertise or do you rely on external resources?
2 Are there any intergovernmental agreements to manage or operate your traffic signals?
3 When modifying traffic signal timing, what is the process and who is involved?
4 What, if any, systematic reviews of signal performance occur? (i.e., level of service)
5 Is your agency employing any advanced operations such as centralized software, advanced coordination, adaptive control, etc.?

Responses to these questions were primarily received at an initial kick-off meeting with the traffic signal technical group held on June 11, 2019. The questionnaire and the meeting minutes are provided in the Appendix.

3.1.1 Oversight

Traffic signals located along state highways and interstate ramp terminals are generally maintained and operated by the local jurisdiction within which the signals are located. Outside the Iowa DOT traffic signals, the majority of traffic signals are maintained and operated by the respective jurisdictions based on geographic boundaries – with the exception of several jurisdictions adjacent to the City of West Des Moines. The City of West Des Moines has agreements with the City of Clive, City of Waukee, and City of Des Moines to maintain and operate traffic signals that are adjacent to its borders.

3.1.2 Process

The process of maintaining traffic signals, from routine maintenance to timing changes, varies across agencies and ranges from ad-hoc to more structured. With limited resources, most agencies are addressing traffic signal changes/updates only when issues arise – either through failure or notification (complaints) by the public or staff. Once issues are identified, they are addressed in relative order of severity and based on available resources.

Some agencies, including the City of Des Moines and the City of Ankeny, are updating their traffic signals using Iowa Clean Air Attainment Program (ICAAP) funds. The City of Des Moines has allocated funds in a systematic process whereby the City's signals are divided into 5 groups each contracted out to consultants under separate projects. The timeframe will likely require 5 to 10 years to complete, after which the process will be reviewed for another future implementation cycle. The City of Ankeny is currently undertaking a project that will address signal timing at approximately 2/3 of the City's traffic signals. The intent of Ankeny's project is to establish a new baseline after which the City will update timing on a more regular basis.

The City of West Des Moines does not have a formal process or cycle for maintaining traffic signals but can monitor signal operations in real-time from a Traffic Operations Center (TOC). Access to intersection pan/tilt/zoom cameras and remote monitoring of traffic signals from the TOC allows confirmation of public complaints and issues during known events.

3.1.3 Evaluation

Performing periodic evaluations of existing traffic signal operations as a part of an agency's internal business practices was not identified for any stakeholder agency and most agencies do not have a formalized method for obtaining quantitative evaluations or performance measures. Operational analyses are currently limited to formalized studies or projects that utilize consultant resources but only relative to that particular project and not in a systemic fashion.

The traffic signal operations project that the City of Ankeny is currently implementing utilizing ICAAP funds will result in before/after analyses of performance measures but only as part of the project scope. After the project is complete, it is not anticipated that the same analysis will be sustained.

Data collection is one of the issues identified as a barrier to evaluating traffic signal operations as level of service calculations require lane-by-lane turning movement volumes by 15-minute increments. Alternatively, automated traffic signal performance measures (ATSPM) can be collected and evaluated at traffic signals provided that high-resolution signal controllers are installed and storing or sending data to a server. While existing traffic signals may have adequate controllers, none of the stakeholders have installed the required server/databases or acquired the necessary software tools for ATSPM.

3.1.4 Resources

Agency staffing resources vary but most do not have staff dedicated to traffic signal operations. The smaller agencies do not have traffic engineering staff and are mostly reliant on external consultants and projects. Some of the larger agencies have staff dedicated to traffic signal operations but those resources do not have adequate time to evaluate traffic signal operations and update traffic signal timing. For example, the City of Des Moines employs traffic engineers but does not have a dedicated position or staff member that can evaluate signal operations, develop new signal timing, and implement changes. Instead, traffic signal timing is spread amongst staff as time allows. The City of Ankeny recently added a new position for in-house traffic signal expertise and this position will be responsible for maintaining traffic signal operations once the current consultant project is complete.

