



U.S. Department of Transportation  
Federal Highway Administration

Turner-Fairbank  
Highway Research Center

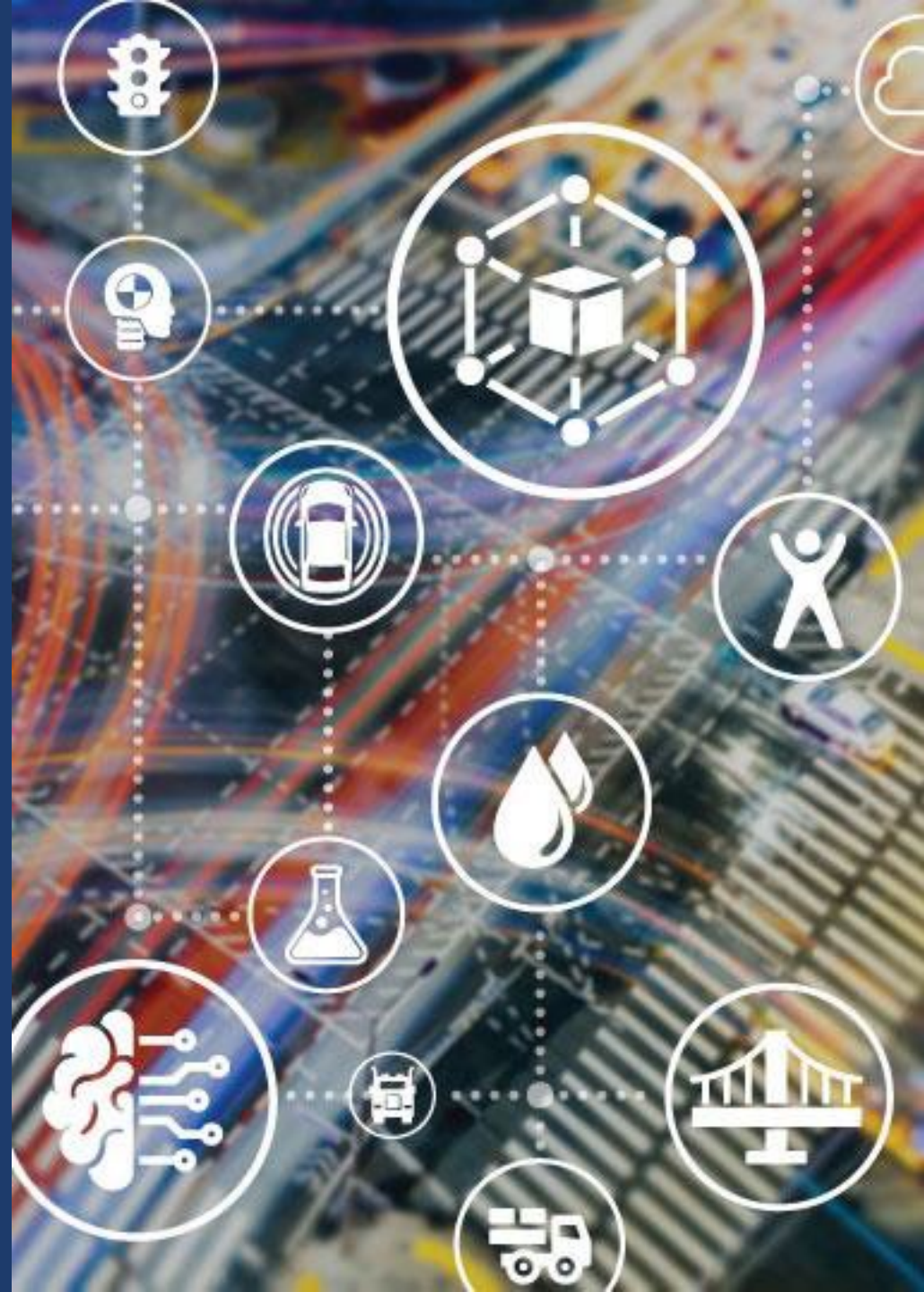
# Cost Estimate Development and Oversight

Guillermo Nevett, Ph.D.  
University of Colorado Boulder

Paul M. Goodrum, P.E., Ph.D., NAC  
University of Colorado Boulder

Matthew Corrigan, P.E.  
Federal Highway Administration (FHWA)

March 3, 2022



# Disclaimer

This presentation was created and is being copresented by both the FHWA and a contractor. The views and opinions expressed in this presentation are the presenters' and do not necessarily reflect those of FHWA or the U.S. Department of Transportation (USDOT). The contents do not necessarily reflect the official policy of the USDOT.

The U.S. Government does not endorse products or manufacturers. Trademarks or manufacturers' names appear in this presentation only because they are considered essential to the objective of the presentation. They are included for informational purposes only and are not intended to reflect a preference, approval, or endorsement of any one product or entity.

