Chapter 4

Contents

4 Starting the Design

4.1 Scoping

Scoping is the very first step to forming and funding projects. The formal scoping process involves multiple disciplines working together and requires the signal designer and signal operations staff to provide a detailed assessment of needs, requirements, risks, and associated cost estimate for all traffic signal work within the defined project limits. A Project Leader will coordinate the scoping effort and each Region will have specific processes and forms that should be used.

When scoping traffic signal work, the following guidance should be used:

- Note any Operational Approvals that are required
- Verify the condition rating of existing traffic signals (See Section 4.1.1)
    - Signals with a condition rating of less than 70% should be scoped for complete replacement.
    - Signals with a condition rating of 70% or greater may be scoped for modifications in lieu of complete replacement.
- Signal work that requires extensive modification (e.g. moving three out of four poles, replacing/rerouting majority of conduit, etc.) should be scoped for complete replacement regardless of the condition rating.
- Verify existing signals meet current statewide goals (see Section 4.1.2)
    - Signals that do not meet current statewide goals and priority improvements should be scoped to include every listed upgrade.
- Review the intersection geometry and note any issues that may impact the traffic signal and will require a solution by the roadway designer. This includes truck turning swept path problems, unacceptable lane shifts, inadequate pedestrian facilities, skewed alignments, lane use problems, sight distance issues, vertical alignment issues, etc. See Chapter 5 for more details. It is important to work with the other disciplines to identify these issues in scoping so they can be funding and properly fixed by a roadway solution rather than a traffic control device band-aid.
- Verify curb ramps, pushbuttons, and pedestrian signal heads meet current ADA requirements (See Section 5.4, Engineering For Accessibility website and Accessibility at ODOT website). This also includes verifying CQCR requests (a typical request is for audible pedestrian signals) and incorporating the goals and features outlined in ODOT policy to meet the ADA Transition Plan for ODOT. Contact the State Traffic Signal Engineer for any questions, as issues and solutions are often site specific.
    - Signal equipment that does not meet current ADA requirements should be scoped to include upgrading all necessary features. Note: this can often trigger other work that may result in the need for a complete signal replacement.

Scoping notes should clearly identify if any of the statewide goals listed in the table in Section 4.1.2 are needed for any of the signals in the project limits but will NOT be addressed by the project. When this occurs, notify the State Traffic Signal Engineer via e-mail with a link to the scoping notes so that this data can be tracked in the Traffic Signal Asset Management program.

Scoping for projects usually takes place several years before the DAP design work begins. As such, it is important to clearly document the design features, assumptions, and judgement used in the scoping notes to ensure they are useful for future reference. It is highly recommended to provide a basic sketch of the proposed design(s) or to clarify assumptions used (in addition to text only descriptions that are provided in the scoping notes). Sketches may not be necessary for all scoping projects, but they can help other disciplines better visualize how the traffic signal equipment impacts their features, improve the accuracy of the cost estimate, and convey design information more efficiently than text only. See Figure 4-1 and Figure 4-2.