The City of West Des Moines has dedicated staff assigned to traffic signal operations as well as the TOC and is currently evaluating a Westside Regional Traffic Operations Group. This would share staffing resources between the City of West Des Moines and the Cities of Clive, Waukee, Johnston, Urbandale, and Windsor Heights.

3.1.5 Advanced Systems

Advanced traffic signal control in the region is largely focused on centralized management. The Cities of Des Moines, West Des Moines, and Ankeny have centralized software with the majority of their traffic signals on fiber/Ethernet connection allowing remote reviewing and modification. The City of Ankeny anticipates updating their centralized software platform in the next several years.

The City of West Des Moines has been utilizing adaptive traffic signal control since 2011 and has approximately 94 of 120 traffic signals running adaptive control. The adaptive traffic signal control allows the City to set a range of cycle lengths and the hardware/software selects the appropriate cycle length and phase timing based on the traffic volumes detected.

3.2 STRENGTHS, WEAKNESSES, OPPORTUNITIES AND THREATS

The operations of traffic signals within the ICM study area is constrained by the existing resources of the agencies. Lack of staffing is a major limiting factor in all agencies and contributes directly and/or indirectly to several of the other identified weaknesses. However, there are several strengths that provide a strong foundation for future efforts. The strengths, weaknesses, opportunities, and threats are discussed below.

3.2.1 Strengths

The use of centralized software to manage many of the traffic signals within the ICM study area, along with fiber/Ethernet connectivity, provides a strong foundation for future operational changes. This combination of connectivity and software can allow remote changes to signal timing parameters, multiple timing configurations to be developed and stored, and built-in evaluation. Maintaining traffic signals from a central location can increase the efficiency and accuracy of the associated traffic signals.

Several of the agencies within the ICM study area are actively making internal changes to improve traffic signal operations either through the development of projects or the request for new staff/resources. This indicates an awareness of the benefits surrounding traffic signal operations and a desire to improve traffic signal timing both of which will help in establishing a new process.

3.2.2 Weaknesses

The largest weakness within the region is staffing. All agencies indicated a shortfall in staff resources to adequately address traffic signal evaluation and maintenance. Many of the smaller agencies lack traffic engineers and even the larger agencies, such as the City of Des Moines, do not have a dedicated position for traffic signal operations. The City of Ankeny recently added a position to focus on traffic

signal operations but has not had such a resource for a long time. Therefore, the task of updating signal performance is either reliant on external resources, requiring a funding source and long lead times, or is spread across staff who may not have adequate availability or technical skills.

Another weakness identified is the lack of performance measurement. Existing traffic signal operations are not systematically evaluated through quantitative metrics. Neither the region nor the individual agencies have a methodology to evaluate individual intersections for needed improvement or to screen/prioritize intersections across a network. This lack of performance measurement is attributable to the lack of staffing mentioned above as well as a lack of data collection as many of the metrics require datasets at a lane-by-lane level.

3.2.3 Opportunities

The development of an ICM approach to traffic signal operations can create several opportunities for the stakeholder agencies. The process will bring together individual agencies to discuss regional goals and will foster increased coordination across jurisdictional boundaries as the focus is on corridor performance and not individual performance. This increased corridor focus will help provide reduced travel times along regional roadways and increase efficiency for the general public.

The various committees and subcommittees will increase communication relative to traffic signal performance and allow for information-sharing among the agencies. Knowledge transfer through the sharing of resources will increase technical abilities of the varying agencies. It is anticipated that common performance metrics and optimization processes developed as part of the ICM project could be applied through the remaining intersections within the region and improve the operations of the agencies' entire network.

In terms of leveraging existing resources, the Regional Traffic Signal Optimization project can coordinate with the current DMAMPO Surface Transportation Block Grant Program (STBG) funds. This program allocates 10-70% of the annual allocation to projects that "optimize" the transportation system including traffic signal projects. The City of Des Moines has utilized these funds in the past for a Traffic Signal Master Plan and similar efforts can use this funding source.

