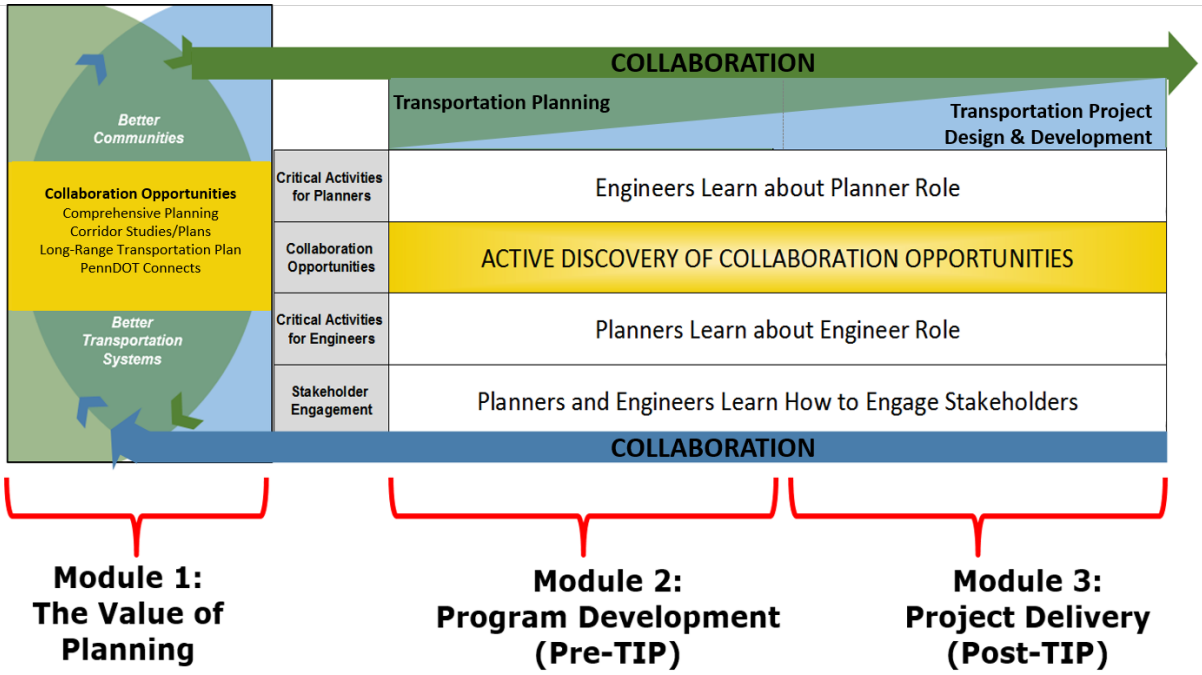
Planning & Engineering 360°

Planning & Engineering 360°

Module 3: Project Delivery

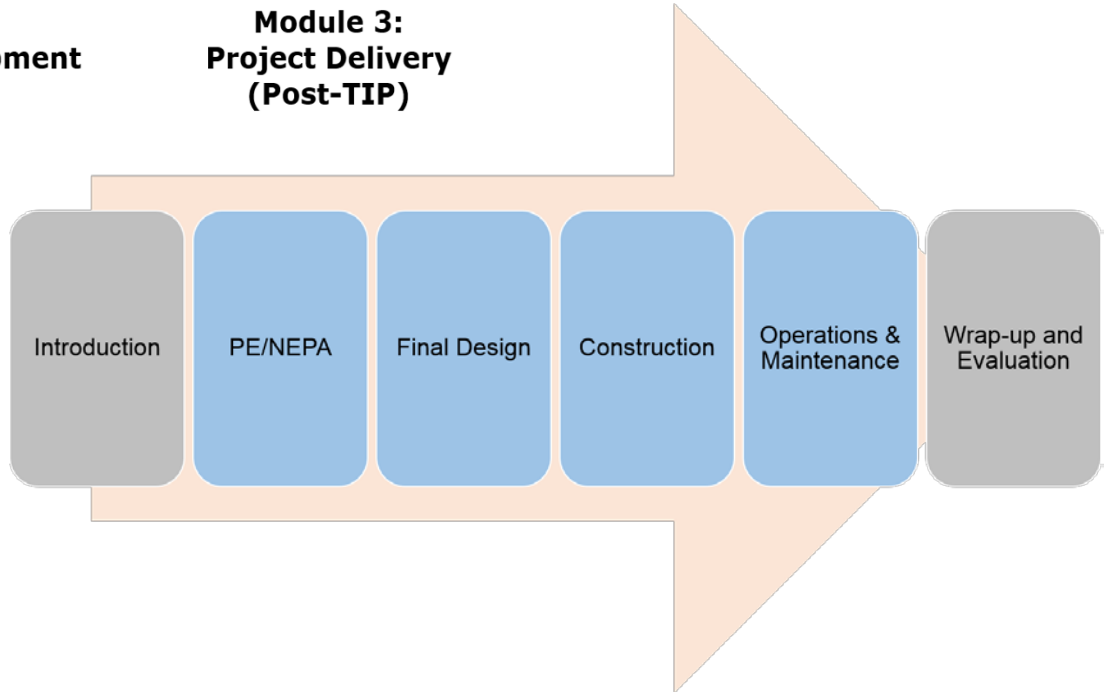
Introduction

Module 3 Overview



P&E 360 Course Overview

Program Development for Module 3



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Leadership Perspective

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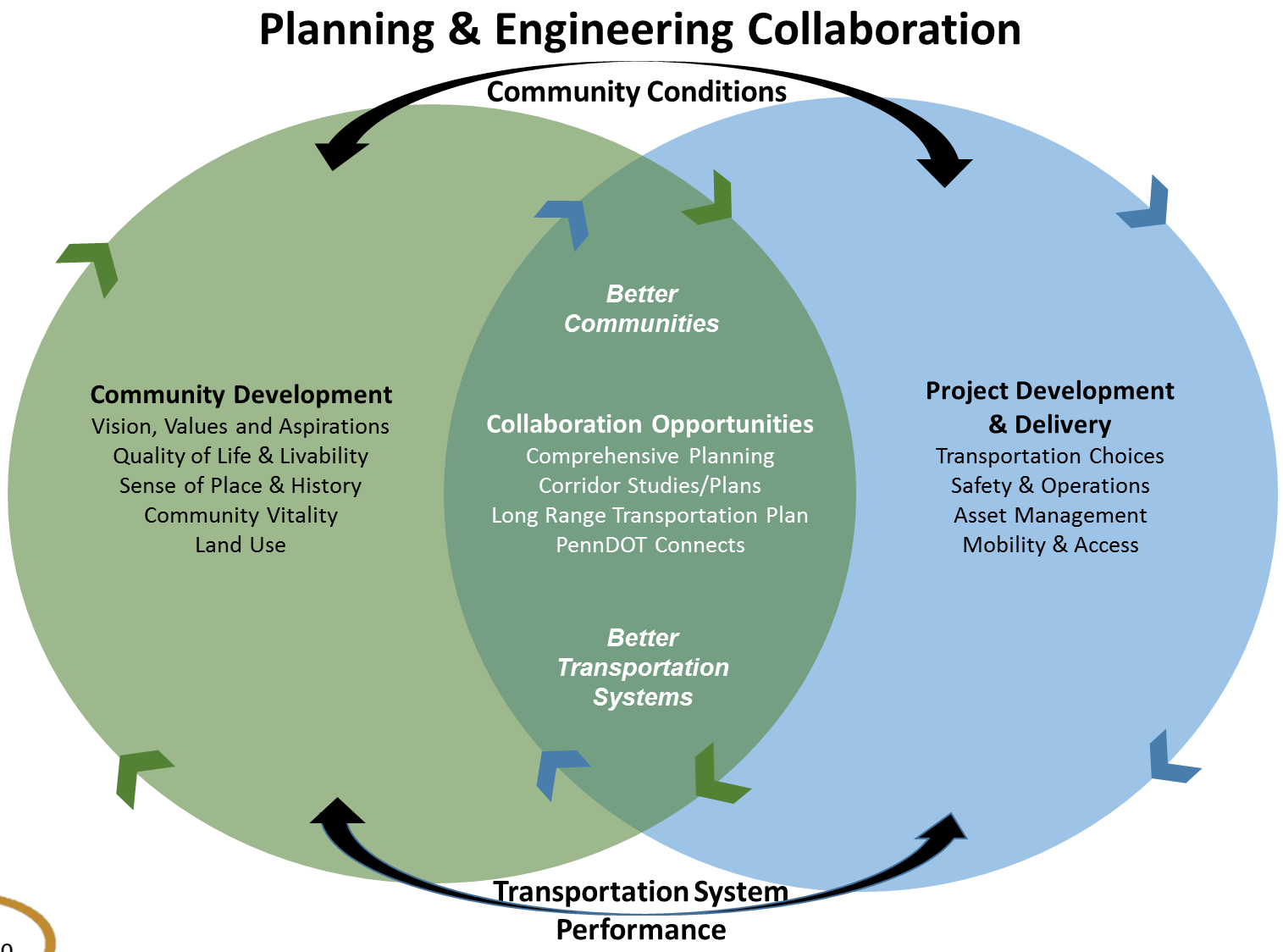
Review of Module 2



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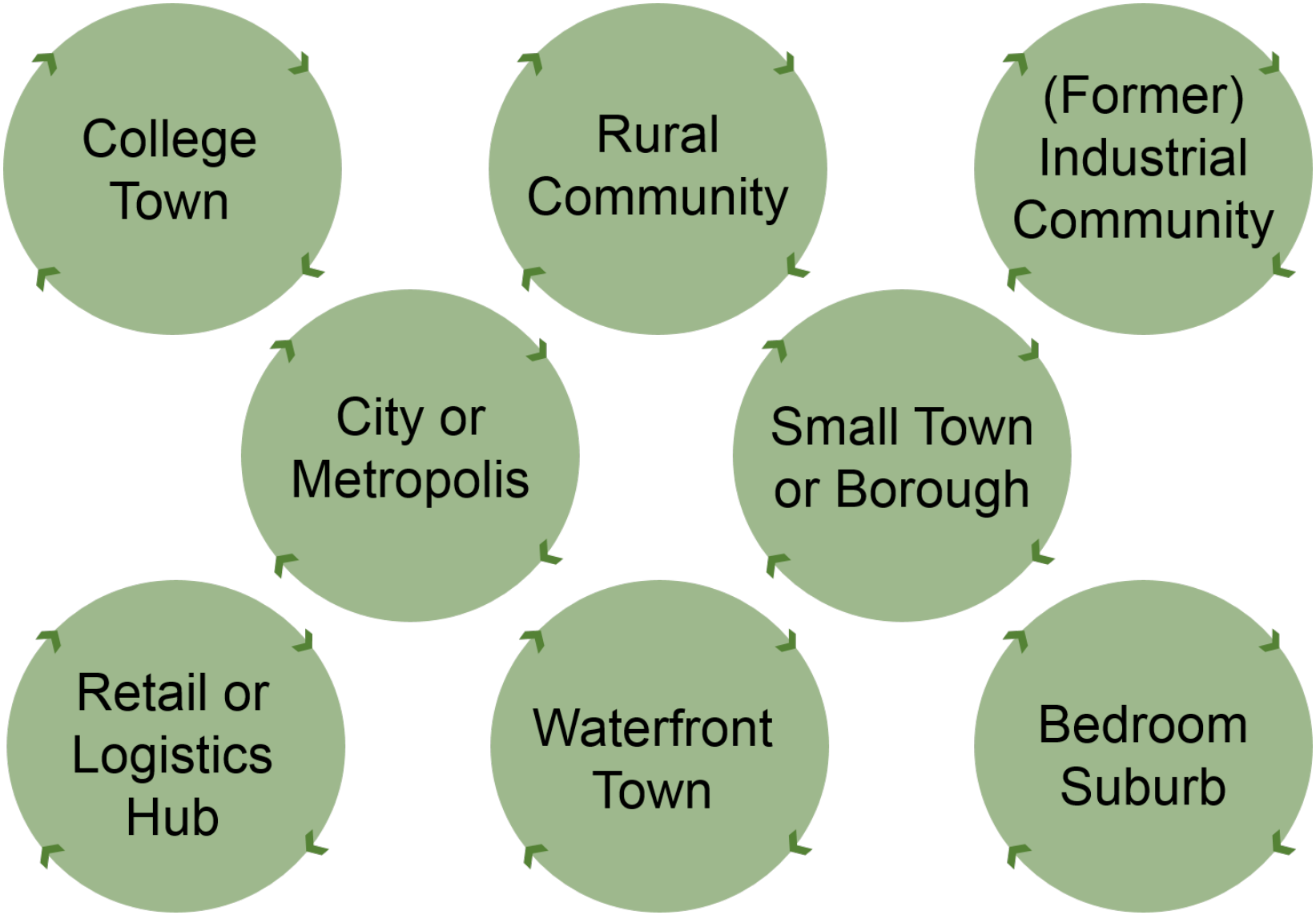
Revisit Your Community

Activity



The Value of the PIF

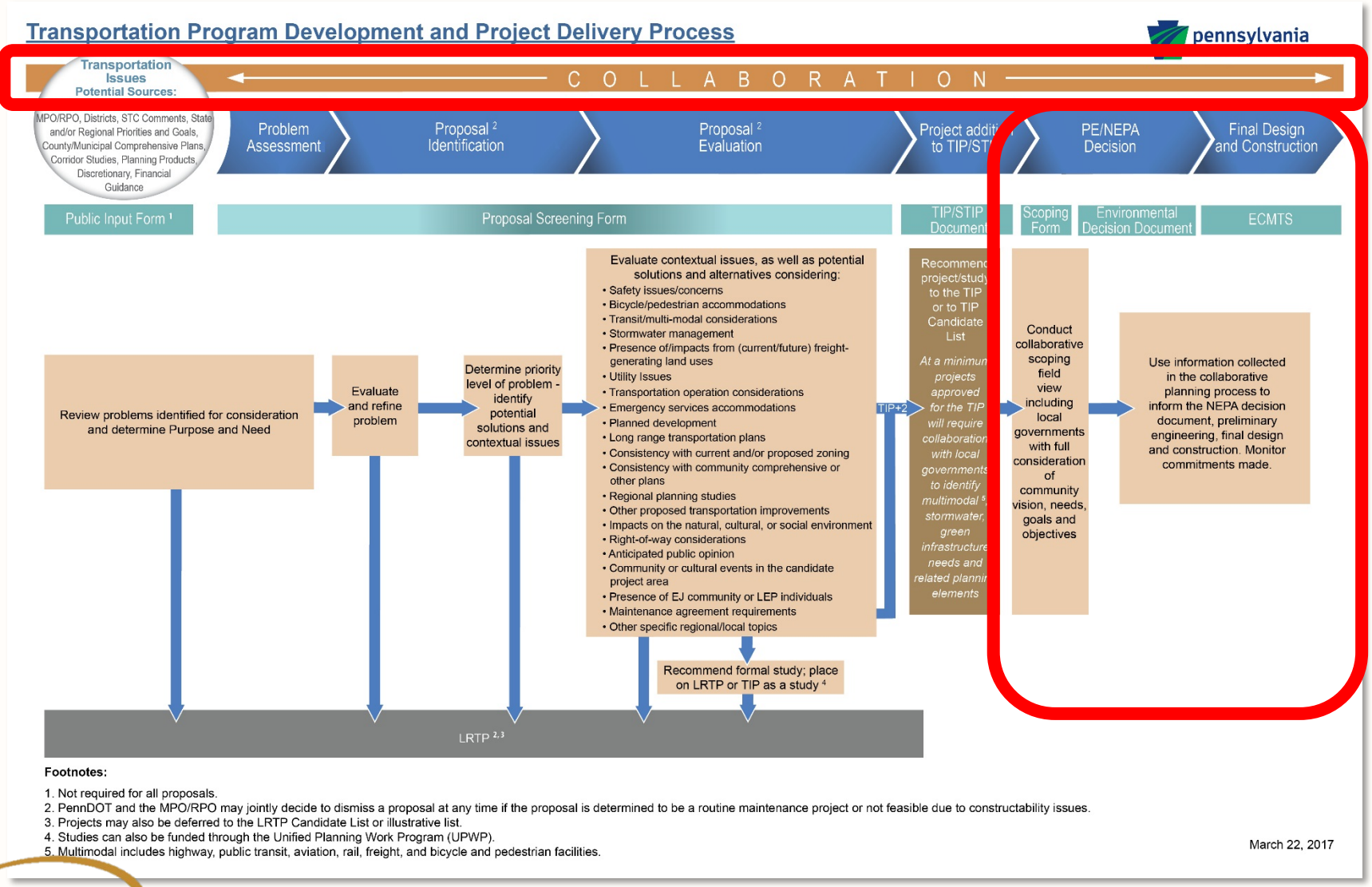
Open your workbook to Appendix 2C and find your community's transportation problem and review it with your table team.

Based on your community's transportation problem, fill in one of the two sections of the Project Initiation Form (PIF) that you have been given.

Be sure to complete it to the level of thoroughness and quality that Engineers would need for the transition to Project Delivery.