Figure 4-1 | Scoping Sketch Example 1

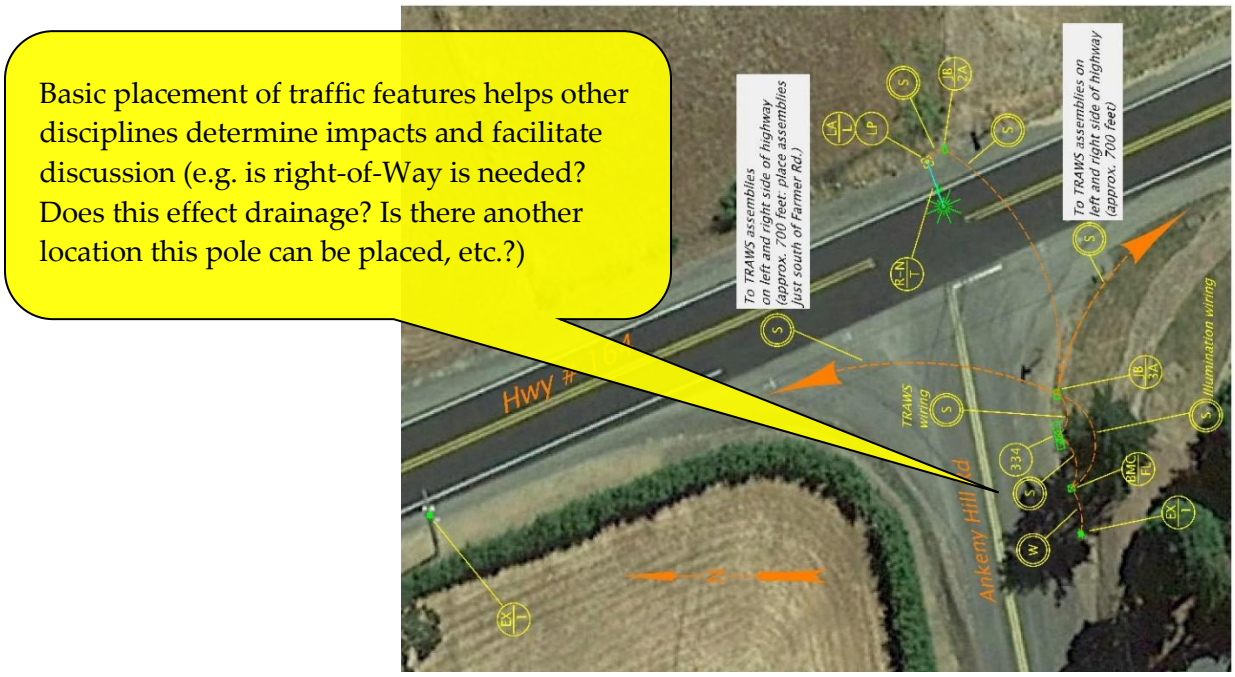
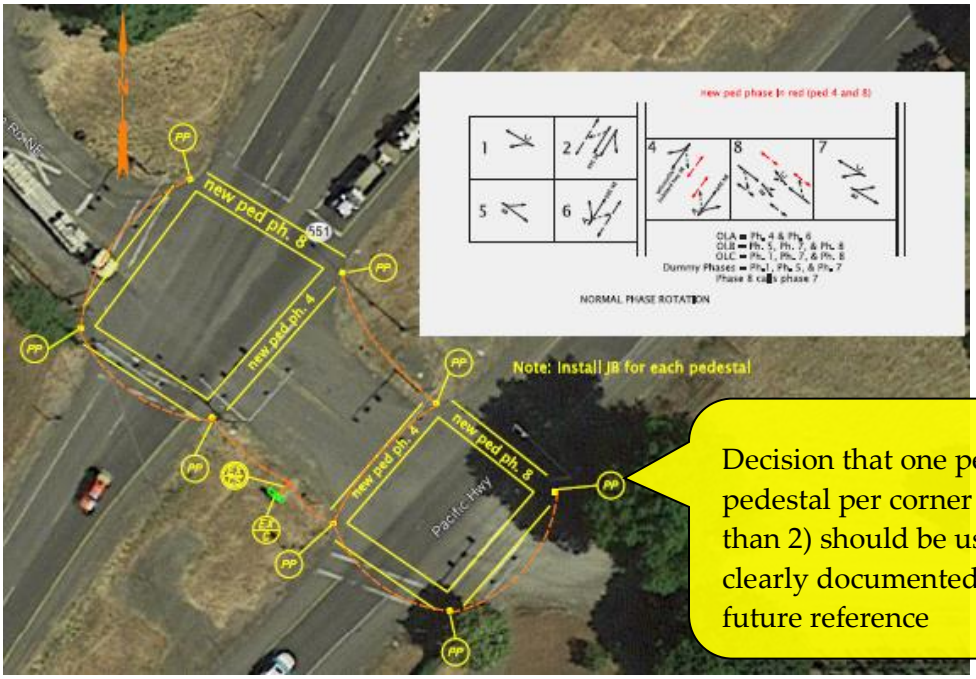