3.2.4 Threats

The largest threat to a new process is sustainability. The Regional Traffic Signal Optimization project must have a strong champion that advocates the need for the process and maintains involvement by the stakeholders. A lack of interest by agencies will result in a lack of project identification, potential under-utilization of funds, and eventually lead toward lack of political support.

In terms of project identification and allocation of resources, the disparity in stakeholder characteristics may impact the perceived equity in the process. Some stakeholder agencies are geographically larger and have more regional routes and traffic signals which could result in more projects. In addition, differences in equipment and staffing may impact the need for support. A transparent and cooperative scoring methodology will be needed to prevent perceived inequities related to project distribution.

4 Operational Needs

The optimization of traffic signal operations within an integrated corridor approach will require new processes that are not currently utilized by stakeholders. Most fundamental of these are that the corridor focus will require coordinated efforts across jurisdictional boundaries. Currently, most traffic signal

operations and signal retiming efforts are performed within individual agencies with little external coordination. Exceptions to this generalization are the coordination between agencies and Iowa DOT on state highways and the coordination between West Des Moines and adjacent jurisdictions. The implementation of a regional traffic signal optimization process will need a committee of representatives that evaluates and prioritizes efforts with a regional focus. This committee will help identify needs and approve resources relative to the ICM Program's goals.

Performance management, in terms of tracking quantitative metrics, is not widespread throughout the region. Common baseline performance measures will be needed as part of any regional ICM effort to ensure that intersections are evaluated and/or compared on a common basis regardless of agency. The performance measures should balance data needs and staffing resources so that it does not become a burden on existing staff. If data collection and/or analysis methodologies are too difficult for all agencies to achieve then qualitative assessments should be identified. Potential measures identified during the initial traffic signal optimization meeting included a mix of qualitative and quantitative measures. Qualitative measures focused on whether the traffic signals were located on a designated emergency/detour route or involved multiple jurisdictions while quantitative measures focused on traffic volume, crash history, and reliability factors. Establishing clear performance measures will allow a transparent and impartial approach to assigning priority and available resources. While not currently deployed in the study area, future use of automated traffic signal performance measures could provide quantitative measures provided all agencies have equal capabilities for comparative purposes.

Quick deployment is needed to be responsive to traffic operational needs. Optimizing traffic signal operations through timing changes does not require physical construction and therefore does not require the same lead time as traditional infrastructure projects. The process that will support this ICM effort will need to be simple and quick so that agencies, and the public, are not waiting for months. The evaluation, prioritization, and approval process should be streamlined for maximum impact.

5 System Concept Operational Context and Understanding

The regional traffic signal optimization ICM project is one of several early implementation strategies under the Des Moines Metropolitan Area ICM Program. This particular strategy will be defined by the following vision, goals and objectives, and description. For a wider understanding of the overall ICM effort, the Program-level ConOps provides a broader context.

5.1 VISION

The vision of the overall Des Moines Metropolitan Area ICM Program is contained in the Program-level ConOps document and applies to all future strategies/effort. Relative to the regional traffic signal optimization project, the portion of the overall vision that is most applicable and relevant is:

"ICM strategies will assist the state and area communities to proactively manage multi-modal transportation systems in a safe and efficient manner using proven technologies and operational strategies while maximizing the use of existing infrastructure and services."

The regional traffic signal optimization project relies on strategies to optimize existing traffic signal operations without adding new infrastructure. The resulting improvement in operations will reduce delay and congestion thereby increasing traveler safety and efficiency.

5.2 PROJECT GOALS AND OBJECTIVES

The Des Moines Metropolitan Area ICM Program developed goals and objectives for the entire effort. Of the goals and objectives listed in the Program-level ConOps, the following are applicable to the regional traffic signal optimization project:

- Goal: Reduce fatalities and serious injuries on public roads in the region.
    - Objectives: Reduce number of traffic fatalities.
        - Reduce number of serious injuries in traffic crashes.
        - Reduce pedestrian and bicycle fatalities.
- Goal: Provide options to travelers that minimize time spent traveling.
    - Objectives: Reduce congestion in key commuter corridors.
        - Reduce congestion in key freight corridors.
- Goal: Improve the efficiency of the surface transportation system.
    - Objectives: Implement ITS technologies along priority commuter and freight corridors.
        - Implement advanced operational strategies along priority commuter and freight corridors.