Workbook p.10
Appendix 2C

Post-TIP Collaboration Opportunities



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Appendix 2B

Scalable Approach

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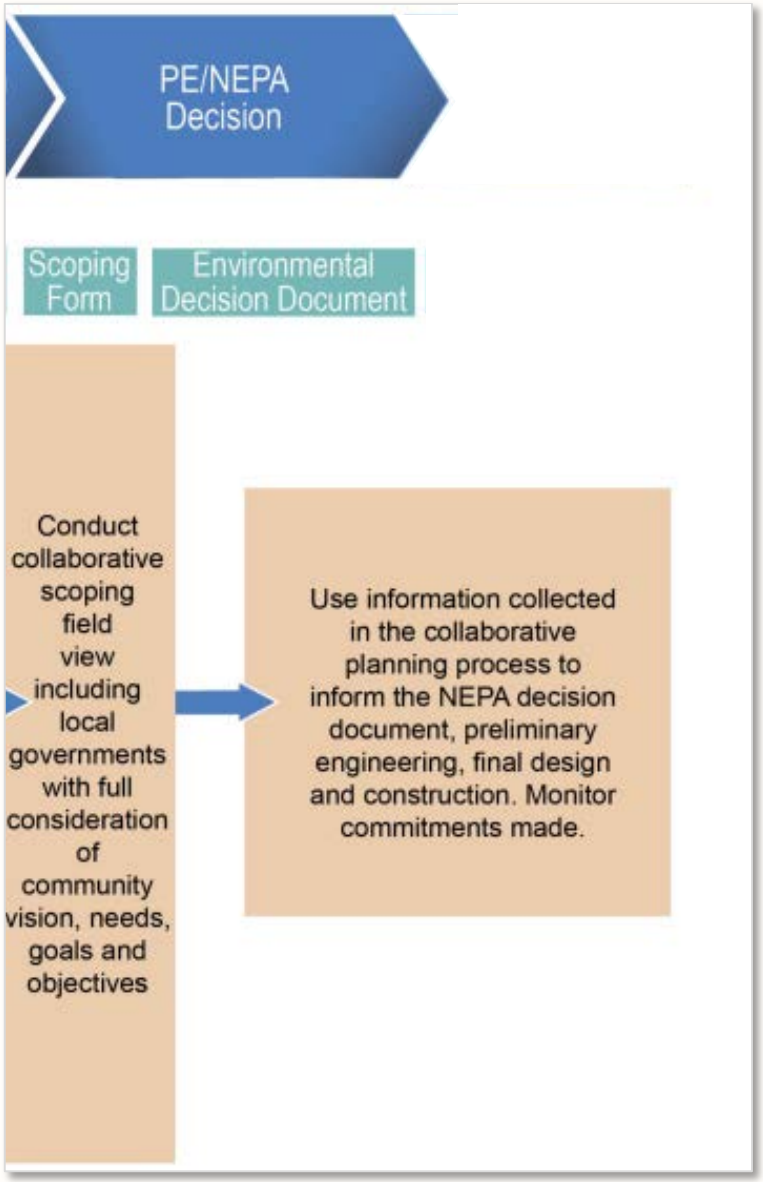
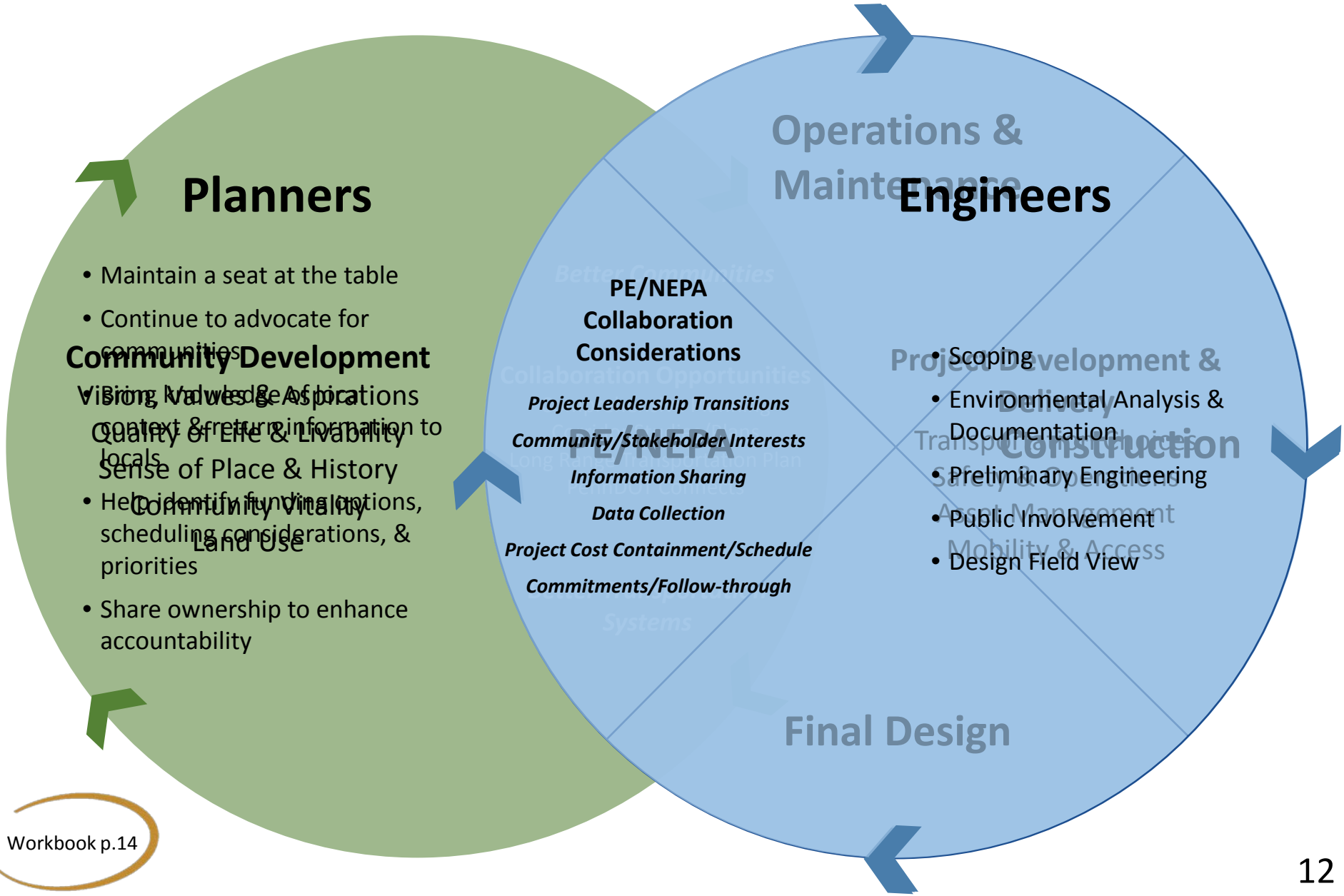

PE/NEPA Decision
Scoping Form
Environmental Decision Document
Conduct collaborative scoping field view including local governments with full consideration of community vision, needs, goals and objectives
Use information collected in the collaborative planning process to inform the NEPA decision document, preliminary engineering, final design and construction. Monitor commitments made.

PE/NEPA

PE/NEPA Collaboration Considerations



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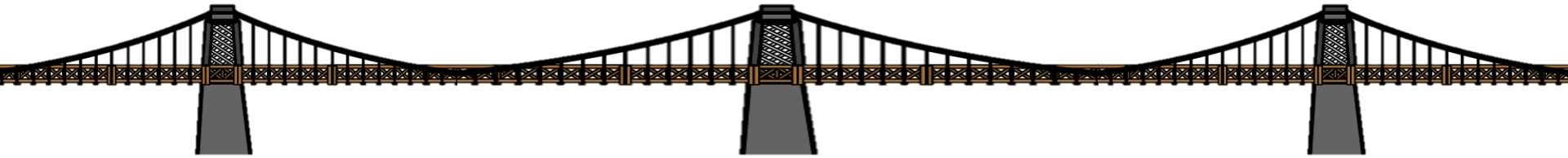
Transitioning into Preliminary Engineering

PennDOT Connects Bridge

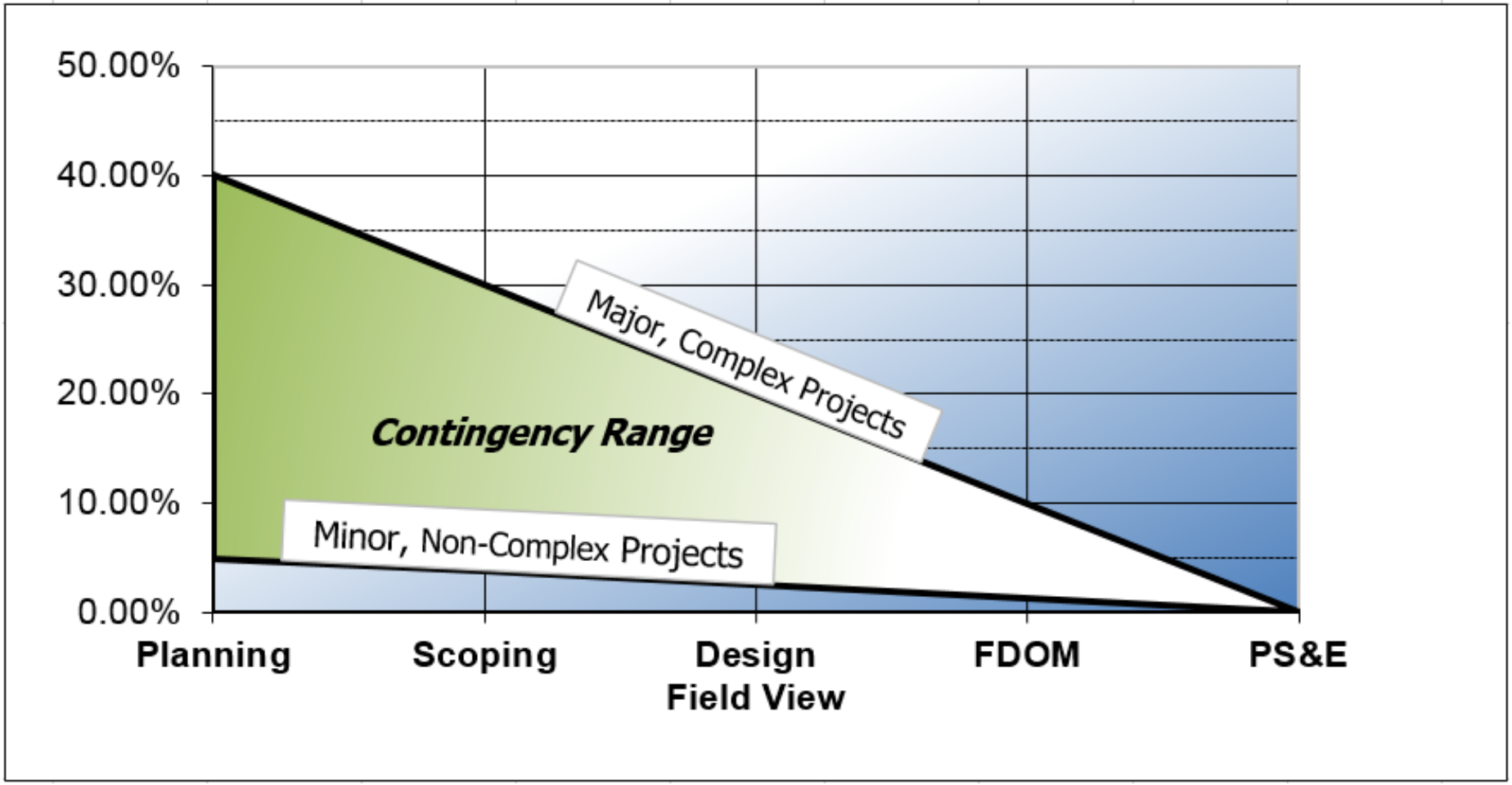
Plans | **Program/TIP** | **Project Delivery**



CONNECTIONS 2040
PLAN FOR GREATER PHILADELPHIA

Workbook p.15

Cost Containment



Workbook p.15

Scoping

Overview

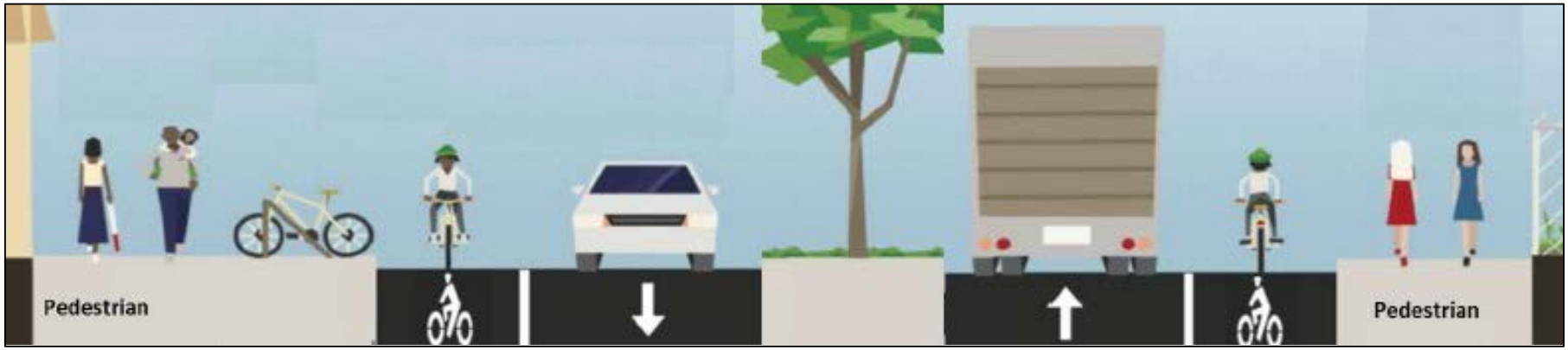
Scoping provides an early interdisciplinary opportunity to:

- Provide a clear description of project objectives, purpose and need.
- Identify potential alternatives (e.g., alignments).
- Identify potential engineering and environmental impacts.
- Identify deliverables.
- Establish basis for scope of work.

Workbook p.16

Design Criteria and Flexibility

- Design speed
- Lane width
- Shoulder width
- Bridge width
- Horizontal/vertical geometry



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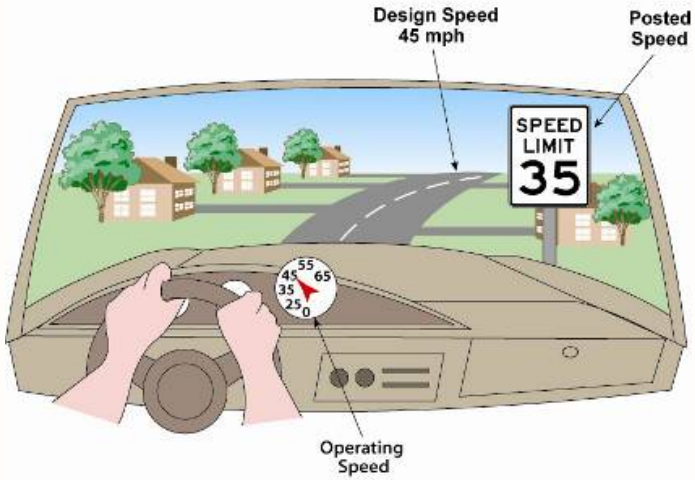
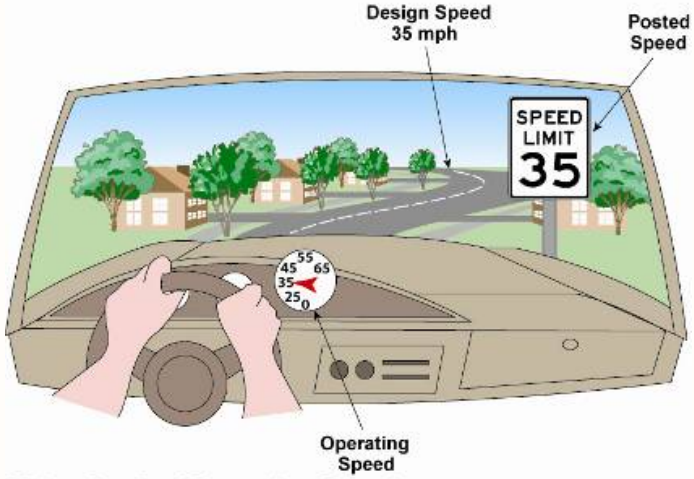
Example: Design Speed



Conventional Design



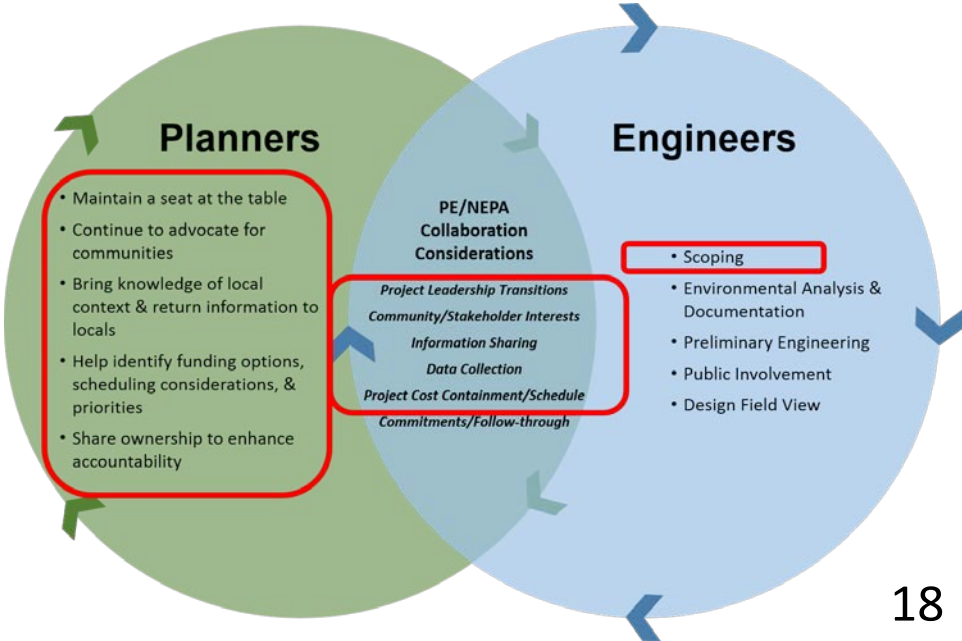
Using Desired Operating Speed

Scoping

Collaboration Possibilities

The Scoping Field View is a proactive, on-site review of the project among team members and key stakeholders.

- Assemble scoping team.
- Obtain stakeholders' perspectives.
- Engage Planner to represent community priorities.
- Maximize local in-depth knowledge of environmental issues (e.g., property owners, etc.).



Workbook p.16

Environmental Analysis & Documentation

Overview

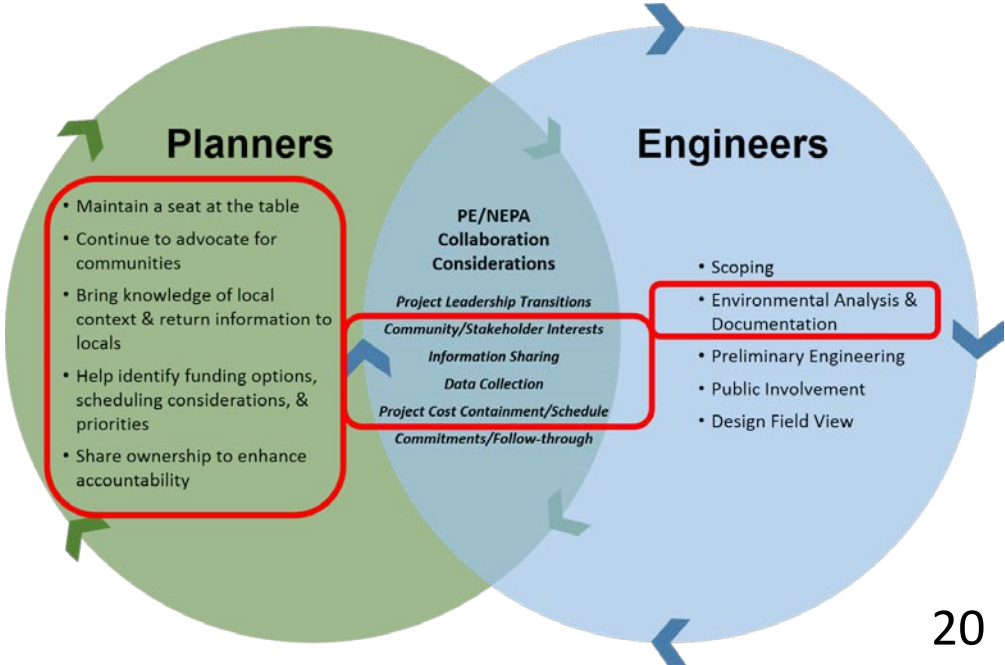
- Follow NEPA/PA Act 120 Process.
- Comply with state and federal environmental laws.
- Determine the extent of environmental impacts that a project may have. (Typically, the more complex a project, the greater the range of potential environmental impacts.)
- Identify mitigation alternatives.

Workbook p.17

Environmental Analysis & Documentation

Collaboration Possibilities

- Gain a clear understanding of project environmental issues.
- Determine value-added support role for Planners, where beneficial.
- Bring forward relevant data from planning.
- Maintain awareness of potential impacts on regional issues.
- Provide additional detail on issues.
- Ensure critical community environmental issues are addressed.
- Share data and mapping resources.
- Work with coordinating agencies.
- Identify streamlining opportunities.