Figure 4-2 | Scoping Sketch Example 2



4.1.1 Traffic Signal Asset Management

The Traffic Standards Crew produced the first traffic signal condition report in 2017. This report is updated every year in September. It contains a condition rating for every ODOT owned or maintained traffic signal expressed as a percentage (from 0% to 100%) with three classification categories:

- Fair or Better (70% +)
- Poor (50-69%)
- Very Poor (49%)

You can find the traffic signal condition reports on the ODOT Traffic Signal website. The ODOT TransGIS also has the condition rating of each signal under the "Equipment-Highway" category, then "signals" layer.

ADA ramps and pushbutton inventory can be found on the ODOT TransGIS under the "Roadside" category, then "ADA ramps" and "ADA pushbuttons" layer.

4.1.2 Statewide Goals, Priority, and Implementation

Planning traffic signal upgrades and replacement requires consideration of many factors, such as crash data, operational data, annual maintenance costs, planning documents, etc. Completing all of the recommended upgrades listed in Table 4-3, Table 4-4, and Table 4-5 below in one project is desirable, but may not be possible due to limited funding. Therefore, each upgrade has been prioritized (High, Medium and Low), assigned a goal date for completion, given associated design impacts, and reasons for the goal to help assist in decision making. The Region Traffic Engineer/Manager should determine how the priorities are implemented and secure funding as necessary to meet the goal dates.

Table 4-3 | Statewide Goals High Priority

		Statewide Goals	Completion Date	Potential Design Impacts	Reason for Goal
High Priority	1	Change existing controller cabinet with a PDA1 to a 332S cabinet	2021	May require a signal rebuild to properly address all impacted features	Safety: PDA1 is fire hazard
	2	Change existing controller (170, 2070, etc.) to an ATC controller	2022	N/A	Safety and operations: 170 and 2070 controller software is unsupported and unmaintainable
	3	Change existing "words" or non-countdown pedestrian signals to countdown LED modules	2032 *	Likely to require a signal rebuild to address ADA issues	Safety: FHWA Crash Reduction Countermeasure
	4	Replace existing loop detection with non-invasive detection (radar or video)	2030	May require a signal rebuild to address conduit issues	Safety and operations: See Chapter 6 & FHWA Every Day Counts 4 Initiative (ATSPM)
	5	Replace existing copper interconnect with fiber optic and install network communication	2030	May require a signal rebuild to address conduit issues	Safety and operations: FHWA Every Day Counts 4 Initiative (ATSPM)
	6	When required, install Type 7 signal heads at railroad interconnected signals	2025	May require a signal rebuild to address structural issues	Safety: clears the RxR tracks faster during a preemption
	7	Change existing 8" lens vehicle signals to 12" lens	2030	May require a signal rebuild to address structural issues	Safety: FHWA Crash Reduction Countermeasure
	8	Add backplates or change existing backplates to reflectorized backplates for the vehicle signals	2030	May require a signal rebuild to address structural issues	Safety: FHWA Crash Reduction Countermeasure

*Note: the MUTCD Table I-2 specifies a 2013 compliance date

Table 4-4 | Statewide Goals Medium Priority

Statewide Goals			Completion Date	Potential Design Impacts	Reason for Goal
Medium Priority	9	Change existing ¼" pushbuttons and H-frame to standard mounts & buttons	2032	Likely to require a signal rebuild to address ADA issues	Accessibility and uniformity
	10	Change existing controller cabinet (336, 336S, 337) to a 332S cabinet	2030	May require a signal rebuild to properly address all impacted features	Operations, uniformity, and lower maintenance costs (less labor, less materials)
	11	Condition rating of signal is 70% or greater	2055	May require a signal rebuild depending on deficiencies	Lower maintenance costs (less labor, less materials)