5.3 STAKEHOLDERS

The primary stakeholders for the regional traffic signal optimization project will be those agencies that maintain and operate the traffic signals in the ICM study area as well as those agencies who rely on partners to operate traffic signals. The following stakeholders will be involved:

- State/Regional/Federal Transportation Management
    - Iowa Department of Transportation
    - Des Moines Area Metropolitan Planning Organization
    - Federal Highway Administration - Iowa Division
- Local Municipality Publics Works/Engineering/Planning
    - City of Altoona
    - City of Ankeny
    - City of Bondurant
    - City of Clive
    - City of Des Moines
    - City of Grimes
    - City of Johnston
    - City of Pleasant Hill
    - City of Urbandale
    - City of Waukee
    - City of West Des Moines
    - City of Windsor Heights
    - Dallas County
    - Polk County
    - Warren County
- Consultant Engineering Firms

Within each of these agencies or organizations, it is expected that a range of members will be involved. Related to regional traffic signal optimization, it is anticipated that agency traffic engineers, engineering staff, and maintenance staff will be involved during the various steps.

Other stakeholders, such as law enforcement or emergency response, may be consulted with during the process but are not anticipated to have a significant or sustained role.

5.4 SYSTEM CONCEPT DESCRIPTION

The regional traffic signal optimization project will require a new approach to traffic signal operations to support ICM Program goals. As previously described in Section 4, the project needs include a regional focus with an oversight committee, common performance measures, and quick deployment. The following discussions outline a high-level concept that provides the processes, steps, and requirements of the proposed strategy.

5.4.1 Management

The necessary resources for the traffic signal timing optimization project will include external consultant services to address the shortage of agency staffing. The consultant effort will require management, oversight, and funding. The following steps and associated roles/responsibilities are required to assign resources:

- Executive Committee:
  - Provide overall vision and goals for the ICM program.
  - Provide annual funding levels for the regional traffic signal optimization project.
  - Approve annual work program for the regional traffic signal optimization project.
- Technical Committee:
  - Hold regular meetings to administer the project – review progress and render decisions.
  - Establish a consultant list through Iowa DOT contracting methods.
  - Establish priority ICM corridors based on technical and political objectives.
  - Approve work orders recommended by the technical signal subcommittee.
- Technical Signal Subcommittee:
  - Hold regular meetings to evaluate and recommend traffic signals to be optimized.
  - Establish performance measures that can be common for all agencies.
  - Create application form/method for agencies to submit intersections for optimization.
  - Facilitate two methods for application: annual call for intersections and a quick turnaround request.
  - Provide recommendations for regional traffic signal optimization to the technical committee.
- Individual Agencies
  - Identify traffic signal intersections that require optimization.
  - Obtain necessary data for screening per established performance measures.
  - Submit intersections to technical subcommittee for consideration.
  - Prepare before/after evaluations to document improvement.

5.4.2 Intersection Identification

The identification of traffic signals that require optimization will be based on a qualitative and quantitative assessment developed by the technical subcommittee. Numerous factors and various sources should be

considered based on the input from agencies and the balance between numerical data, flexibility, and time/resources. Initial discussions have identified the following key factors: regional significance, safety, reliability, and mobility. The following steps and associated roles/responsibilities are required to identify intersections:

- Technical Signal Subcommittee:
  - Establish performance measures based on ICM goals and objectives, traffic signal operations, and available data resources.
    - Readily available data includes: average daily traffic volumes, annual number of crashes, observed peak hour queue lengths, and distance to interstate/freeway.
    - Future data may include 3rd party data, automated traffic signal performance measures, or other metrics.
    - Data sources may include: Iowa DOT, Des Moines MPO, Inrix data (under contract), and individual agencies.
  - Review submittals by all agencies, rank all intersections by performance measure score, and recommend top candidates for approval by the technical committee.
- Individual Agencies
  - Identify traffic signal intersections whose improved operation would improve the effectiveness of the ICM program operation. Intersections can be identified through visual observation, project analysis, complaints from the general public, or other methods.
  - Screen the traffic signal using the establish performance measures and submit application to the technical signal subcommittee.