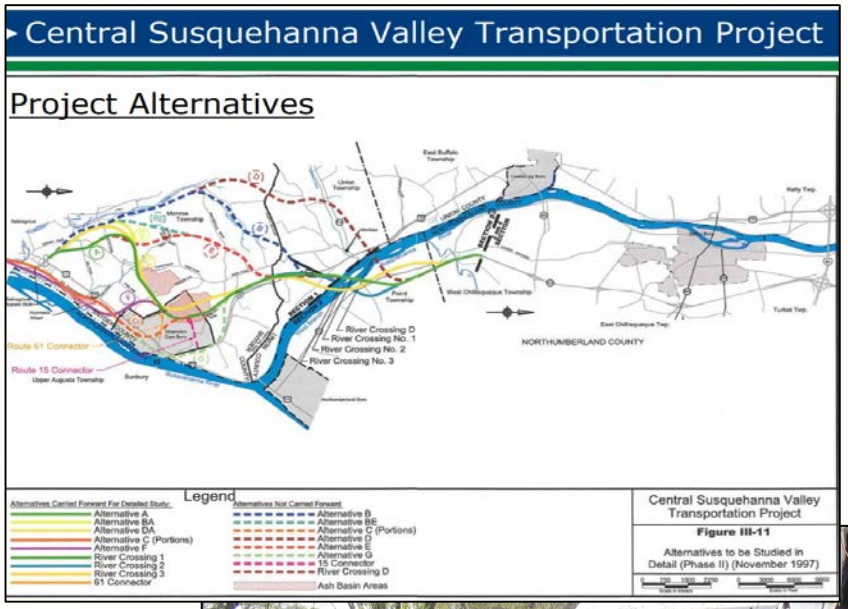


Workbook p.17

Preliminary Engineering

Overview

- Prepare engineering studies, designs, analyses, and associated documentation.
- Support and align with the project's environmental studies.



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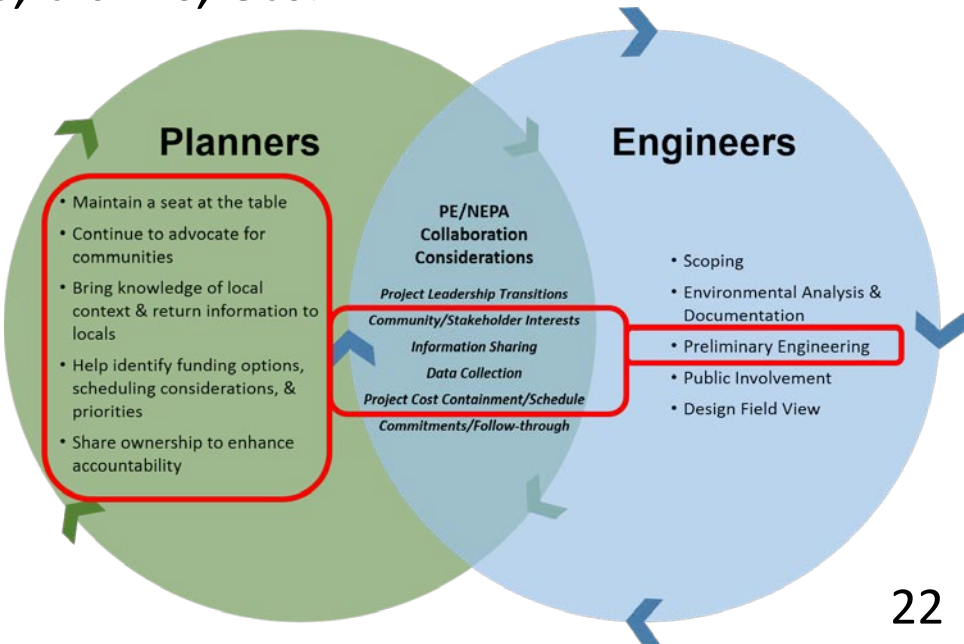
Preliminary Engineering

Collaboration Possibilities

- Ensure project coordination between MPOs/RPOs, municipalities, and districts, as beneficial.
- Advocate for alternatives that benefit communities.
- Involve Planners as project alternatives are refined.
- Leverage Planner's knowledge of community environmental issues, population, demographics, traffic, etc.
- Consider the following:
  - Context Sensitive Solutions
  - Design Value Engineering
  - Intersection Control Evaluations (ICE)



Workbook p.18

Public Involvement

Overview

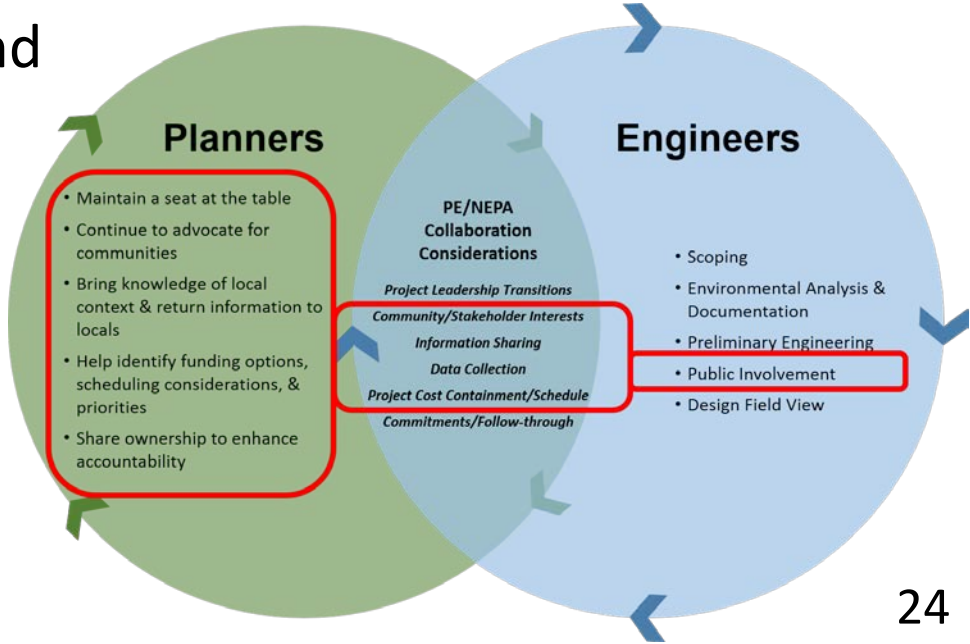
- Planning requires public participation; project delivery requires meaningful public involvement.
- One size doesn't fit all - approach should be customized for a specific project (e.g., complexity, context and intensity of impacts, location, etc.).
- Typically, amount of public involvement increases with the level of environmental documentation required.

Workbook p.19

Public Involvement

Collaboration Possibilities

- Identify creative, value-adding ways to engage key stakeholders, considering:
  - Local perceptions and concerns.
  - All transportation needs and modes.
  - Opportunities to improve quality of life.
- Obtain public feedback on alternatives.
- Leverage the best data, maps, and other media available.
- Consider issues beyond the borders.
- Reconcile conflicts.



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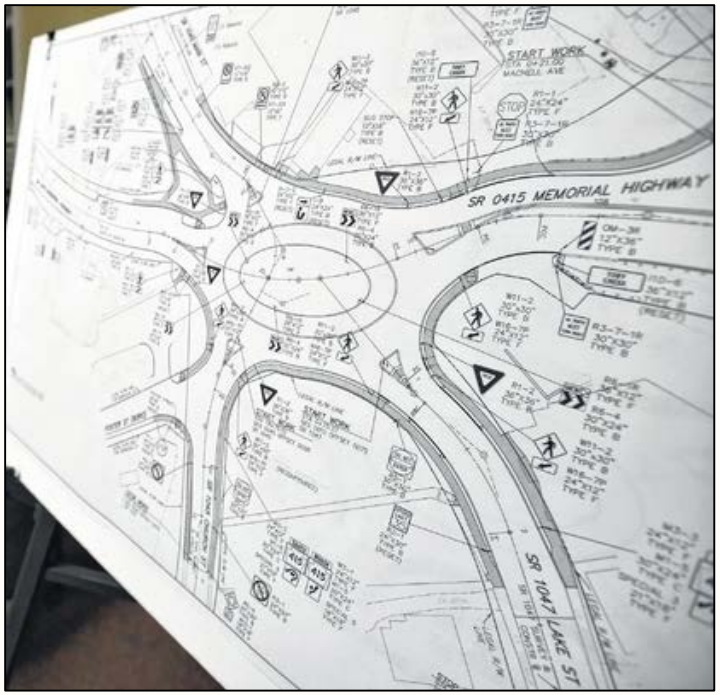
Design Field View

Overview

The Design Field View is the culmination of PE/NEPA efforts and involves both engineering and environmental elements.

The purpose of the Design Field View is to:

- Support the project's Purpose and Need.
- Confirm project impacts from the NEPA document.
- Receive and review comments on Preliminary Design.
- Refine the project detail resulting from the PE/NEPA activities.



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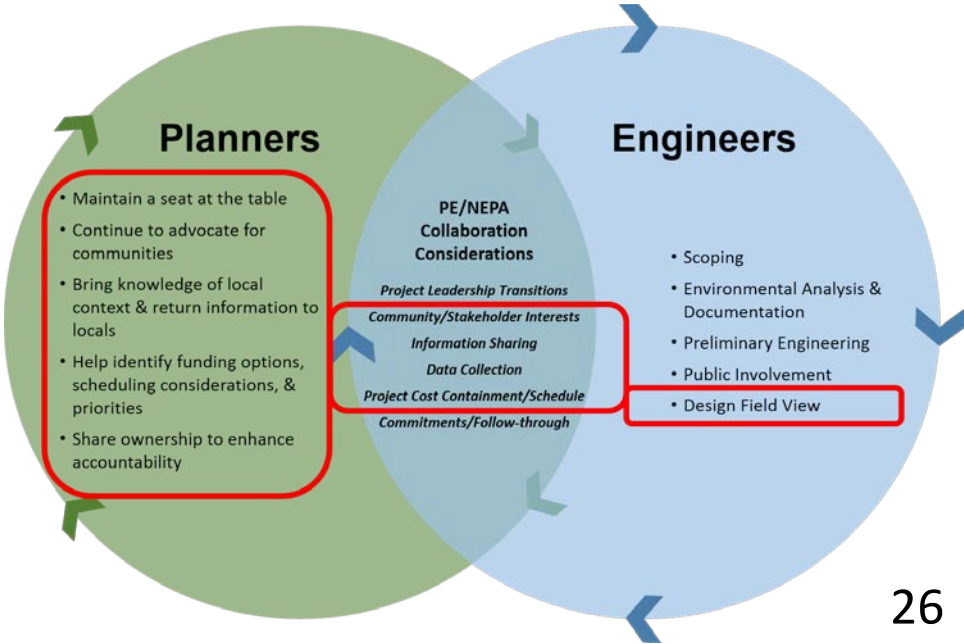
Design Field View

Collaboration Possibilities

- Review Preliminary Engineering commitments (PIF/NEPA).
- Participate in the Design Field View, if beneficial.
- Address municipal agreements (sidewalks, maintenance, etc.).
- Address agencies' involvement.
- Address utilities' involvement.

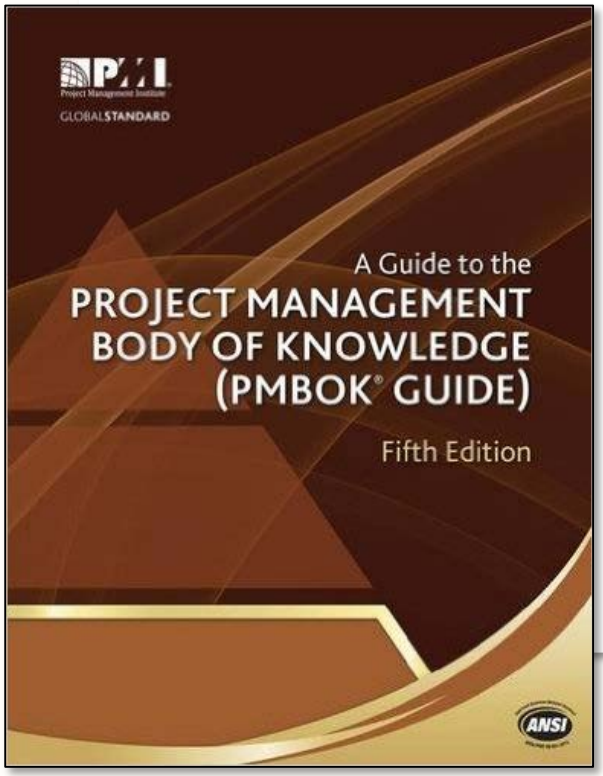


Workbook p.20

PE/NEPA in Your Community

Activity

Based on your community's problem and alternatives generated in Module 2, select a project for your community and name it. Then…



1. Identify three (3) stakeholders that have a high stake in the project (e.g., utility companies, private companies, public officials, freight shippers & carriers, etc.).
2. Identify key issues or concerns that each stakeholder might have.
3. When and how would you engage them?

PennDOT Connects Pointer:
Consider stakeholders identified early on.

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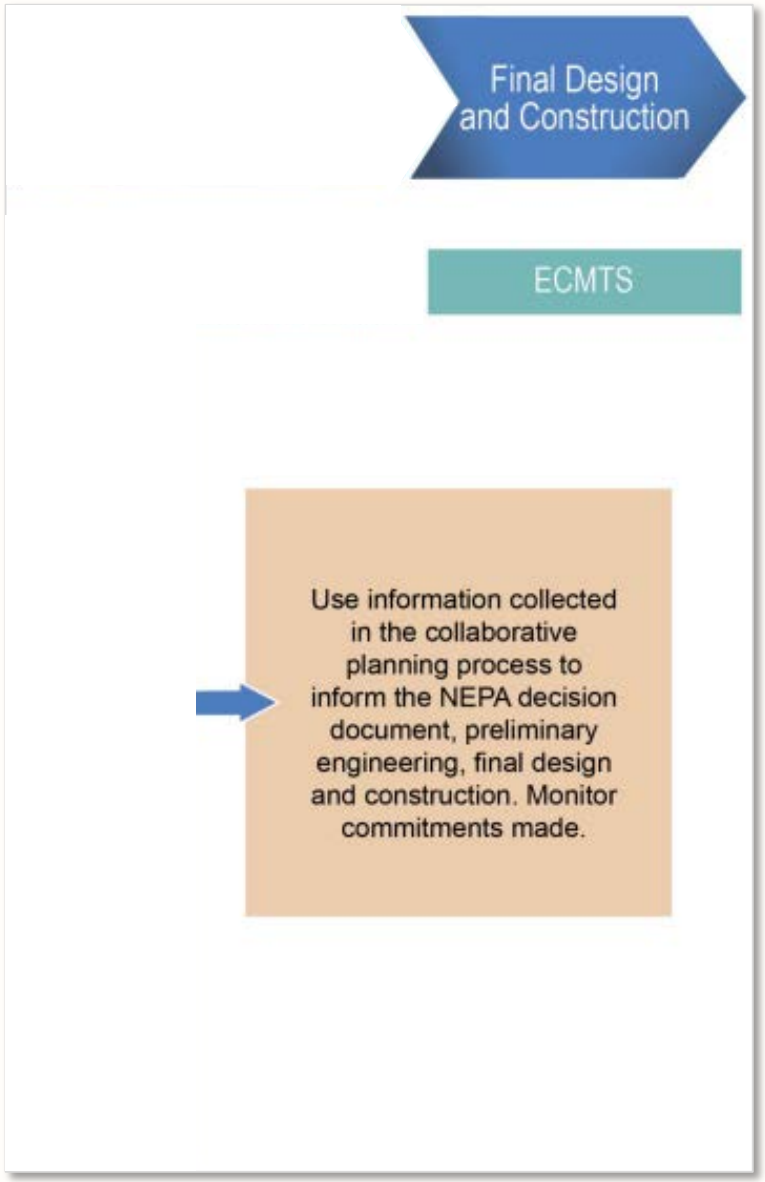
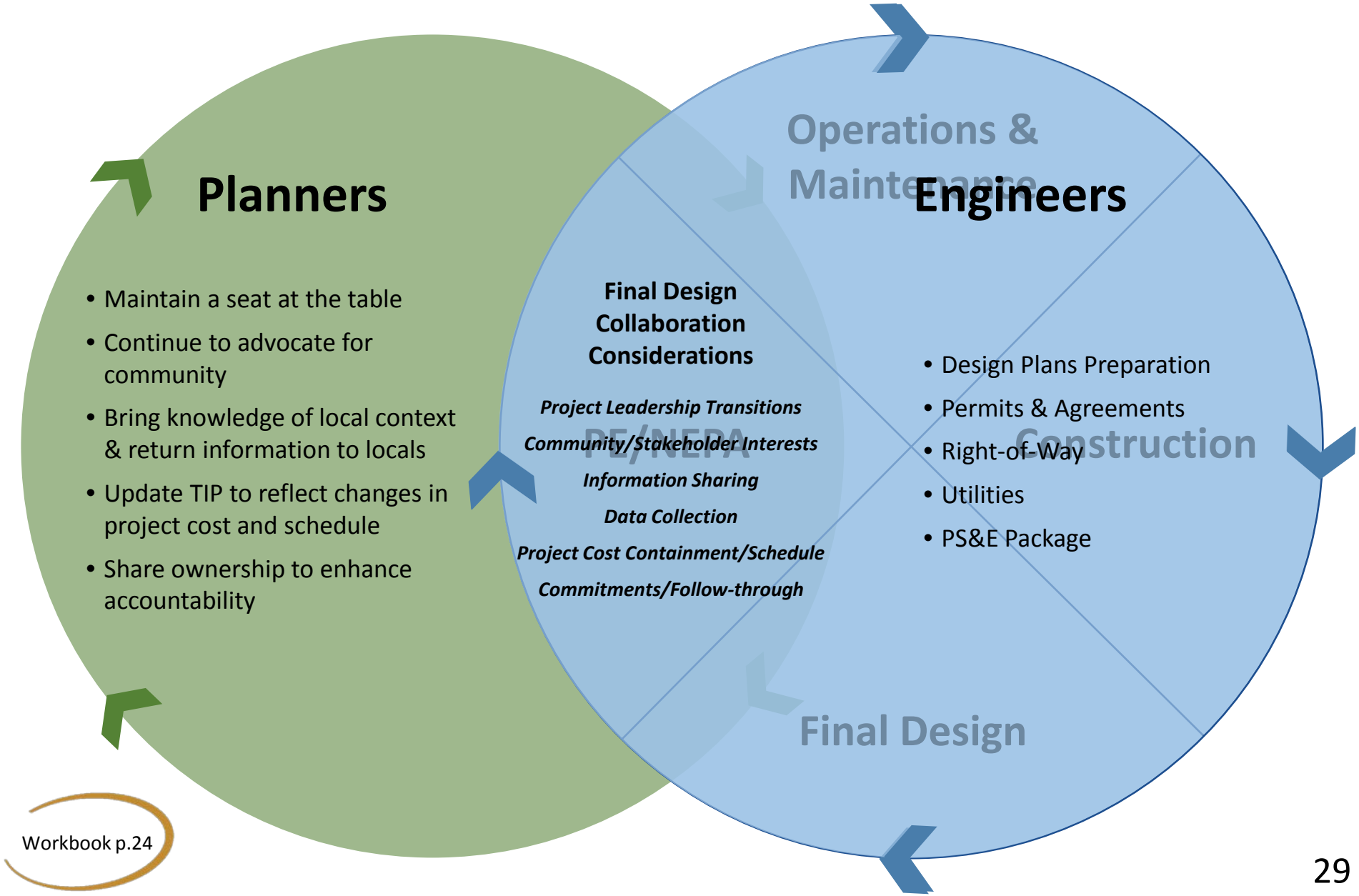