Table 4-5 | Statewide Goals Low Priority

Statewide Goals			Completion Date	Potential Design Impacts	Reason for Goal
Low Priority	12	Replace 4 bolt base vehicle signal poles (mast arm and strain poles) with 8 bolt mast arm poles. Note: strain poles no longer an option for permanent traffic signals due to new 75' mast arm length.	2055	Likely to require a signal rebuild to address all poles at an intersection	Lower maintenance costs (less labor, less materials)
	13	Change existing power service (RPS & service/meter base mounted to poles, etc.) to BMC/BMCL service	2050	May require a signal rebuild to properly address all impacted features	Lower maintenance costs (less labor, less materials)
	14	Install battery back-up at railroad interconnected traffic signals	2030	May require a new controller cabinet, which then may require a signal rebuild to address all impacted features	Safety: allows preemption sequence to occur during a power outage (note: power outage of an extended duration is historically a very low risk).

4.2 Starting the DAP Design

Before starting the design, follow the simple check-list below. Design work should not begin until every item on the check list is complete. Starting a design with incomplete check-list items usually results in wasted time through unnecessary rework.

- Operational Approval is complete (See Chapter 3),
- Standards applied to the project are known (See Section 4.3), and
- Applicable background information has been compiled (See Sections 4.5 through 4.6)

The signal designer should also take a few moments to plan out what design work will be required:

- Will there be any unique details that are not covered in the Standard Drawings? The most current standard drawings (updated every 6 months in January and July) should be reviewed for any changes that may affect the design. If unique details are anticipated, these details will need to be included in plan set. See Chapter 9 and Chapter 18 for more information.
- Will any existing signal equipment need to be removed? If equipment will be permanently removed, where will ODOT want that equipment stockpiled? Check with the Region Electrical Crew.
- Will a temporary signal be needed for any stage of construction? Existing signals need to remain in service until the re-built signal is turned on and certain lane use configurations should not be open to traffic unless they have proper signalized control (e.g. dual turn lanes). Check with the Roadway Designer and Workzone Traffic Control Designer. See Chapter 11 for more information.

4.3 What Standards Will Be Used?

This question MUST be answered before starting the design and specifications. Failure to determine which standards will be used could result in complete failure of the project. In extreme cases, plans and specification will not be approved for construction and the entire project might be terminated. Every traffic signal within the state of Oregon, regardless of jurisdiction, is required to meet the minimum standards as stated in current, adopted editions of the Manual on Uniform Traffic Control Devices (MUTCD), the Oregon Supplement to the MUTCD, and the National Electric Code. There are levels of standards that apply to signal design:

- **Full ODOT design standards and specifications:** This is typically required for any project on the State Highway System. If ODOT will maintain and operate the traffic signal this is always the case. Full ODOT standard consists of the ODOT Traffic Signal Design Manual, the ODOT Traffic Signal Drafting Manual, and the ODOT Traffic Signal Policy and Guidelines.
- **Partial ODOT design standards and specifications:** This is typically allowed if a Local Agency will maintain and operate the traffic signal on the State Highway for ODOT. This is also the case where ODOT will maintain and operate a traffic signal owned by a Local Agency. The portions of the design and specifications that are not full ODOT standard are negotiated in the Inter-Governmental Agreement (IGA) or directly with the Traffic-Roadway Section during the Design Approval Process. Generally the variance to ODOT Standards is minor, such as the use of interior illuminated lane use signs.
- **Full Local Agency design standards and specifications:** This standard only applies to local agency owned and maintained traffic signals. As stated above, if the local agency will maintain and operate an ODOT owned traffic signal then some of the local agency standards might be allowed through negotiation.