5.4.3 Evaluate Traffic Signal Operations

Traffic signal timing evaluation will require traffic data and tools to develop appropriate analysis and alternatives. If local jurisdictions have the resources and expertise, the evaluation can be done internally. However, it is anticipated that most jurisdictions will utilize Iowa DOT's on-call consultant to analyze and develop optimized traffic signal timing. The following steps and associated roles/responsibilities are required to perform the timing evaluation:

- Individual Agencies
  - Evaluate the traffic signal operations and optimize traffic signal timing, if resources are internally available.
  - If consultant is utilized, review and accept traffic signal timing changes developed by consultant.
- Consultant
  - Collect any necessary traffic data that is required for signal timing analysis.
  - Develop optimized traffic signal timing for the intersections identified along the ICM corridor. Traffic signal timing should be developed utilizing the existing infrastructure and signal equipment unless additional modifications have been planned.
  - Submit recommendations to the individual agency for review and comment.

5.4.4 Implement Changes

The implementation of the traffic signal timing changes may be completed by the local agencies or the consultant once the timing plans are approved. The following steps and associated roles/responsibilities are required to implement the timing changes:

- Individual Agencies or Consultant
  - Perform field changes to the traffic signal timing per the optimized traffic signal plans. The changes can be performed in the cabinet or through centralized software by qualified technicians or traffic engineers.
  - If required, establish interagency agreements to implement and operate the optimized traffic signal timing if adequate resources are not available. These agreements can be for specific intersections or a blanket agreement for the entire network.
  - Coordinate with adjacent jurisdictions as needed for traffic signal operations that require coordination along a multi-jurisdiction roadway.
  - Replace or repair traffic signal equipment as needed to ensure that controllers, detection, power, and indications are present and functioning for the optimized timing plans.

5.4.5 Post Evaluation

Once the traffic signal timing has been optimized, it will be necessary to prepare a post-implementation evaluation to determine the realized benefit. Field observations will be made and "after" performance measures will be determined using the same screening criteria used for the "before" condition. This step will be performed by the local agency to maintain consistency and transparency. Results will be submitted to the technical subcommittee for review.

Once this step is complete, the traffic signal optimization process as envisioned and outlined in this document is considered complete. The traffic signals that were part of the project should be monitored as part of the respective agency's typical operations and maintenance efforts. This would vary by agency and may range from responding to complaints/failures to periodic performance measure evaluation.

6 Operational Environment

The physical operational environment associated with the Regional Traffic Signal Optimization project includes all facilities, equipment, computing hardware, software, personnel, operational procedures and support necessary to operate the ICM strategy.

The traffic signal hardware is the major physical component of the signal operations. Key components include the signal controller, the signal indications (heads), vehicle detection systems, and power source. While the proposed regional traffic signal optimization project does not include upgrades to these physical components, the modification of signal timing will depend on these features. The signal controller must be able to accommodate the revised timing plans and all changes will be input into the controller. The signal phasing and any changes to protected/permitted operation will depend on the signal indications (heads) as well as vehicle detection.

Communication systems that link traffic signals together and to centralized platforms are part of the operational environment. The communication systems include fiber optic cables, Ethernet connections, cellular modems, or other modes/methods. These systems will facilitate the implementation of the optimized traffic signal timing plans either through signal-to-signal coordination or through remote access/input.

Computer software, including centralized platforms or standalone analytical tools, will be necessary to optimize and evaluate timing plans. These can be owned by local agencies or utilized by partner agencies or consultants. The standalone analytical tools will primarily be used to develop signal timing plans and develop performance measures such as level of service and queuing. Centralized platforms, while not necessary for the project, can facilitate area-wide management and control of traffic signal systems if agencies already own the software. If present, agencies can enter and manage the optimized traffic signal timing within the centralized platform.