Final Design

Final Design Collaboration Considerations



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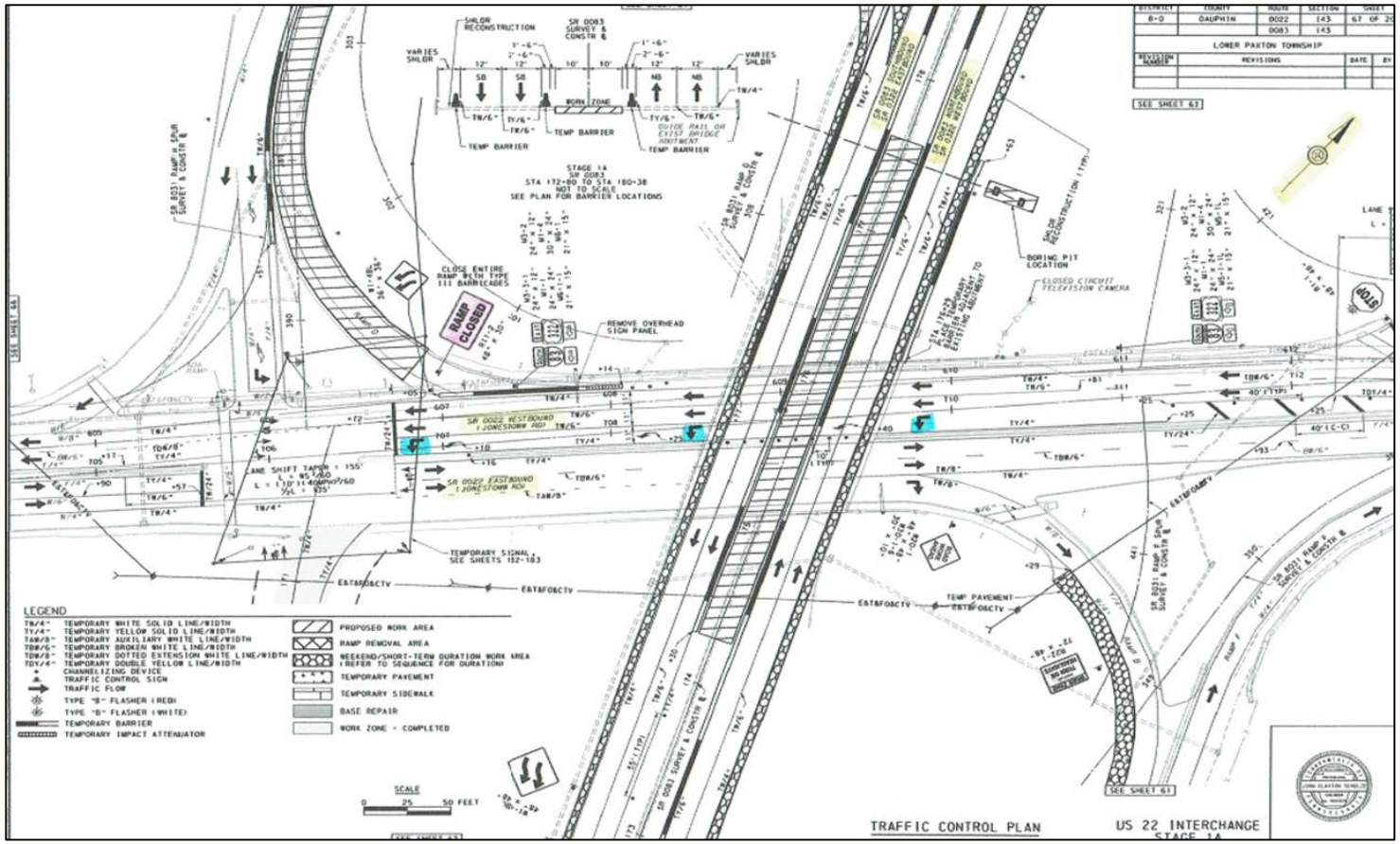
Final Design: Avoiding Re-work

Design Plan Preparation

Overview

Identify project-related improvements/details, materials, and quantities.



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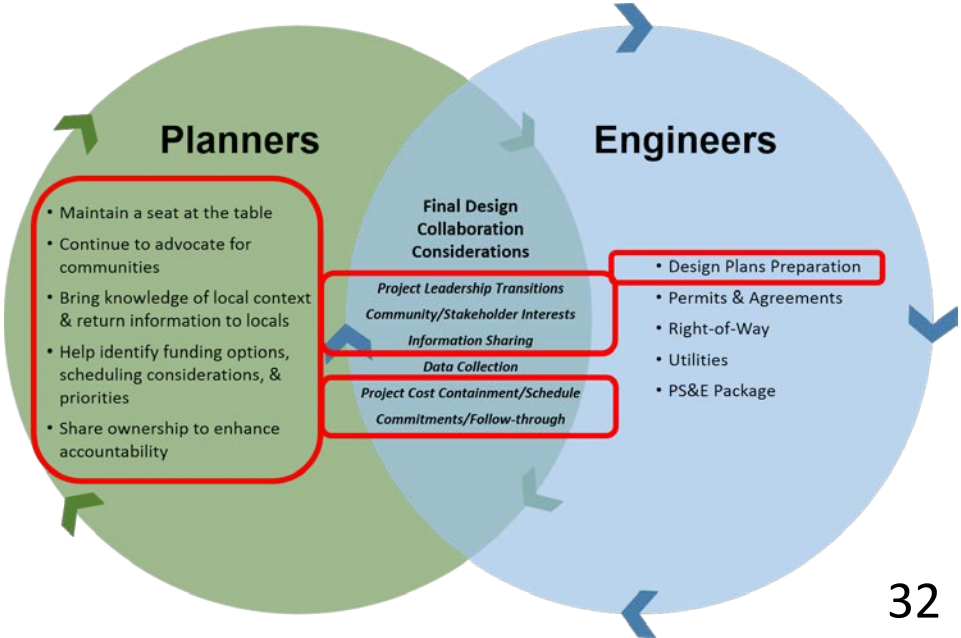
Design Plan Preparation

Collaboration Possibilities

- Review/confirm Final Design commitments (NEPA).
- Engage public officials, resource agencies, and the public to resolve PE and/or new issues.
- Address design details as they relate to prior PIF commitments.



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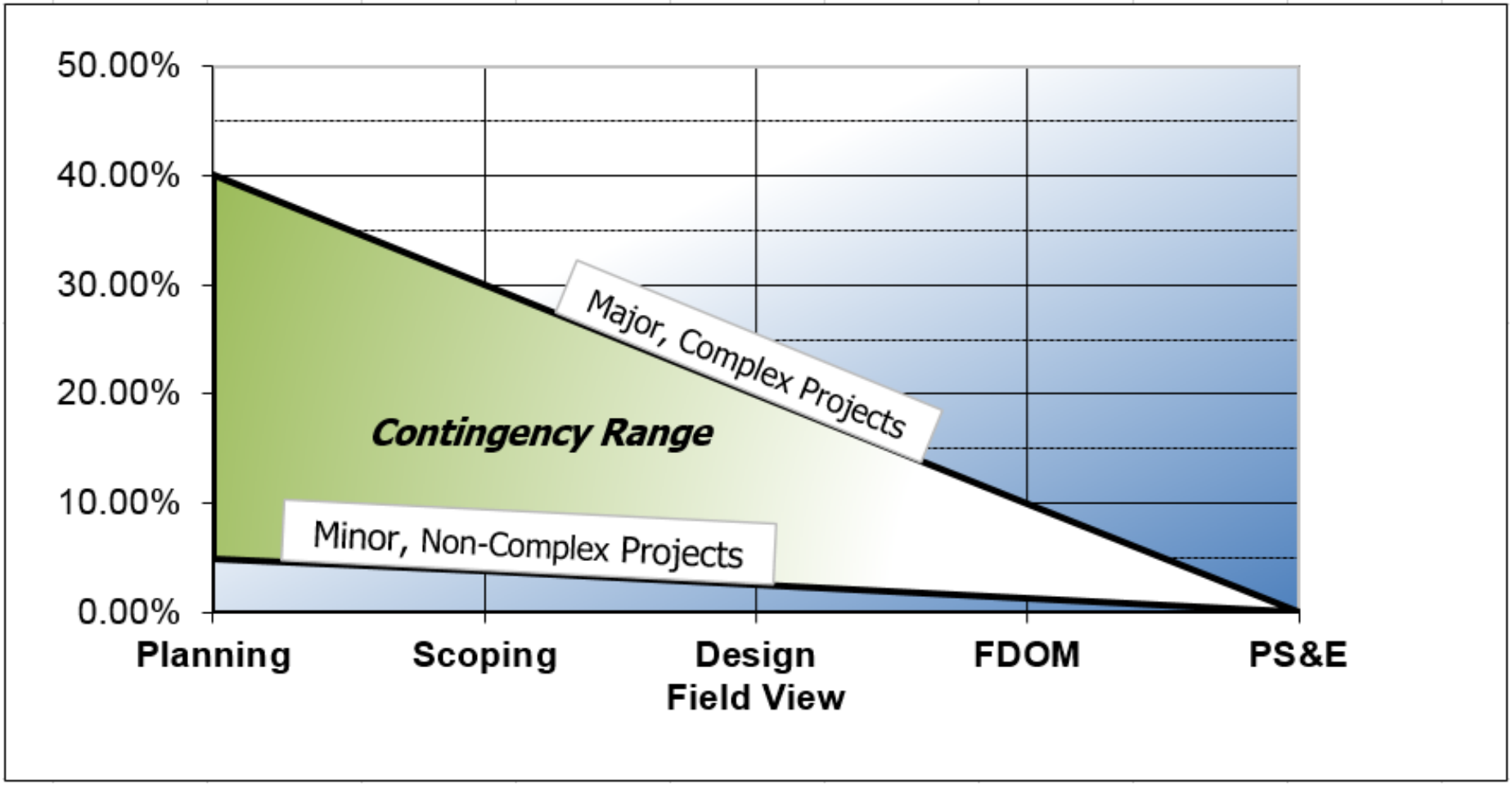
Cost Containment Revisited



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Permits & Agreements

Overview

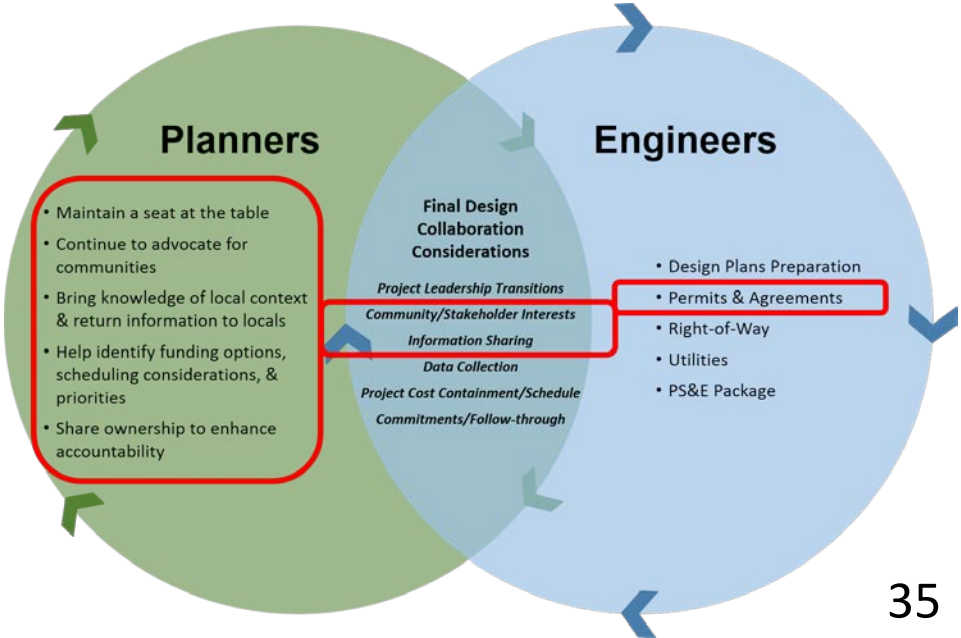
Submit required documentation to federal, state, and local regulatory agencies/officials to gain approval to advance the project.

Workbook p.27

Permits & Agreements

Collaboration Possibilities

- Include analyses and completed reports/forms that are necessary to fulfill the permitting requirements.
- Remain aware of any required permits based on the complexity of the project.
- Remain aware of specific agreements with local municipalities (e.g., maintenance agreements, sidewalks, trails, recreation areas, etc.).
- Ensure that stormwater requirements are known and coordinated with community interests.



PennDOT Connects Pointer:
Risk Management Strategies

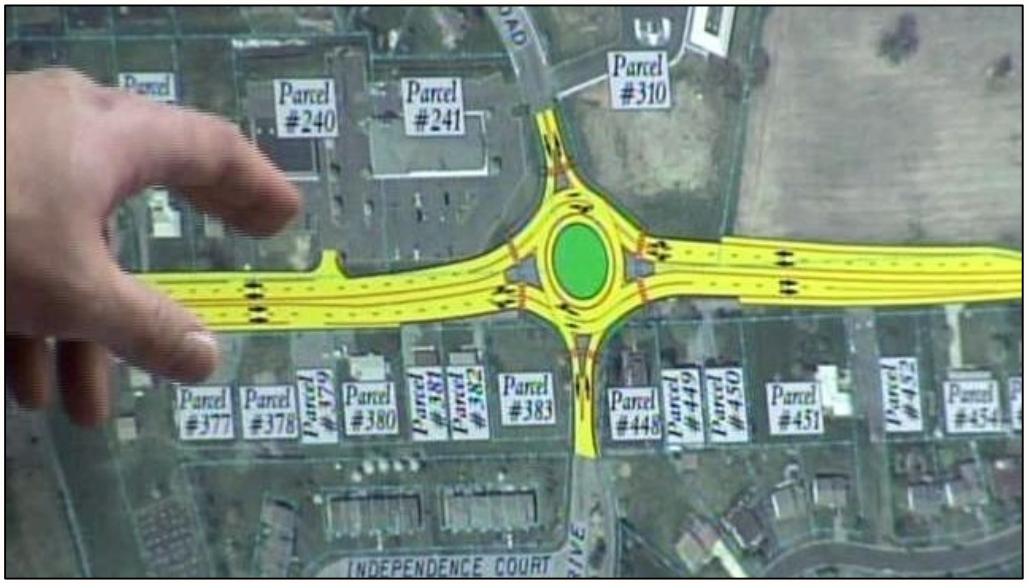
Workbook p.27

Right-of-Way

Overview

Right-of-way is a formal and legally intensive process entailing the following:

- Analyzing and minimizing impacts
- Developing plans
- Preparing legal agreement
- Negotiating
- Acquiring property



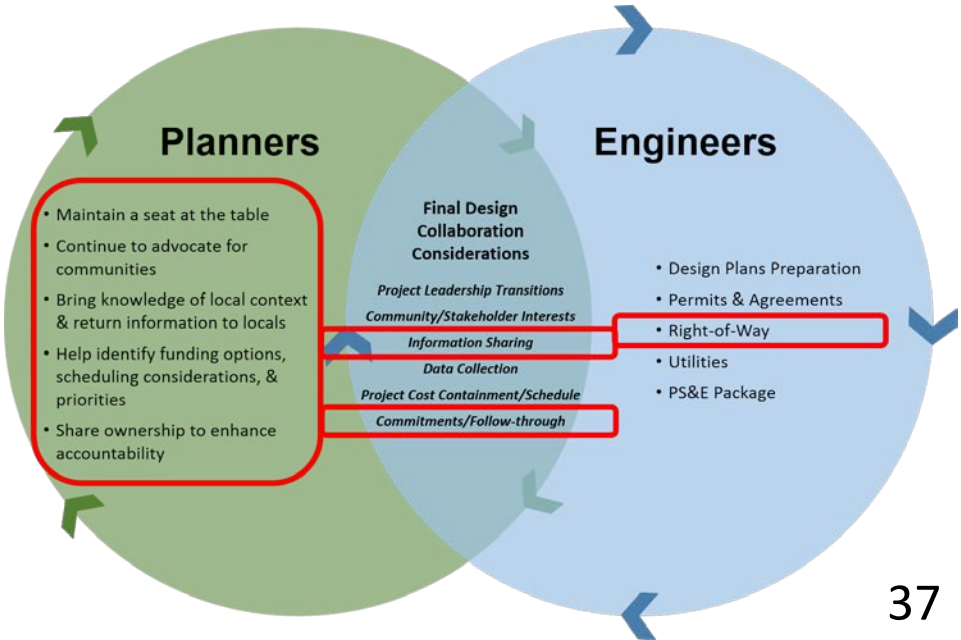
Workbook p.28

Right-of-Way

Collaboration Possibilities

Remain aware of potentially significant right-of-way requirements that may affect:

- Community traffic flow
- Land use
- Zoning requirements
- Residential
- Agricultural
- Business development
- Commercial development



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Utilities

Overview

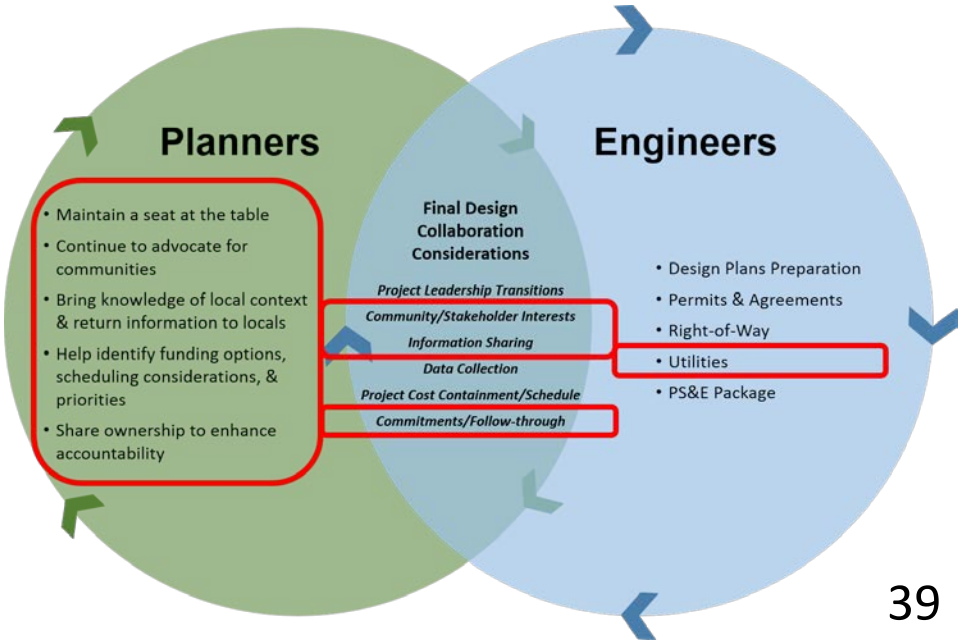
- Include details of utilities above or below project area that may be affected by design components.
- Coordinate relocation of the utilities with utility companies.
- Promote ongoing communication and coordination among all impacted parties.
- Adjust project details, as necessary.