4.4 Intergovernmental Agreements (IGA) and Jurisdictional Transfers

An Intergovernmental Agreement (IGA) is a legally binding document that defines the obligations of each party involved in a project. An IGA is typically needed for a state highway intersection with a local county road or city street. Depending on the scope and nature of the project there could be a lot of responsibilities to define, some of which have a direct impact on the design of traffic signal, for example; Maintenance responsibility (what design standards should be used), signal timing responsibility (what type of controller and type of detection should be used), and aesthetics (what decorative treatments are to be used).

Jurisdictional transfers allow agencies to legally redefine who has ownership of the roadway (typically changing from ODOT owned to local agency owned). They are rare, but if one is being considered on the project, it is imperative that Jurisdictional Transfer Agreement is complete and final prior to any design work. The fundamental question of what design standard should be used cannot be answered until then.

Unfortunately, the IGA or the jurisdictional transfer is sometimes processed simultaneously with the design the traffic signal. If this is the case, it is highly recommended that the signal is designed according the applicable standards that CURRENTLY apply, not to the standards that are ANTICIPATED. It is VERY risky to design according the anticipated standards, as past history has shown IGAs and especially jurisdictional transfers often do not go forward as expected given the many negotiated factors and political nature. Also, the Traffic-Roadway Section review and design approval process becomes more onerous and may cause delays to the project due to the uncertainty of the proper standard that should be applied.

Designing a signal according to anticipated standards is risky. This will result in wasted time and effort should the IGA or Jurisdictional Transfer fall through.

4.5 Background Information to Gather

4.5.1 As-Built Drawing Archive (Filenet)

As-built plan sheets should be downloaded from the internet at the Traffic Standards Crew Website under "Drawing Archive". There is also a "Getting Started Guide" for help in using the database.

http://www.oregon.gov/ODOT/Engineering/Pages/Signals.aspx

When searching for drawings, it is often best to search with the Highway Number. Also, leave the search as generic as possible (while still specific enough to return less than 200 entries). This is because many of the more specific fields are not consistently populated for all intersections entered in the database. Searching these specific fields may result in missing certain drawings.

4.5.2 Electronic Information

Prior to the field verification discussed in Section 4.5.3 below, it is good to get familiar with the project area using the available electronic sources of information: ODOT digital video log and Google/Bing maps. This can help the signal designer zero in on issues/questions to address during the field verification, resulting in an efficient use of time when on-site. Note that ODOT uses a unique numbering system for all the highways; use the Cross-Reference Guide link below to find the ODOT highway number.

ODOT Highway Number Cross-Reference Guide:

http://www.oregon.gov/ODOT/Data/Documents/Routes-to-Highway-Cross-Reference-Table.pdf

ODOT Digital Video Log: http://www.oregon.gov/ODOT/Data/Pages/index.aspx

4.5.3 Field Verification

Field verification is the one of the most important steps in the process of designing a traffic signal or signal modification and should not be skipped. Thousands or tens of thousands of dollars can be saved during the construction phase of the project by simply making a field visit during the design phase and verifying the existing conditions. Seeing the actual site with you own eyes is more valuable than just looking at photos or a base map because photos and drawings only provide limited perspective and can be incomplete or misleading.

A field visit is ALWAYS cost effective and well worth the effort. At least one field visit should be done during the design phase.

When conducting the field visit, bring a camera and take a lot of photos. These photos will be very helpful throughout the design and construction support phase the project. If in doubt, take a photo; something that seems insignificant now may prove to be extremely useful in the future (it may save an additional trip in the field to re-verify or might be useful data in resolving a construction claim). Some tips for taking good photos (depending on the scope and nature the project, some may not apply):

- Take photos of the same area from different perspectives

- Get specific, micro detail photos – inside of junction boxes (conduits and wire), inside the controller cabinet (front and back), existing signal equipment and attachments.
- Get "bigger picture" photos – each approach (approximately 500' feet back from the intersection), each quadrant of the intersection, slopes, utility locations (the ones that are visible)