Personnel associated with the regional traffic signal optimization project include agency staff and consultant staff. Agency staff and supporting human technical resources will provide the physical effort needed to develop and implement the changes in operation.

7 Support Environment

The support environment associated with the overall Des Moines Metropolitan Area ICM program, including the management structures and non-physical assets that support the program, is detailed in the Program-Level ConOps. Management will consist of an Executive Committee, a Technical Committee, Technical Subcommittees, and a Steering Committee. With respect to the regional traffic signal optimization project, these groups will guide and approve much of the activity.

7.1.1 Executive Committee

The Executive Committee will largely provide oversight of the program and assign funding levels for the particular efforts/projects. As stated in the Program ConOps, it is likely that this membership will closely follow the Des Moines Area MPO Executive Committee. For the regional traffic signal optimization project, this committee will provide strategic direction, identify the annual resources (funding) available, and approve annual work plan provided by the Technical Committee. Interaction with this group will be limited to high-level decisions and not focus on individual traffic signal efforts.

7.1.2 Technical Committee

The Technical Committee will be the primary decision-making body associated with the regional traffic signal optimization project. As stated in the Program ConOps, it is likely that this membership will closely follow the Des Moines Area MPO Transportation Technical Committee. This group will allocate funds and establish projects that align with the goals and objectives of the ICM program. The Technical Committee will manage the external consultant process and approve recommendations from the Technical Signal Subcommittee. The Technical Committee will be responsible for providing an annual work plan describing past accomplishments and future direction to the Executive Committee.

7.1.3 Technical Signal Subcommittee

The Technical Signal Subcommittee will consist of members from the individual agencies that have technical expertise in traffic signal operations. This will be the day-to-day working group that will establish performance measures, an evaluation process, and facilitate the prioritization of the identified locations. It is anticipated that this group will be comprised of a member from Iowa DOT, the Des Moines Area MPO, and those stakeholder agencies with dedicated traffic engineers. Recommendations from this subcommittee will be submitted to the Technical Committee for approval.

7.1.4 Steering Committee

The Steering Committee represents the broadest set of ICM stakeholders and helps set the vision, goals, and objectives of the ICM Program. This group would be comprised of any person that has an interest in

providing input on ICM-related matters. The Steering Committee will meet less frequently than the other groups and will not be a decision-making entity. Issues and needs raised by Steering Committee members should feed into programmatic update cycles and should be reflected at the Program-level.

7.1.5 Other

Outside these formal committees and groups, there may be additional coordination between individual agencies that supports the implementation of the regional traffic signal optimization project. Situations may arise where geography, staffing, timing, or other factors result in more efficient implementation of signal timing by partnering/neighboring agencies. Examples include: agencies with very few traffic signals and no dedicated staff, locations where one agency has the majority of the traffic signals along a route/area, or an agency that is preoccupied with traditional maintenance. In these cases, an intergovernmental agreement may be required to permanently or temporarily transfer operational oversight of the effected traffic signals.

8 Operational Scenarios

8.1 SCENARIO #1: CALL FOR PROJECTS

The regional traffic signal optimization project will be allocated a set amount of funding that is available for agency staff or for engaging a consultant. As this amount of funding is known, a formal process will be established to allow agencies to submit intersection locations that can be optimized using these resources. The interval can be annual based on the preference of the Technical Committee. Primary objectives of this recurring call for projects are to address identified issues and/or plan for known events. This can include: known queuing or bottleneck intersections, past and future special events, typical incident detour routes, or other identified issues generated from internal or external stakeholders.

Individual agencies will complete the formal call-for-projects when issued by the Technical Signal Subcommittee. This will include some data collection and site visit though much of the application will be based on qualitative factors or data from readily available sources. The application will be submitted to the Technical Signal Subcommittee who will review and prioritize all submitted applications. Once consensus has been reached at the subcommittee level, the recommended projects will be sent to the Technical Committee for approval and assignment to a consultant.