Workbook p.29

Utilities

Collaboration Possibilities

- Remain aware of utility requirements associated with the project.
- Consider project design adjustments resulting from utility data discovered through the design process (particularly when changes must be worked out with local government authorities).



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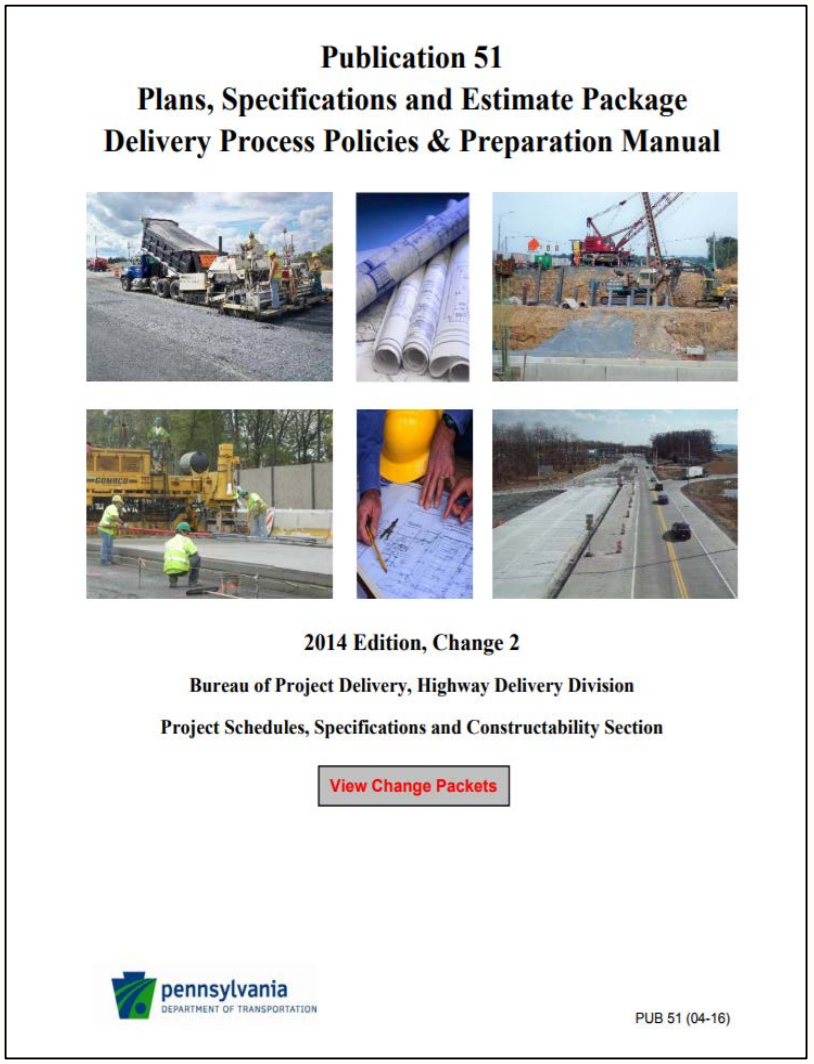
PS&E Package

Overview

- The Plans, Specifications and Estimate Package is the final document for review.
- Include engineering data and information necessary to place a transportation project under contract for construction.

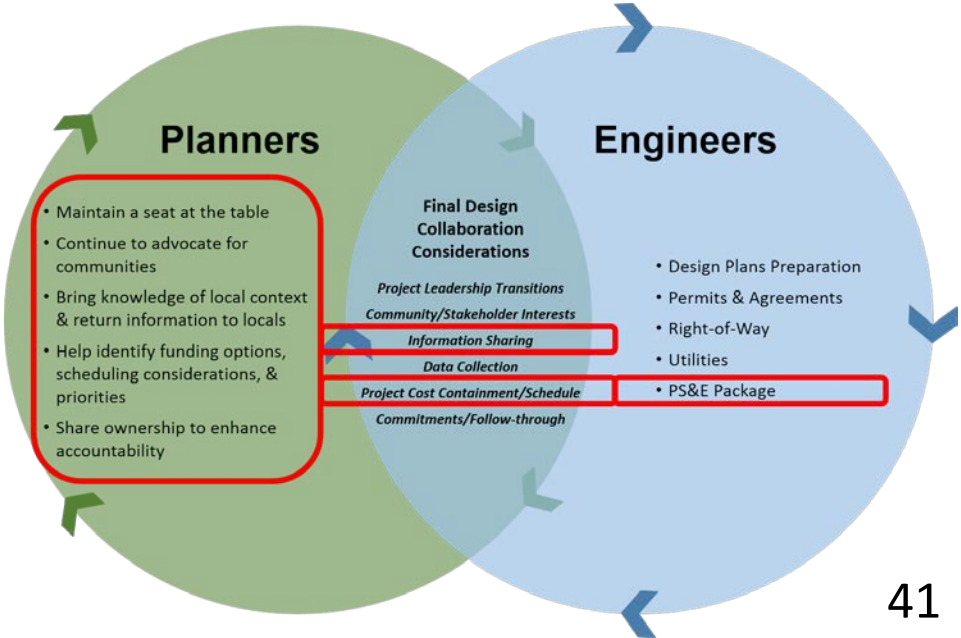


Workbook p.30

PS&E Package

Collaboration Possibilities

- Remain aware of the project advertisement schedule.
- Adjust cost and schedule information in TIP to reflect approved price and schedule.
- Confirm that any remaining commitments are reflected in the PS&E Package.
- Confirm that any commitments not reflected in the PS&E Package are communicated back to the community.



Workbook p.30

Collaboration during Final Design

In your Table Teams, fill out the form below. For each of the elements we've covered under Final Design, think of an event or issue that could trigger an opportunity for beneficial collaboration. Make a note of the type of collaboration that would be needed for each trigger (e.g., inform, discuss, decide). Finally, note the type of collaboration that would be needed for each trigger.

Final Design Element	Trigger	Type of Collaboration Needed	Benefits of Collaboration
Design Plan Preparation			
Permits & Agreements			
Right-of-Way			
Utilities			
PS&E Package			

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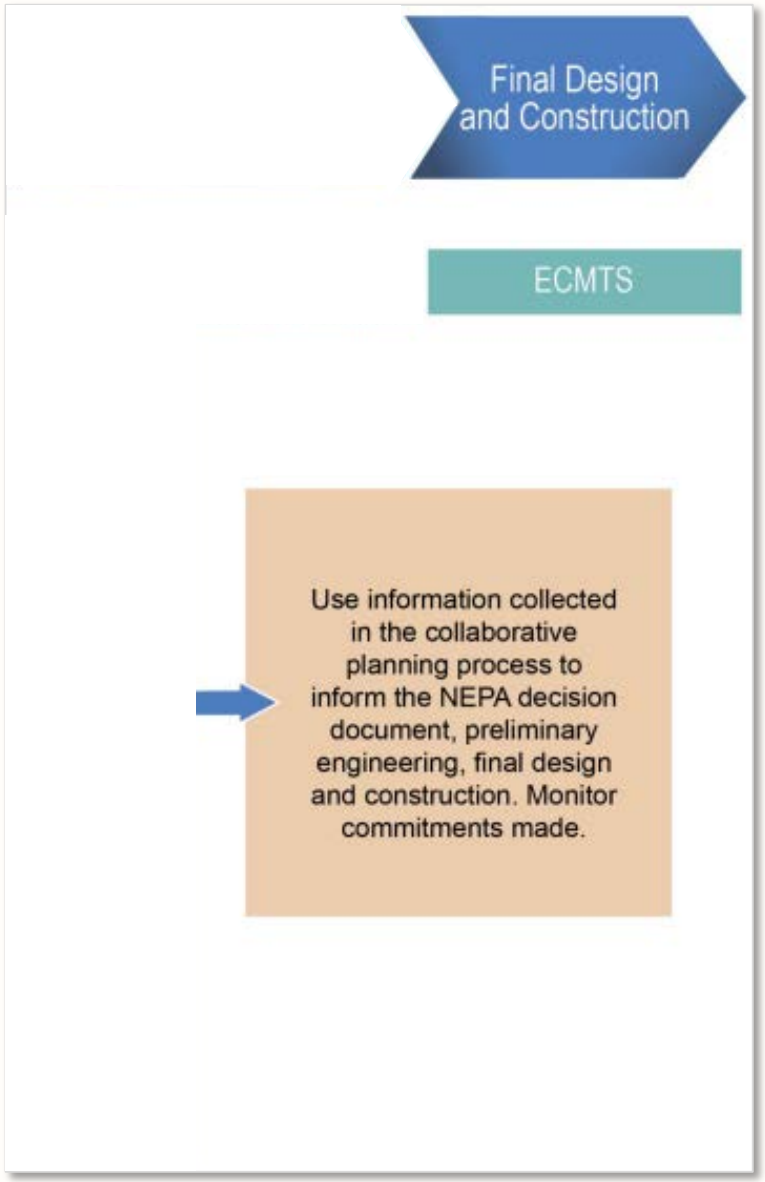
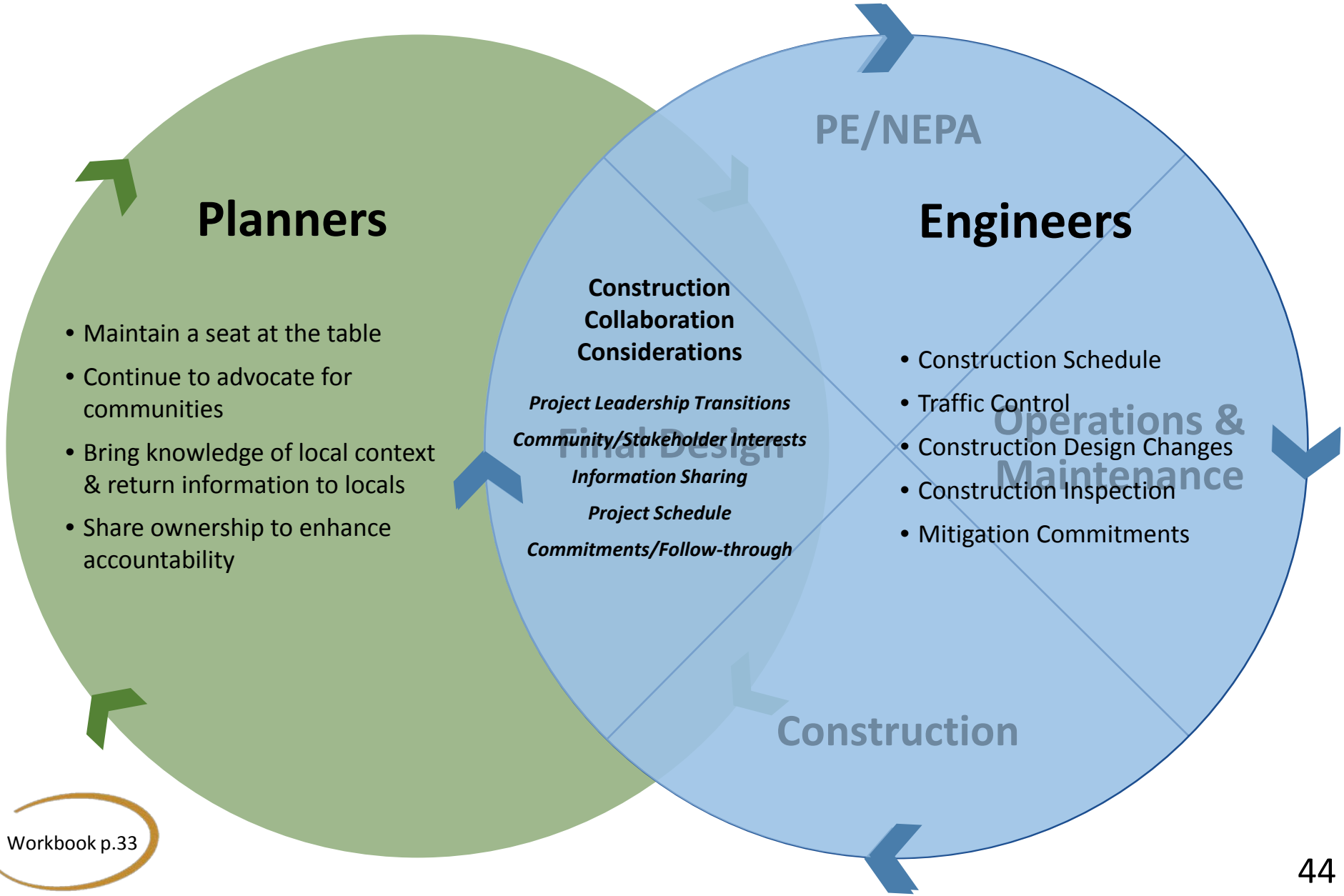


Construction

Construction Collaboration Considerations



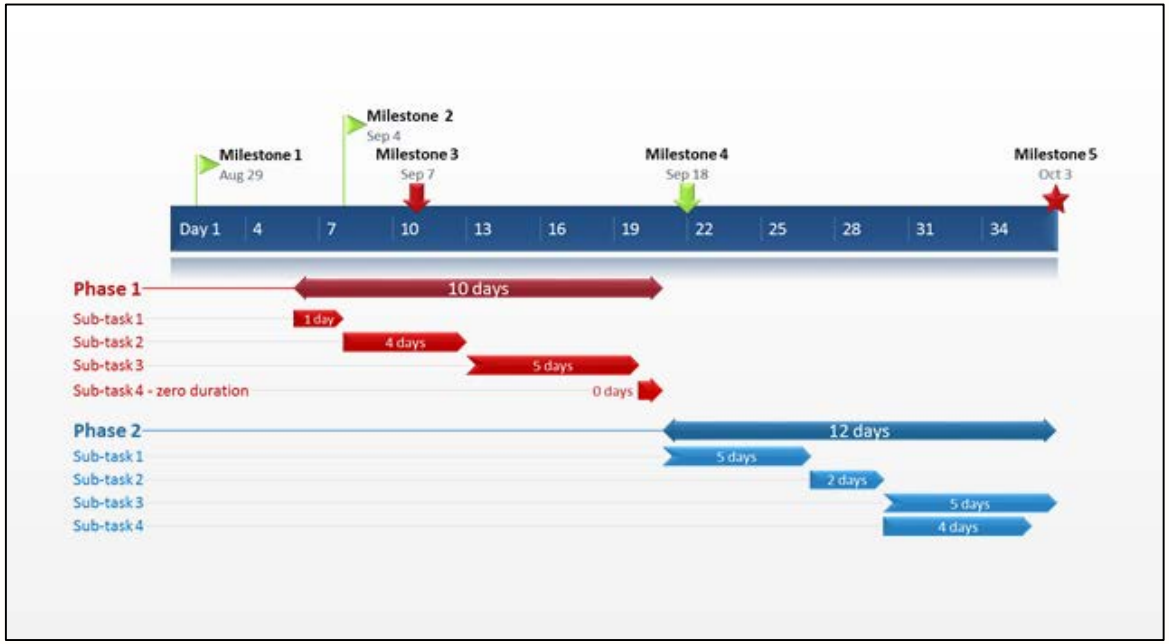
Workbook p.33

Construction Schedule

Overview

Completing the project on time depends on a well-prepared and monitored construction schedule. Construction schedule requires:

- Effective communication to resolve project issues
- Assessment of the impacts of changes to the schedule
- Accurate decisions concerning corrective actions

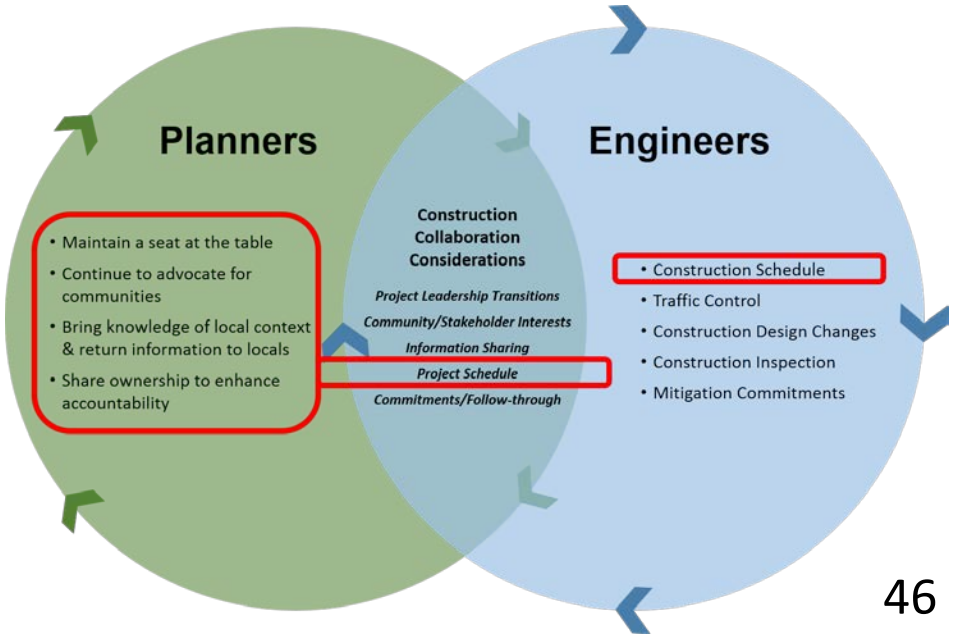


Workbook p.34

Construction Schedule

Collaboration Possibilities

- Communicate the initial project schedule for community awareness.
- Update key community interests if project schedule changes occur.
- Update the community in the spring of each construction year.



Workbook p.34

Traffic Control

Overview

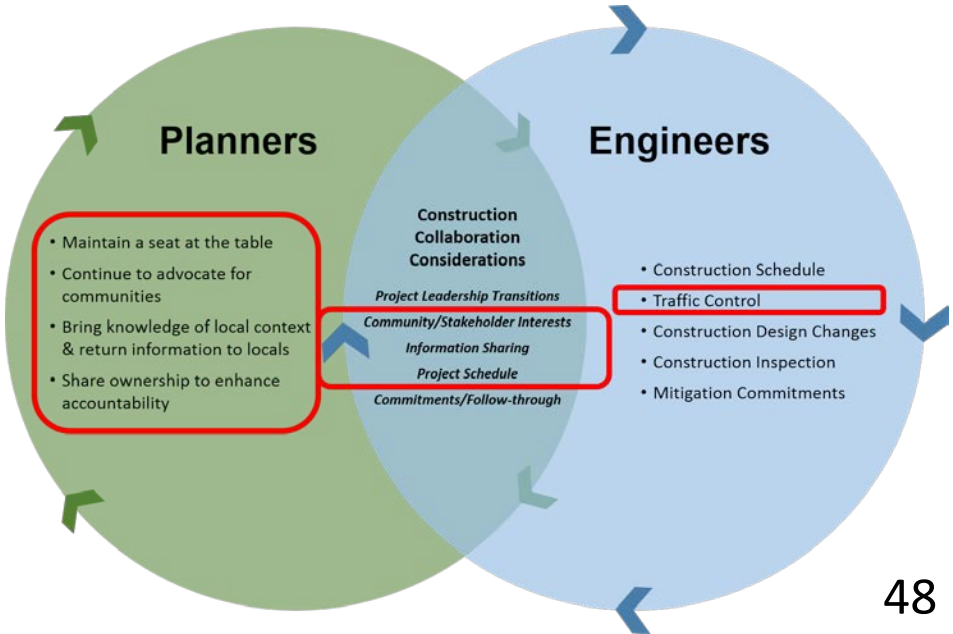
- Provide a safe construction zone while maintaining traffic flow for all users throughout the project limits.
- Attempt to minimize detours or traffic control patterns that cause severe choke points or undue congestion during construction.