Measurements can also be very helpful, especially if the project has limited or no survey information (depending on the scope and nature of the project, some may not apply):

- Existing conduit sizes and number of wires (these measurement are critical if attempting to re-use them or add additional wire)
- Push button and pedestrian head mounting heights (if the project will be adjusting or adding ADA ramps)
- Sight distance measurements

Other useful information to gather in the field includes:

- Posted speed in the vicinity
- Location and nature of any accesses/streets that are close by
- Potential locations for all of the signal hardware (poles, pedestals, & cabinets)
- Power source location (typically nearest transformer)
- The driver's perspective – drive each approach, note any sight distance issues (depending on the time of year, vegetation may block sight distance when leaves return).
- Information on the signal pole

4.6 Background Information from Others

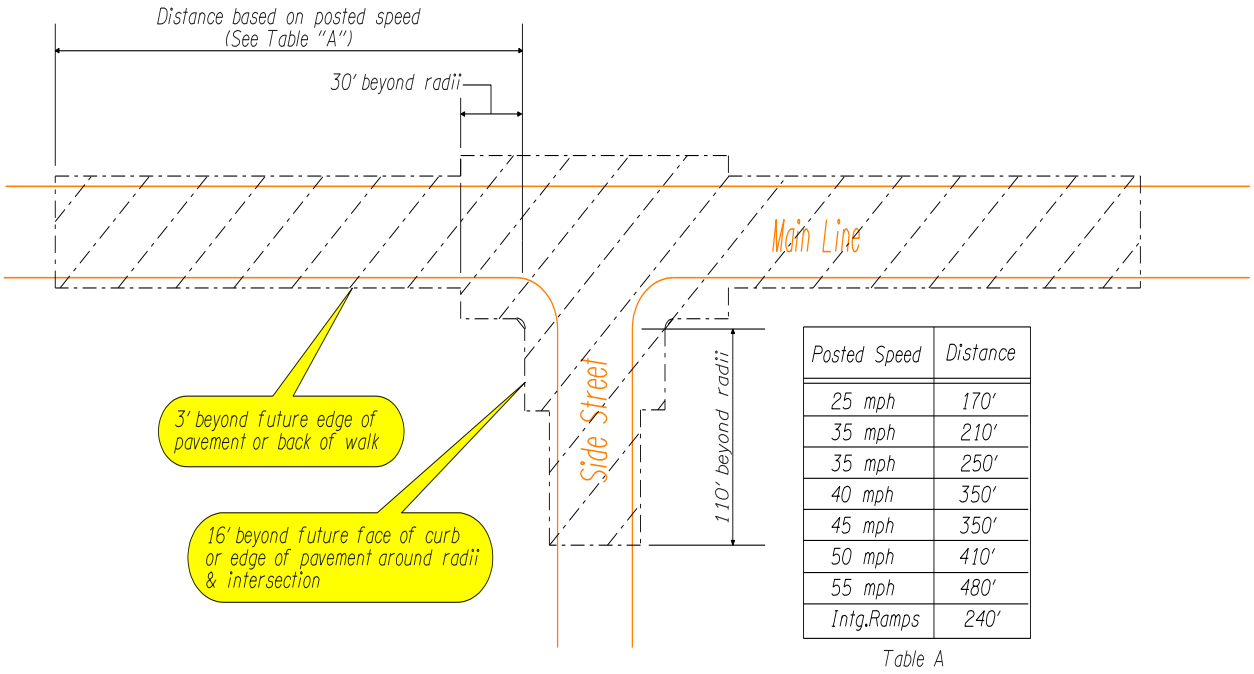
4.6.1 Base Map and Survey Information

Survey data is needed on most projects. To determine the amount and type of survey needed, the scope of the design must be defined. Below are a few examples:

- **Replacement of existing loops** – Typically as-built plans and field visit are all that is needed.
- **Rebuild of detection system** – Typically as-built plans and field visit are all that is needed. If utilities appear to be an issue a simple survey is needed.
- **Installation of pedestrian signal poles, vehicle pedestals, controller cabinets, service cabinets** – A simple survey is needed
- **Installation of SM or STP poles** – Full survey is needed with geotechnical report

Figure 4-6 below shows the recommended minimums for a survey within the intersection area. If the intersection has not yet been surveyed or additional information is required, this figure will help guide you in getting the necessary data.