Consultants, managed by the Technical Committee, will optimize the traffic signal timing and provide a timing plan to the agency for implementation. Alternatively, if the agency has adequate resources, internal staff may also optimize traffic signal timing. Once complete, internal staff will review and implement the revised signal timing plans. If resources are not available, an intergovernmental agreement may be developed to allow a partner/neighboring agency to implement the timing plans.

Field adjustments will be made and an “after” analysis will be prepared to document the change in operations.

8.2 SCENARIO #2: IMMEDIATE NEEDS

In the event that there is an unexpected change in traffic patterns or an unforeseen issue, the regional traffic signal optimization project will set aside funding for immediate needs. It is anticipated that this allocation of funding will be less than the formal call for projects but still utilize the same process as described above without the time constraint. Primary objectives of this immediate need process are to address unforeseen events. This can include: new traffic impacts from development, unplanned

construction, large weather events, or other issues not part of preplanned construction, maintenance, or permitting activities.

Individual agencies will complete the same form developed for the call-for-projects for documentation of the "before" condition. The application will be submitted to the Technical Signal Subcommittee who will review and approve the application on its individual merit. To maintain timeliness, it is not anticipated that the immediate need projects will be submitted to the Technical Committee for approval at the regularly scheduled meeting. Instead, the Subcommittee may obtain concurrence from the Technical Committee via email or other polling process.

Consultants, managed by the Technical Committee, will optimize the traffic signal timing and provide a timing plan to the agency for implementation. Alternatively, if the agency has adequate resources, internal staff may also optimize traffic signal timing. Once complete, internal staff will review and implement the revised signal timing plans. If resources are not available, an intergovernmental agreement may be developed to allow a partner/neighboring agency to implement the timing plans.

Field adjustments will be made and an "after" analysis will be prepared to document the change in operations.

9 Analysis of the Proposed System

9.1 SUMMARY OF IMPACTS

9.1.1 Operational Impacts

Operational impacts from the regional traffic signal optimization project will center around intersection performance measures. The most visible benefit will be a reduction in delay and associated queuing. Updated signal timing will better accommodate traffic volumes and improve level of service so that the utilization of green time is maximized. The reduction in unnecessary delay will reduce the queuing impacts on turn lane storage.

Travel time is a secondary measure related to delay but from a corridor perspective. Travel time includes multiple intersections and provides an indication of not only delays at individual intersections but the relationship in signal timing and coordination of progression along a corridor. Updated signal timing parameters between multiple traffic signals will reduce the cumulative delay along a trip path.

Traffic safety is a key concern at signalized intersections as there are numerous conflict points and traffic signals control the assignment of right-of-way. It is not anticipated that optimizing the traffic signal timing will result in a major reduction in serious injury collisions but it will indirectly improve traffic safety through a reduction in stops and queuing length. The majority of the safety benefit will be in a reduction in rear-end collisions that occur in the same direction.

9.1.2 Organizational Impacts

Organizational impacts from the regional traffic signal optimization project will center around enhanced regional capabilities. The use of a regional process to evaluate, prioritize, and improve intersections will result in a more regional focus in terms of operations. Traffic does not follow jurisdictional boundaries and, therefore, this interagency coordination allows for better response to traffic issues. The formalized

process will also prioritize the limited funds to address the highest regional priority which is in the public's best interest.

The use of external consultants to supplement agency resources will allow for quicker changes than if agencies waited for internal availability. For agencies without technical resources, this regional traffic signal optimization project fills a critical gap in services. In both cases, the coordination and review of the technical services will add some level of knowledge transfer to existing staff. This knowledge transfer will help agencies plan for future staff and project allocations.

Documentation of the qualitative and quantitative performance measures will require agencies to focus on measurable impacts and "before and after" comparisons. This not only provides transparency but also increases awareness to the benefit and impact of non-construction TSMO activities.