Workbook p.35

Traffic Control

Collaboration Possibilities

- Planners may be a resource in helping to establish modal alternatives during construction.
- Liaison with the community or regional officials.
- Communicate new travel patterns to the public.

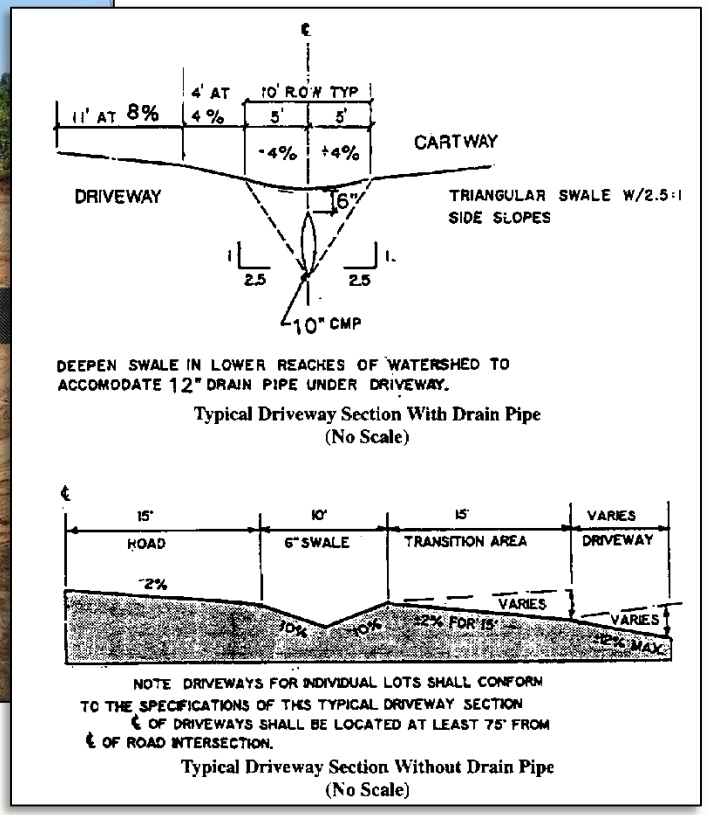


Workbook p.35

Construction Design Changes

Overview

During the Construction phase, previously unforeseen circumstances may require changes to the design.



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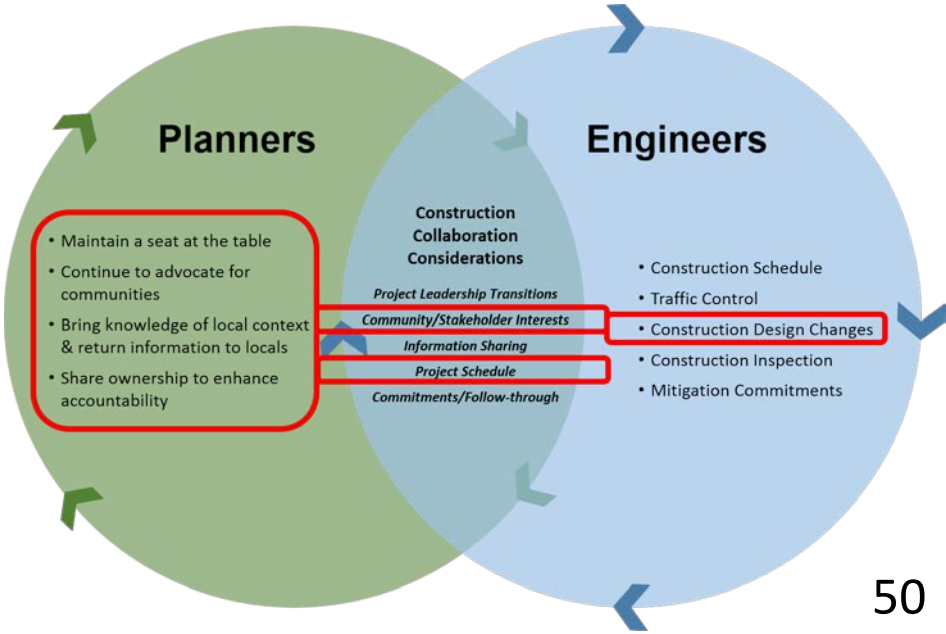
Construction Design Changes

Collaboration Possibilities

- Remain available to provide input when necessary due to unforeseen/unanticipated construction complications.
- Monitor project construction process to coordinate concerns or impacts on residents, business owners, etc., during construction.



Workbook p.36

Construction Inspection

Overview

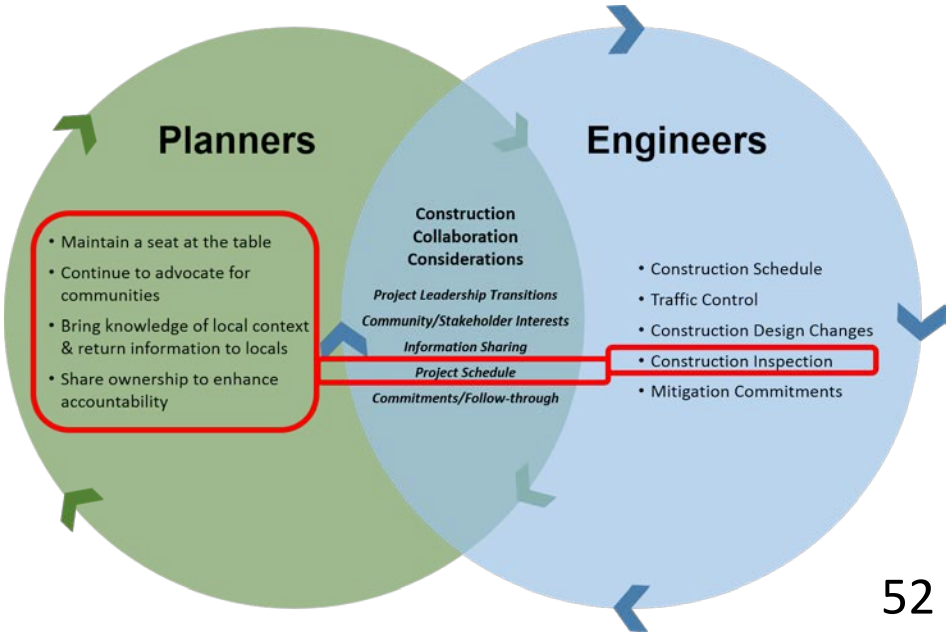
Validate that appropriate construction methods, techniques, and materials are used during project construction and monitoring of construction activities.

Workbook p.37

Construction Inspection

Collaboration Possibilities

Should construction inspection result in any need-to-know items for the community, follow up appropriately with community interests.



Workbook p.37

Mitigation Commitments

Overview

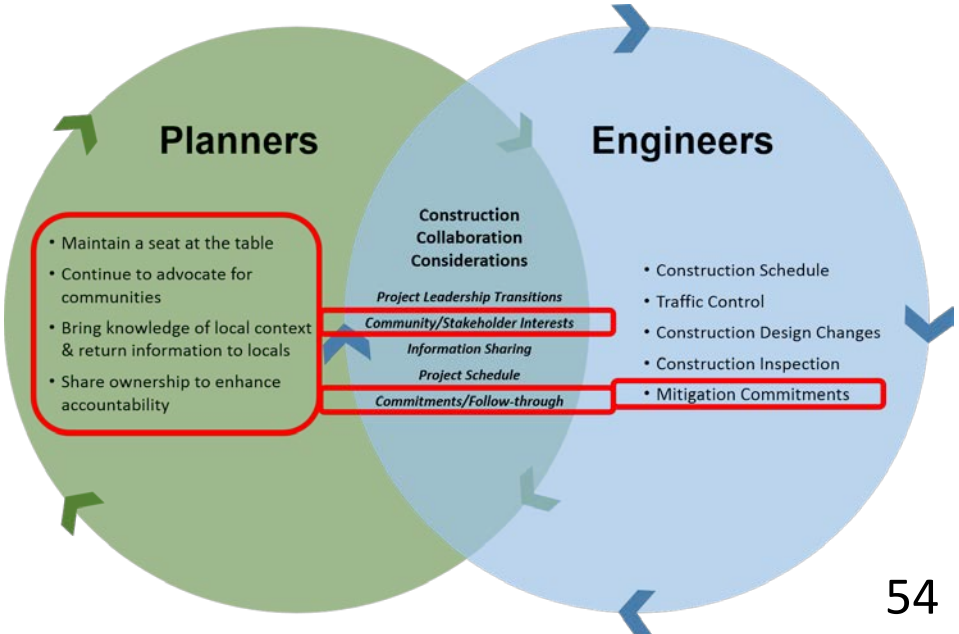
- Many construction projects involve mitigation requirements for the disturbance or disruption to environmental features or other elements that may be impacted due to the project scope.
- If avoiding an environmental feature is not possible, then some type of mitigation to the impact of the environmental feature is required.

Workbook p.38

Mitigation Commitments

Collaboration Possibilities

Keep community and other key stakeholders informed of mitigation measures.



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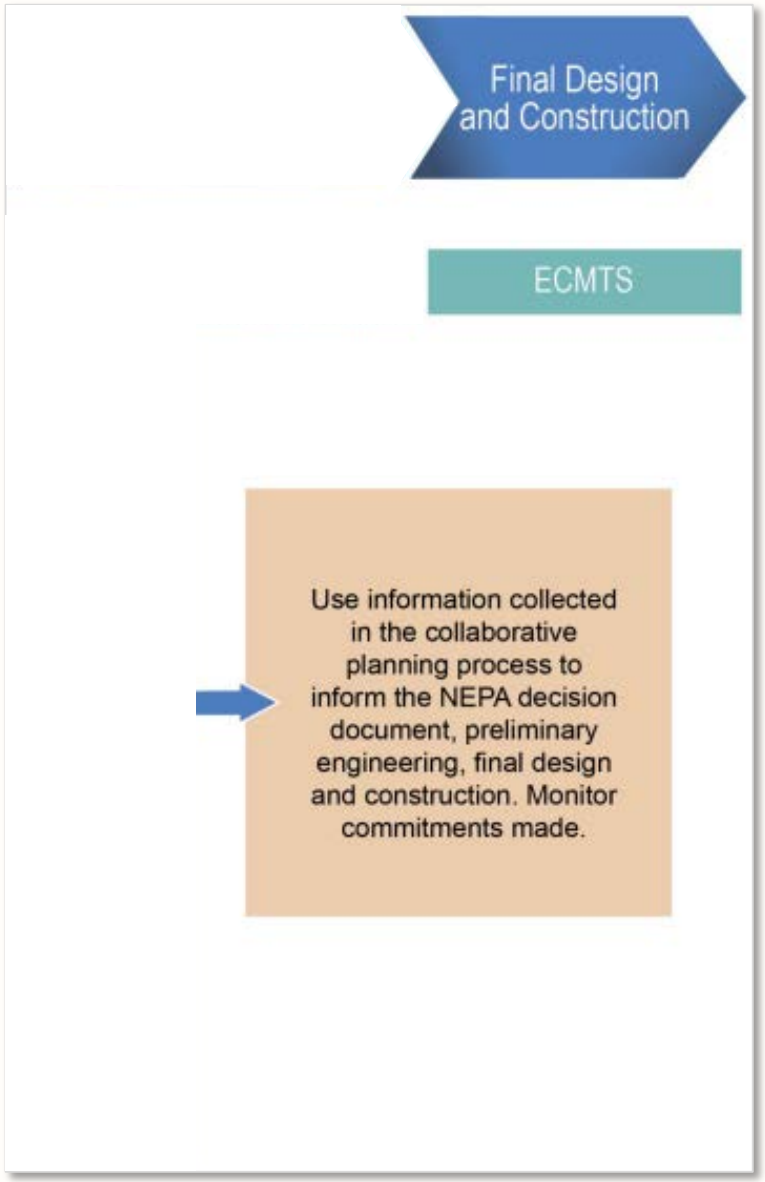
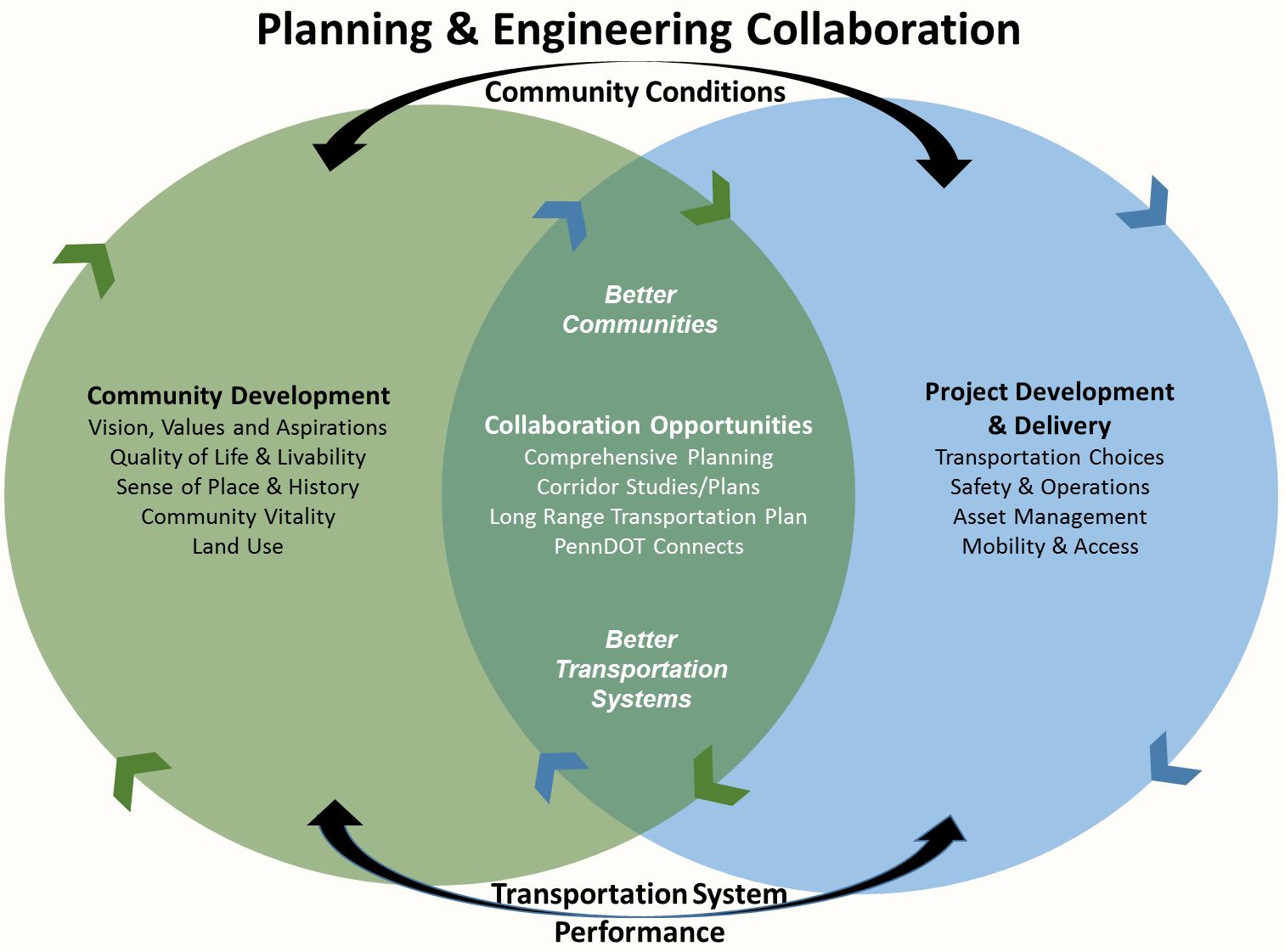
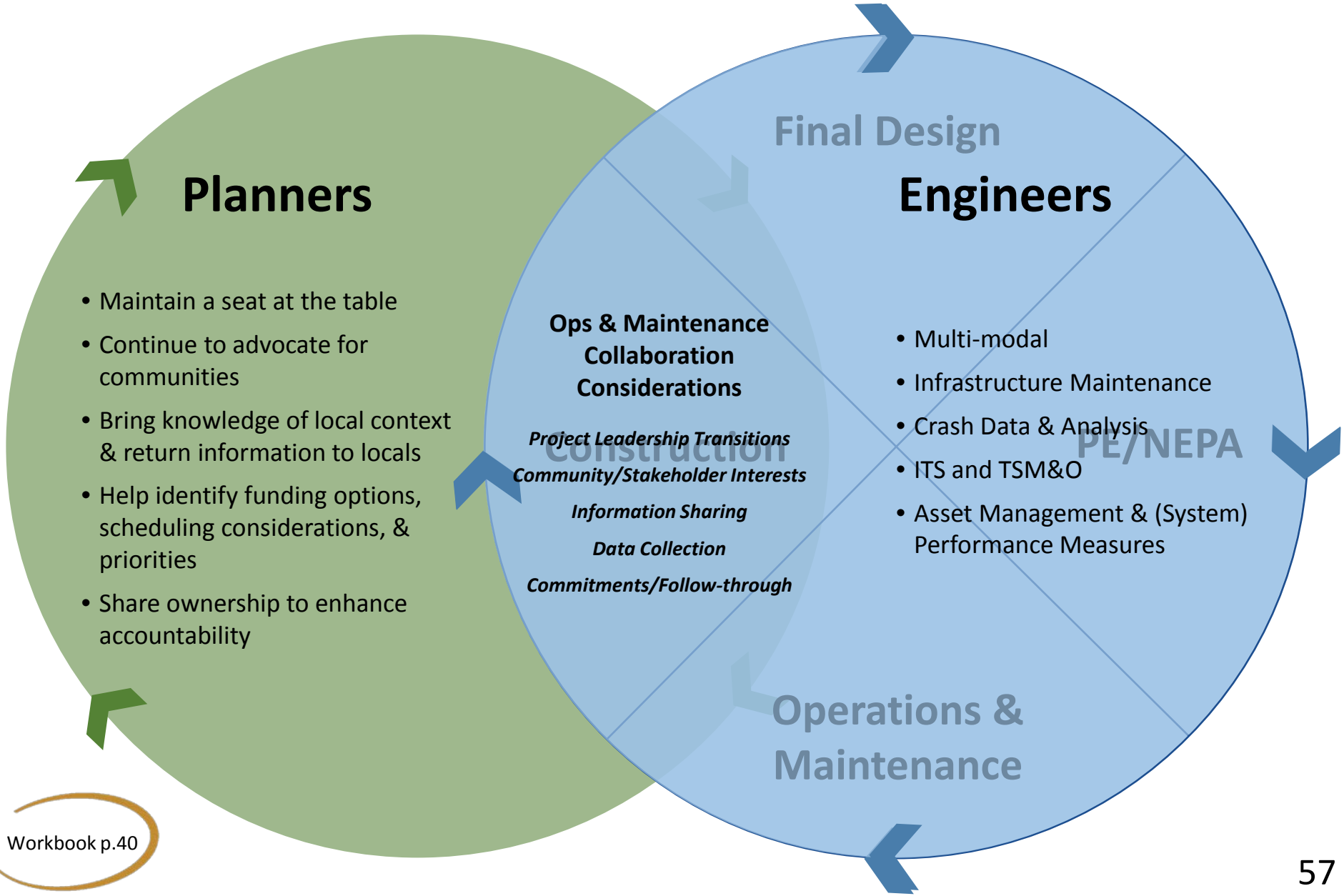


Operations & Maintenance (System Performance Monitoring)

Feedback Loops



Ops & Maintenance Collaboration Considerations



Workbook p.40

Multi-modal

Overview

It is important to monitor the transportation system performance for future consideration of transit, bike, pedestrian, and freight enhancement.