Figure 4-6 | Survey Needs For Typical Traffic Signal



Posted Speed	Distance
25 mph	170'
35 mph	210'
35 mph	250'
40 mph	350'
45 mph	350'
50 mph	410'
55 mph	480'
Intg.Ramps	240'

Table A

Data to collect within the survey area shown in Figure 4-6:

- Underground utilities less than 18' deep in the 16' wide survey areas around the radii (pole foundation conflicts)
- Underground utilities less than 3' down in the 3' wide survey areas beyond edge of pavement or back of walk (conduit and junction box conflicts)

- Above ground utilities and wire attachment heights in 16' wide survey areas around the radii (mast arm and span wire conflicts)
- Power poles with transformers (potential power source). Note: this may be located outside of survey area
- All Striping within survey area: lane lines, centerline, fog lines, crosswalks, stop bars, legends
- Any existing signal features within survey area: controller cabinet, poles, junction boxes, loops, etc.

4.6.2 Roadway Design

If the project is rebuilding the roadway, then there will be a roadway design base map. It is critical that the signal design is based on what will be built in the field. The Signal Designer must communicate with the Roadway Designer from the start of design through final plans and specifications. Since the Roadway Designer's final product is the base for the Signal Designer to start their design, it is easy to see using outdated roadway base maps will result in total failure of the traffic signal design.

4.6.3 Geotechnical Report

If new SM or STP poles are proposed, then a geotechnical report is required to determine the foundation depths. Standard loading, not actual loading, is shown in the Standard Drawings for the poles and is what is used to determine foundation depth.

As soon as the pole locations are defined, contact the Region Geo/Hydro Manager for a foundation investigation of the proposed site. This information will need to be incorporated into the pole entrance chart for the pole foundations.

4.6.4 Utility Hook-ups

New signals require a connection to commercial power and may require other connections (e.g. telephone). Or the project may involve moving existing utilities. The signal designer must coordinate with the Region Utility Specialist when locating the power supply and any other utility connections as early as possible in the design process.

4.6.5 Rail Crossing Order

If a rail crossing order is required for an intersection, it will be processed simultaneously with the design the traffic signal. The final Rail Crossing Order will be issued prior to letting the project. The signal designer will provide a sealed Railroad Preemption Plan Sheet during the early stages of the design (DAP or Preliminary Plans) for inclusion into the Rail Crossing Order. See Chapter 16 for more detailed information.

4.7 Signal Design Project File

A project file for the signal designer's personal use should be created and maintained for the project in ProjectWise. It should contain all of the supporting documentation, calculations and major decisions related to the traffic signal design and construction. The items listed below, if applicable, are typically included in the signals file:

- Project narratives
- Operational Approval letters
- Photometric Data for Illumination
- Calculations for:
    - Wire size
    - Wire fill
    - J-Box Size
    - Wire count
    - "AH" for strain poles
- Cost estimates (itemized breakdown for each bid item, total bid item cost, and anticipated item cost)
- E-mails and memos concerning design decisions
- Photos
- Field verification information
- Geotechnical report
- Rail crossing order
- Pole submittals and shop drawings
- Manufacturer's cut sheet or submittals
- Correspondence between project managers, consultants or contractors
- Existing as-builts

Other documentation related to signals, such as special provision boiler plates, review comments and their resolution, etc. will be also created and maintained in ProjectWise, but will not be stored in the signals file. They will be stored in the appropriate file as designated by the ProjectWise standards.

Good record keeping can save time and effort when issues/questions arise during the design, construction, or even maintenance phase.