Workbook p.41

Other LRTP / PennDOT Connects Considerations

LRTPs in general have adopted a more multimodal and intermodal approach to project development. This direction is positive and is encouraged. PennDOT Connects' focus is on "better transportation and better communities" with the broadest goal to produce LRTPs that guide and integrate investments in all travel modes in ways that result in better communities. Below is a list of various elements of the transportation system that should be considered in an LRTP involving planners, engineers, communities, and their stakeholders to the greatest extent.

Area	LRTP – PennDOT Connects Considerations
Bike-Ped	▪ Identification of projects where the incorporation of bike and pedestrian accommodations can enhance safety and provide community benefits. ▪ Alternative funding strategies.
Public Transit	▪ Consideration of supporting improvements such as road and bike-ped access, community-related opportunities and priorities, traffic flow, etc.
Freight/Goods Movement	▪ Identification of priorities for improved freight movement efficiency, reduced congestion, and where possible the community related issues and opportunities (e.g., economic development)
TSMO	▪ System management goals, priorities, and projects and their community impacts
ITS	▪ ITS goals, priorities, and projects and their community impacts
Aviation	▪ Airport-heliport development priorities and community compatibility, land use, etc.
Water Ports	▪ Improvement goals and priorities for ports and port access and community related issues and opportunities

Infrastructure Maintenance

Overview

Infrastructure maintenance follows prescribed cycles and includes the following:

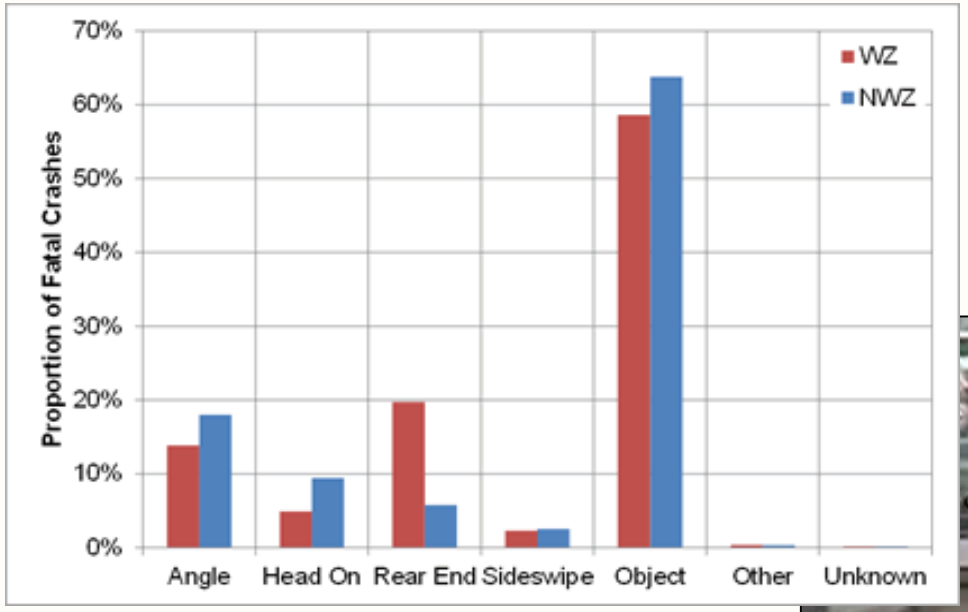
- Drainage facilities
- Winter maintenance
- Pavement maintenance
- Damage repairs (e.g., potholes, guide rails, etc.)
- Roadside maintenance

Workbook p.41

Crash Data & Analysis

Overview

Identify problem areas that could indicate safety improvement needs.



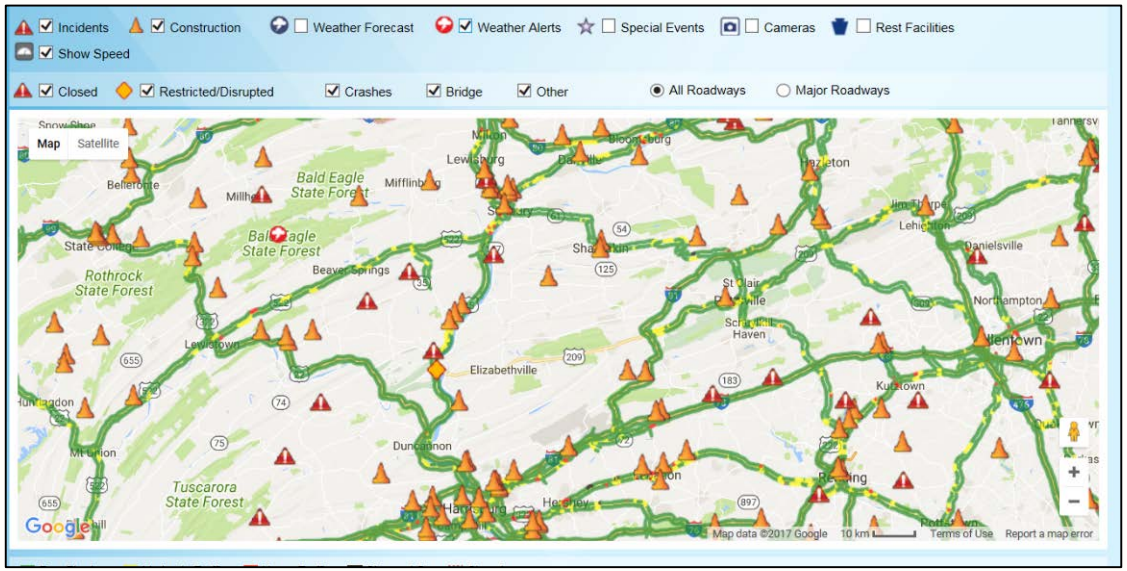
Workbook p.42

ITS and TSM&O

Overview

Integrate information technology/systems with transportation to improve throughput, operational efficiency, safety, incident management, and to provide a higher level of customer service. Include traffic management.

ITS = Intelligent Transportation System
TSM&O = Transportation Systems Management & Operations



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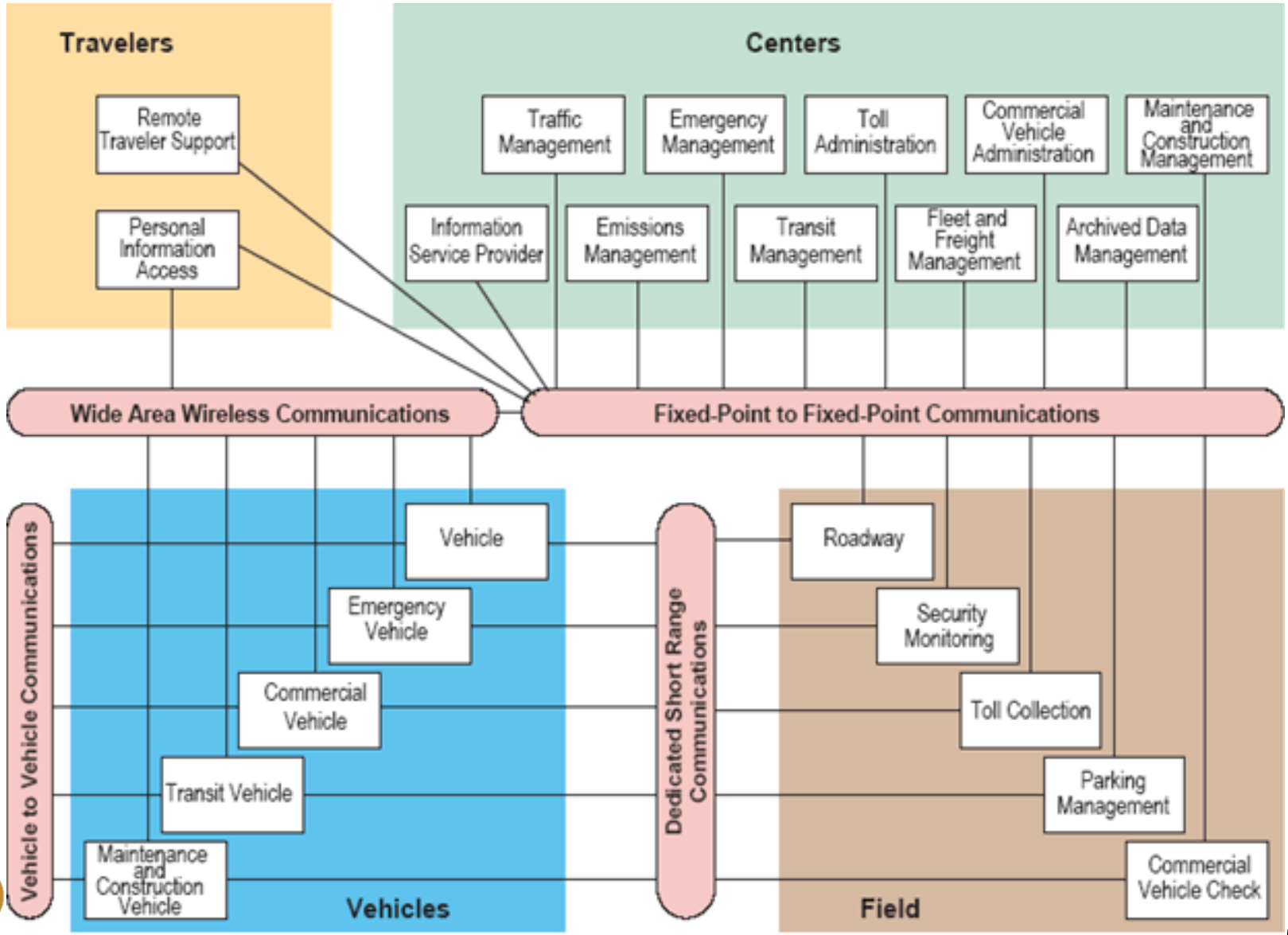
Transportation & Information Marriage



Workbook p.42

Asset Management & (System) Performance Measures

Overview

This is a structured approach to the maintenance and replacement of bridge, highway, and other assets. Often follows specific backlog and improvement cycles, and/or asset management plans.

Data and inputs to asset management include:

- Monitoring system condition and changing needs
- System age
- Cost trends

IRI Categories	Interstate Routes	NHS Non-Interstate Routes	Non-NHS Routes with ADT ≥ 2000	Non-NHS Routes with ADT < 2000
≤ 70	Excellent	Excellent	Excellent	Excellent
71-75	Good			
76-100		Good		
101-120	Fair		Good	
121-150		Fair		Good
151-170	Poor		Fair	
171-195		Poor		Fair
196-220			Poor	
> 220				Poor

IRI Ranking Categories

Workbook p.43

Traffic Signal Performance Measures

Automated Traffic Signal Performance Measures (ATSPM)
Pennsylvania Implementation

pennsylvania DEPARTMENT OF TRANSPORTATION

What are Automated Traffic Signal Performance Measures?

Automated Traffic Signal Performance Measures (ATSPM) are a series of visual aids depicting real-time and historical functionality of signalized intersections using logs of controller and detection outputs. This allows traffic engineers to measure what they previously could only model. Accurate decision-making about signal performance and timing helps signal management personnel identify vehicle and pedestrian malfunctions. This cost effective solution also measures vehicle delay and the volume, speeds and travel time of vehicles. These metrics can be used to identify operational deficiencies, optimizing mobility and helping manage signal timing and maintenance. Evaluating signals helps reduce congestion, save fuel costs and improve safety.

Why Automated Traffic Signal Performance Measures? Why now?

ATSPM are a valuable **asset management tool**—aiding technicians and managers in the control of both hardware and overall mobility within the system. This allows **analysis of data 24 hours a day, 7 days a week**, improving the accuracy, flexibility and performance of signal equipment and the system as a whole.

This technology provides a clear **framework for performance and decisions**, informing good dialogue and helping calibrate expectations—of the public, agency leadership, legislators, first responders and other mobility partners.

In addition, signal timing is a resource that can be used to model or track how the asset degrades over time and therefore what kind of maintenance is required to sustain good, basic service. ATSPM will help Pennsylvania achieve better scores on the National Traffic Signal Report Card. When last compiled, the overall score on the National Traffic Signal Report Card in 2012 was a D+.

ATSPM work because they were developed, tested and successfully adopted by your peers. The AASHTO Innovation Initiative assembled those innovators on a team that is standing by now to help deliver ATSPM for Pennsylvania stakeholders.

What are Pennsylvania's Traffic Signal Performance Objectives?

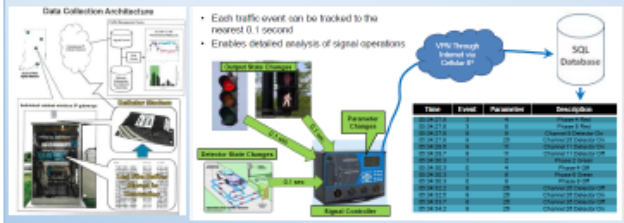
- Safe and consistent operation of signals
- Efficient, optimized signals with effective use of green time
- Consistency in the quality of the design and operation of signals
- Consistent and comprehensive maintenance

ATSPM helps achieve these objectives as follows:

- Monitor signals frequently enough to identify when maintenance or operational intervention is warranted
- Good allocation of green times
- Good progression on selected corridors at selected times of day

What is Required to Implement Automated Traffic Signal Performance Measures? Where does the information come from?

ATSPM uses a combination of modern signal controllers and vehicle detection systems to collect and archive operational data with tenth-of-a-second timestamps, referred to as "high resolution data." With communication from each signal to the central computer server, the data can be stored and archived for further analysis and reporting. ATSPM does not require a central traffic management or traffic adaptive system, and the data storage and reporting are achieved with open-source software developed by the Utah Department of Transportation (UDOT).



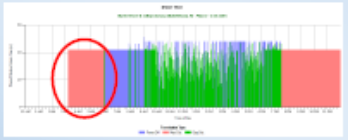
Controllers	Detection	Communications	Server	Website
• High-Resolution Controller (current support by 4 vendors) • 0.1 second resolution data logger	• Any detection technology can be used (as long as it works) • Existing detection often adequate	• Need IP-based communication from signal to data center • Allows active monitoring • Ideal: fiber interconnect (not required) • Rapid deployment: cellular modems • Encrypt data over VPN	• Translate raw log files • Store in database • 11 MB per intersection per day • UDOT software available for free • Central Signal System not used or needed	• Query database • Display graphics • UDOT software available for free

Who uses Traffic Signal Performance Measures data?

- **Signal engineers** to optimize and fine-tune signal timing
- **Maintenance signal technicians** to identify broken detector problems and investigate trouble calls.
- **Traffic engineers** to conduct various traffic studies, such as speed studies, turning movement studies, modeling studies, and optimizing intersection operations.
- **Consultants** to improve signal operations as PennDOT and municipal signal owners outsource some of the signal operations, design and planning to consultants.
- **PennDOT** to conduct various traffic studies and/or in determining the time-of-day where construction or maintenance activities would be least disruptive to motorists.
- **Municipal Governments** to use the data in a similar manner to PennDOT.
- **Metropolitan Planning Organizations (MPOs)** to calibrate regional traffic models.
- **Academia** to conduct various research studies, such as evaluating the effectiveness of operations during adverse weather, evaluating the optimum signal timing for innovative intersections, etc.

Example use cases from Pennsylvania Intersections (using existing controllers and detection)

- Identify malfunctioning pedestrian push buttons based on movements operating for maximum time in the middle of the night (left below—bars represent green time in each cycle; colors represent reason for phase termination; pink is maximum time)
- Identifying malfunctioning vehicular detection based on movements operating for the maximum time at off-peak times (such as shadows at a certain time of day affecting video detection)



- Modifying offsets to reduce corridor travel time and increase reliability (before offset adjustment on left below, after on right). Green shading represents the probability of the signal being green at any point during the cycle based on actual green times. Black bars represent the proportion of vehicles arriving at that time in the cycle.

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Corridor Performance Measures

Outcome Assessment using Connected Vehicle Data to Justify Signal Investments to Decision Makers

Drake Krohn[1], Lou Rymarcsuk[1], Jijo Mathew[1], Christopher Day[1], Howell Li[1], Ashwin Patel[2], Daniel Farley[2], Darcy M. Bullock[1]

1: Purdue University; 2: Pennsylvania Department of Transportation

TRB Paper # 17-00314

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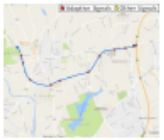
Abstract

This paper describes the use of connected vehicle data to perform corridor travel time outcome assessment along five corridors in the greater Philadelphia, Pennsylvania area. These corridors are comprised of a total of 2,184 signals and are considered five of the most critical corridors in this region, experiencing a high volume of traffic, with AADT greater than 30,000 vehicles. These corridors were evaluated for six weeks before and after the installation of adaptive controls and signal retiming using private-sector segment speed data. Medians and interquartile ranges of travel times were used to assess the impact on arterial progression. Various graphs, charts, and figures produced through web tools and traditional metrics provide a user-interactive component to the dashboards. In addition, user cost reductions and CO_2 emission impacts were also determined. Four out of the five corridors had substantial reductions of arterial travel times that amounted to approximately $32 million in annualized user benefits.

Study Corridors

Corridor ID	Corridor Name	AADT	Length (mi)	Average Speed Limit (mph)	Signal Count (Adaptive Signals)	Before Date Range	After Date Range
A1	PA 132 / Street Rd	33,965	15.2	45	50 (21)	10/12/2015–11/23/2015	1/4/2016–2/15/2016
A2	PA 332 (Newtown Bypass)	35,015	4.8	53	12 (12)	2/22/2016–4/4/2016	4/25/2016–6/6/2016
A3	US 1/Baltimore Pike/Township Line Rd/City Ave	35,268	10.0	36	40 (4)	10/12/2015–11/23/2015	3/7/2016–4/18/2016
A4	US 202/Wilmington Pkwy	46,553	8.6	45	16 (9)	9/4/2015–10/26/2015	1/4/2016–2/15/2016
A5	PA 611/Old York Rd/ Easton Rd	30,919	16.3	42	68 (15)	4/27/2015–6/8/2015	1/4/2016–2/15/2016

Corridor A1



Corridor A2

Corridor A3

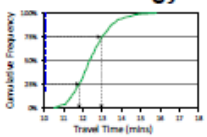
Study Corridors in Greater Philadelphia Area

Corridor A4

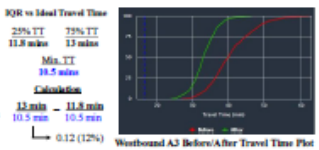
Corridor A5

Evaluation Methodology

Corridor A3 mapping in ArcMap

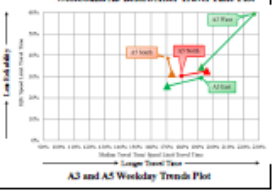


IQR Normalization



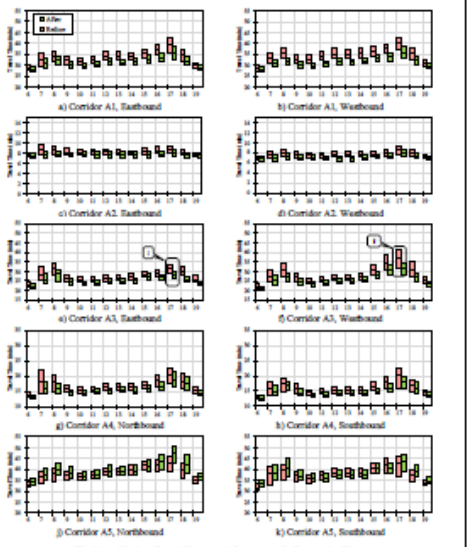
Westbound A3 Before/After Travel Time Plot

Weekday Rush-hour Speed and Reliability



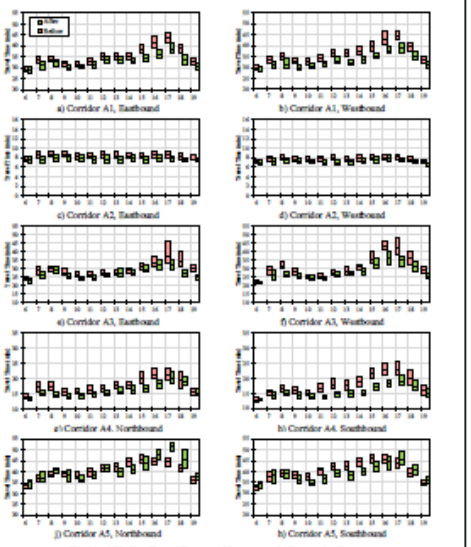
A3 and A5 Weekday Trends Plot

Weekday Median and IQR Evaluation



Weekday Median Travel Times and Interquartile Ranges by Hour

Weekend Median and IQR Evaluation



Weekend Median Travel Times and Interquartile Ranges by Hour

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Corridor Performance Measures

Outcome Assessment using Connected Vehicle Data to Justify Signal Investments to Decision Makers

Drake Krohn[1], Lou Rymarcsuk[1], Jijo Mathew[1], Christopher Day[1], Howell Li[1], Ashwin Patel[2], Daniel Farley[2], Darcy M. Bullock[1]

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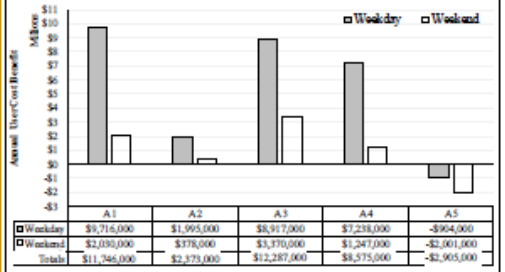
$32M Net User Cost Benefit



	A1	A2	A3	A4	A5
Weekday	$9,716,000	$1,995,000	$8,917,000	$7,238,000	-$904,000
Weekend	$2,030,000	$378,000	$3,370,000	$1,247,000	-$2,001,000
Totals	$11,746,000	$2,373,000	$12,287,000	$8,575,000	-$2,905,000

Summary of Annual CO_2 Emission Reductions for the Adaptive Signals

Corridor	Weekday CO_2 Savings		Weekend CO_2 Savings	
	Tons	Dollars	Tons	Dollars
A1	3120	$112,000	650	$23,000
A2	640	$23,000	120	$4,000
A3	2890	$104,000	1080	$39,000
A4	2320	$84,000	400	$14,000
A5	-310	-$11,000	-650	-$23,000
Total	8660	$313,000	1630	$58,000

Equation and Calculation Analysis

User Cost Benefit

The hourly volumes were estimated by the following equation

$$vol_i = AADT * k_i * d$$

where,
vol_i = estimated volume for hour i
AADT = annual average daily traffic
k_i = hourly vehicle percentages from (1)
d = directional distribution (assumed to be 0.5)

The difference in travel times for each hour, before and after the adaptive signal deployment was calculated using the following equation

$$\Delta TT_i = TT_{after,i} - TT_{bef,i}$$

where,
$TT_{bef,i}$ = median travel time during the before period for hour i
$TT_{aft,i}$ = median travel time during the after period for hour i

The user benefit for trucks during each hour was then calculated

$$user_{truck,i} = vol_i * \Delta TT_i * \%T_i * PPV_t * VOT_t$$

where,
$\%T_i$ = percentage of truck traffic for hour i, from (1)
PPV_t = number of passengers for commercial vehicles (1 for trucks)
VOT_t = time value of money for commercial vehicles, $96.00/veh-hr (2)

The user benefits for passenger cars were computed

$$user_{car,i} = vol_i * \Delta TT_i * \%C_i * PPV_c * VOT_c$$

where,
$\%C_i$ = percentage of car traffic for hour i, assumed as $(1 - \%T_i)$
PPV_c = number of passengers for passenger cars, 1.25 for cars (2)
VOT_c = time value of money for passenger cars, $17.63/person-hr (2)

The hourly user costs for passenger cars and commercial trucks in both directions were aggregated to compute the daily user cost for each corridor. The annual user costs were then computed by using weekly and yearly multipliers. Analysis was carried out separately for weekdays and weekends.

(1) SR4 Pennsylvania Traffic Data
(2) SR4 Urban Mobility Scorecard
(3) TRB No. 2589, 2016, A.32
(4) Greenhouse Gas Equivalencies Calculator
(5) EPA Fact Sheet Social Cost of Carbon

CO_2 Emissions Reduction

Changes in carbon dioxide (CO_2) emissions were computed using the method adopted by (3). Using conversion factors from the Argonne National Laboratory, a passenger car is expected to consume 0.87 gal of gasoline per hour. This number was conservatively used to determine the fuel consumption.

$$fuel = \Delta TT * vol * \frac{0.87\ gal}{hour}$$

The following equation computes the CO_2 emissions in tons. The U.S. Environmental Protection Agency estimates the amount of CO_2 emitted when a gallon of gasoline burns to be 19.6 lb/gal (4).

$$CO_{2,emissions} = fuel * \frac{19.6\ lb}{gal} * \frac{1\ ton}{2,000\ lb}$$

The USEPA also estimates the social cost of CO_2 as $36/ton (5) and the cost of CO_2 was determined using this equation.

$$CC = CO_{2,emissions} * \frac{\$36}{ton}$$

In summary, the net user benefit from the five corridors was determined to be $32 million. In addition, carbon dioxide emissions were reduced by over 10,000 tons – an equivalent savings of nearly $275,000.

$32 Million total benefit

$275,000 CO_2 savings

10,000 tons CO_2 reduced

PennDOT Web Application Suite

Corridor Analysis Procedure

(1) Corridor Selection

Corridors are listed alphabetically (a) for *Travel Time* and *Travel Delay Monitor*. A county selection (b) is used for *Arterial Ranking*.

a) Alphabetical selection b) County selection

(2) Analysis Date Selection

Before (red) and after (green) dates displayed on a calendar.

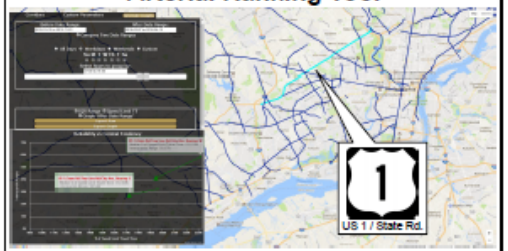
(3) Time Selection

Arterial Ranking allows selection of specific hour ranges (a) while *Travel Time* defaults for the integration of timing plan data (b). *Travel Delay Monitor* displays the hours within the date selection in the output figures.

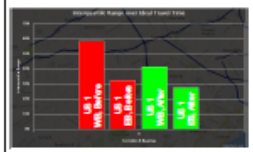
a) Hourly selection

b) Timing Plan selection

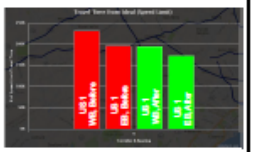
Arterial Ranking Tool



Arterial Ranking displays arterial performance as Reliability vs. Central Tendency in the graph in the lower left hand corner of the figure above.



Arterial Ranking also outputs this one-dimensional graph, displaying the reliability of the corridor using the difference of the 75th and 25th percentile and the ideal travel time.



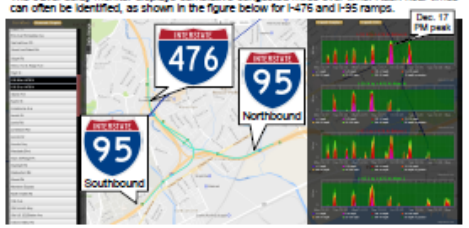
Arterial Ranking also outputs this one-dimensional graph, normalizing the actual travel times as a percentage of the ideal travel time.

Travel Time Comparison Tool

Travel Time outputs cumulative frequency diagrams. The vertical blue line represents the ideal travel time, no stoppage and following the speed limit.

Travel Delay Monitor

The travel delay monitor displays cumulative congested miles over time. Rush hour times can often be identified, as shown in the figure below for I-476 and I-95 ramps.



Clicking on the peak times highlights the corridor with the delay speeds, as shown above for corridor A3. Hovering also provides the distances these speeds occur, as show below.

For the given date of Wed. Dec. 16, from 1700 to 1730, US 1 / State Rd intersections of Belmont Ave and Lancaster Ave had the highest delay, at speeds of 5-9 mph for 2.4 miles of the corridor.

Workbook p.44

Operations & Maintenance Collaboration

Collaboration Possibilities (System Performance Monitoring)

- Review system performance evaluations/data.
- Share asset management and performance measures to identify potential infrastructure improvement projects to inform the LRTP and TIP processes.
- Collaborate on crash data to identify areas where safety may be enhanced by transportation improvements.
- Consider community level performance data (e.g., bike/ped) that may impact future maintenance decisions and system performance, including future project modeling or forecasting, to the Engineers.
- Obtain input regarding community/county work programs (e.g., bike/ped).
- Collaborate on operational/safety audits.

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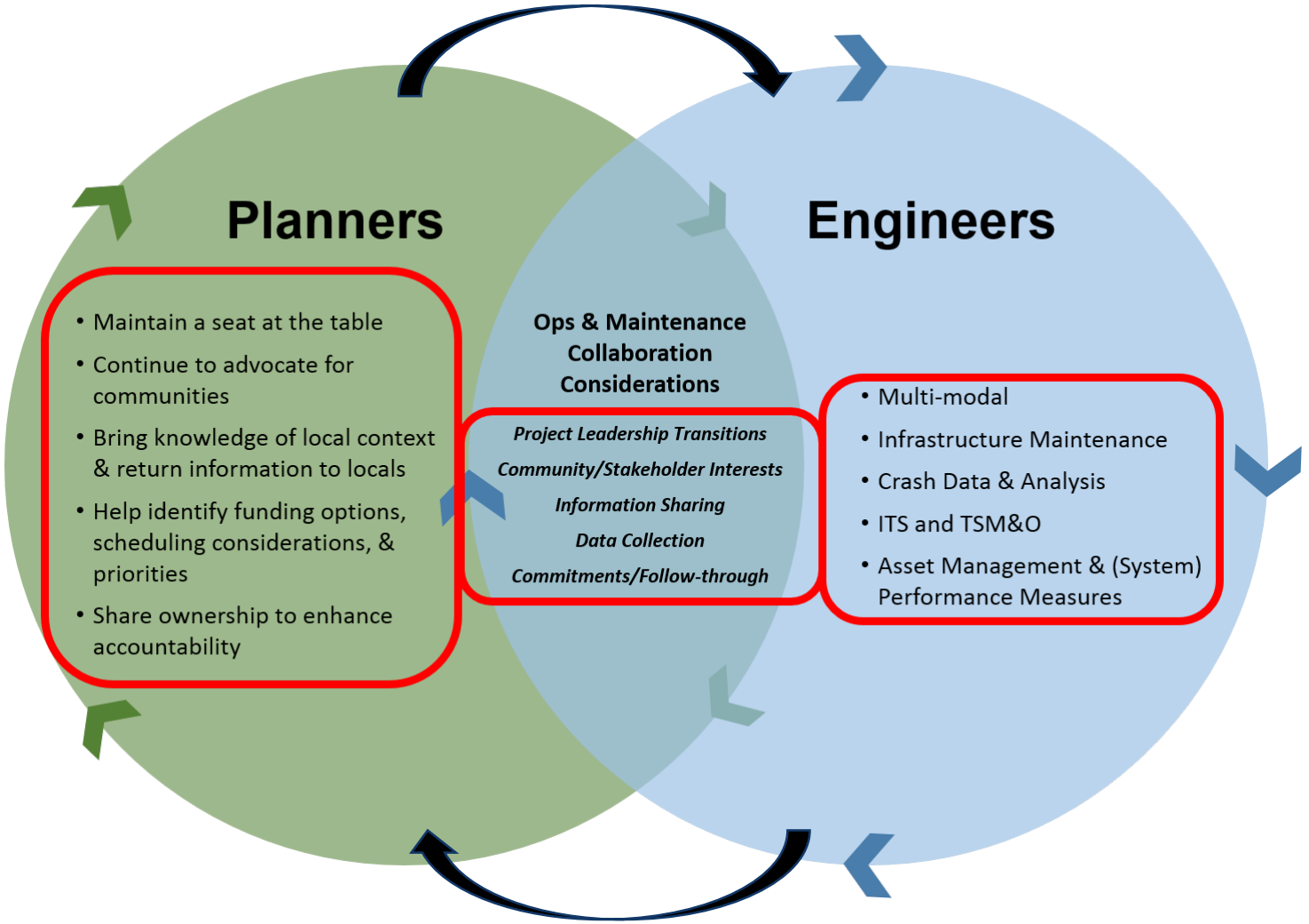
Operations & Maintenance Collaboration

Collaboration Possibilities (System Performance Monitoring)



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Wrap-up & Evaluation

Challenges/Opportunities Results

Challenges/Opportunities Form

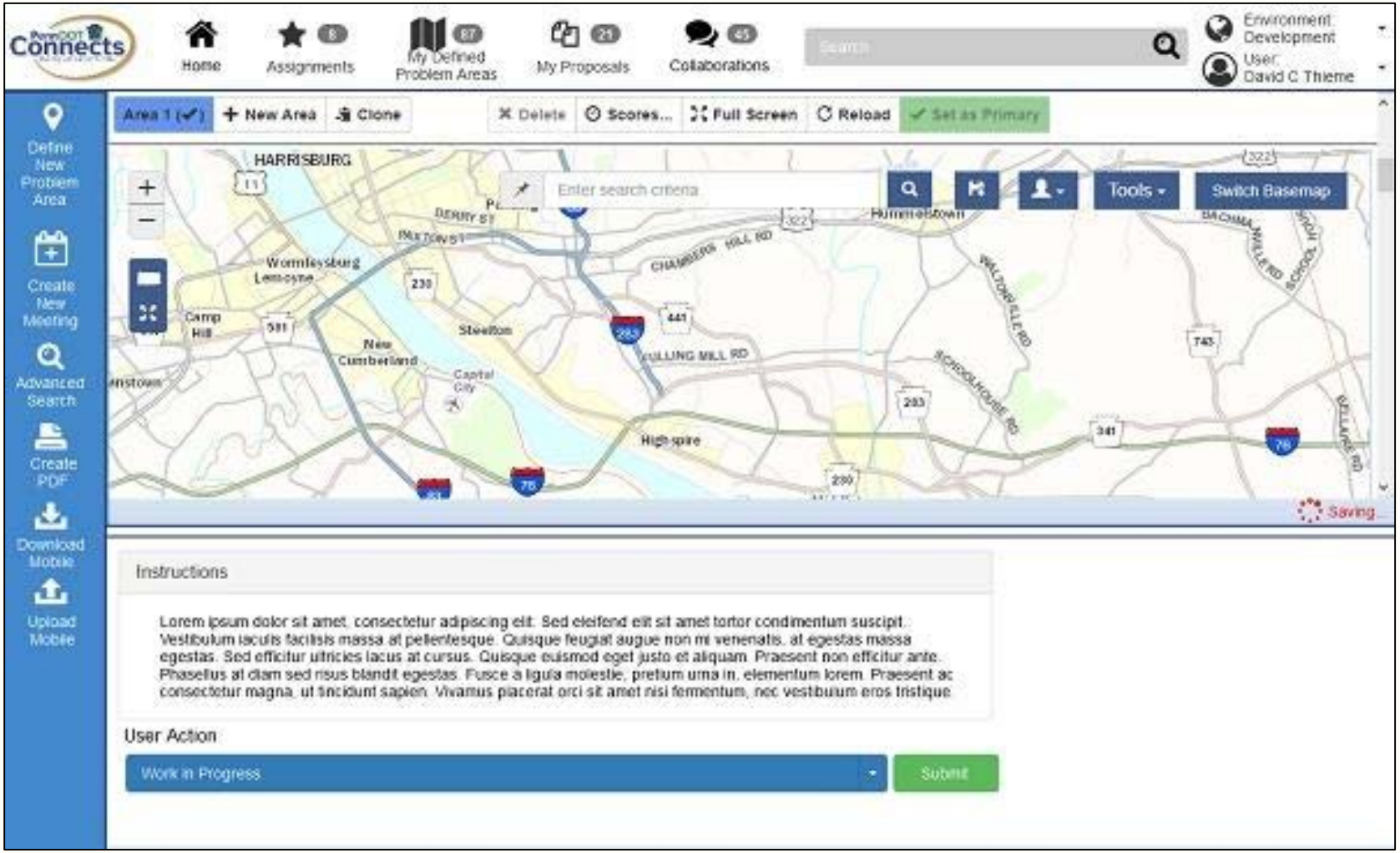
Community Name: _____

Date: _____

Challenges/Opportunities	Strategies

Workbook p.47

Tools to Support Mutual Success



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Crossing the Bridge…Together

Discussion

As a large group, discuss your answers to the questions in your workbook in response to your facilitator's prompts.

Plans | **Program/TIP** | **Project Delivery**

Workbook p.49

Course Reflection

In what ways can collaboration during project delivery be improved to enhance both community outcomes and transportation project delivery …and beyond?

Course Evaluation

All participants of P&E 360 will be sent a link to a more detailed course evaluation.

When you receive this link, please fill out the evaluation as soon as possible.

Your feedback will help us identify the best opportunities for making improvements to the course.

Thank you!

Planning & Engineering 360°

Module 3: Project Delivery