# Agenda

- ▶ Introduction.
- ▶ Background.
- ▶ Research methodology.
- ▶ Results.
- ▶ Recommendations.
- ▶ Acknowledgements.







© 2015 USchools / iStock.

# Introductions



U.S. Department of Transportation  
Federal Highway Administration

Turner-Fairbank  
Highway Research Center

# Introductions

## **Matthew Corrigan, P.E.**

Construction Research Engineer and Contracting Officer's Representative  
Office of Infrastructure Research and Development, FHWA

## **Guillermo Nevett, Ph.D.**

Postdoctoral Research Associate, Department of Civil, Environmental, and  
Architectural Engineering, University of Colorado Boulder

## **Paul M. Goodrum, P.E., Ph.D., NAC**

Professor and Department Head, Department of Construction Management,  
Colorado State University







© 2015 USchools / iStock.

# Background



U.S. Department of Transportation  
Federal Highway Administration

Turner-Fairbank  
Highway Research Center

# Background

## **Most common cost estimating methods:**

- ▶ Historical bid-based estimation.
- ▶ Conceptual estimation.
- ▶ Risk-based estimation.
- ▶ Cost-based estimation.
- ▶ Combination of historical and cost-based estimation.

**How do you know if the cost estimate is reasonable?**



# Project Objective

Identify **what**, **when**, **why**, and **how** FHWA and the Office of Federal Lands Highway (FLH) oversee and/or develop cost estimations.





# Project Overview

This presentation shows relevant findings related to **cost estimate** and **cost estimate oversight** for transportation construction projects for FHWA Federal-aid division offices (DOs), State transportation agencies (STAs), and FLH.





© 2015 USchools / iStock.

# Research Methodology



U.S. Department of Transportation  
Federal Highway Administration

Turner-Fairbank  
Highway Research Center

# Research Methodology

## Qualitative research with two major components:

- ▶ Literature review.
- ▶ Data collection via subject matter expert interviews:
  - ▷ First round of interviews.
  - ▷ Follow-up/validation interviews.







© 2015 USchools / iStock.

# Cost Estimates Development and Oversight



U.S. Department of Transportation  
Federal Highway Administration

Turner-Fairbank  
Highway Research Center



# Cost Estimating Approaches

- ▶ Historical bid-based estimation.
- ▶ Combination of historical and cost-based estimations.
- ▶ Risk-based method.
- ▶ Conceptual estimation.
- ▶ Cost-based estimation.



# Cost Estimating Approaches (Continued)

## Ranking of DO familiarity with cost estimating approaches:

1. Historical bid-based estimation.
2. Combination of historical and cost-based estimation.
3. Conceptual estimation.
4. Risk-based estimation.
5. Cost-based estimation.



# Cost Estimating Approaches (Continued)

## Ranking of STA familiarity with cost estimating approaches:

1. Historical bid-based estimation.
2. Conceptual estimation.
3. Combination of historical and cost-based estimation.
4. Cost-based estimation.
5. Risk-based estimation.



# Cost Estimating Oversight

## **Common practices:**

- ▶ Applying the Pareto principle.
- ▶ Comparing historical projects.
- ▶ Monitoring and updating cost estimates.
- ▶ Identifying factors that influence project cost.
- ▶ Analyzing cost estimate procedures.





# Cost Estimating Oversight (Continued)

## **Ranking cost estimate oversight practices by perceived usefulness (STAs and DOs combined):**

1. Identifying factors that influence projects cost.
2. Comparing historical projects.
3. Applying the Pareto principle.
4. Monitoring and updating cost estimates.
5. Analyzing cost estimate procedures.





© 2015 USchools / iStock.

# Perceptions and Challenges



U.S. Department of Transportation  
Federal Highway Administration

Turner-Fairbank  
Highway Research Center

# Perception of Agencies Performance

How STAs and DOs perceive each other.

State	DO Perception of STAs	STA Perception of DOs
A	—	5.8
B	—	9.6
C	1.0	7.5
D	2.0	7.3
E	8.5	2.6
F	—	6.8
G	7.0	—
H	9.0	—
I	8.9	—
J	9.4	—
K	8.5	—
L	—	N/A

—No data.  
N/A = not applicable.

# Challenges

## **Major challenges STAs report when creating estimates and providing oversight:**

- ▶ Time to develop estimates.
- ▶ New bid item estimations (especially for States using the historical bid-based approach).
- ▶ Staff shortages.
- ▶ Lump sum items.





# Challenges (Continued)

## **Major challenges DOs report when creating estimates and providing oversight:**

1. Lack of early-stage involvement.
2. Limited access to available software systems.
3. Rework required for shelved projects.
4. Quantity of bid items.
5. Package to the bidder lacks detail (i.e., no locations).
6. Lump sum items.





© 2015 USchools / iStock.

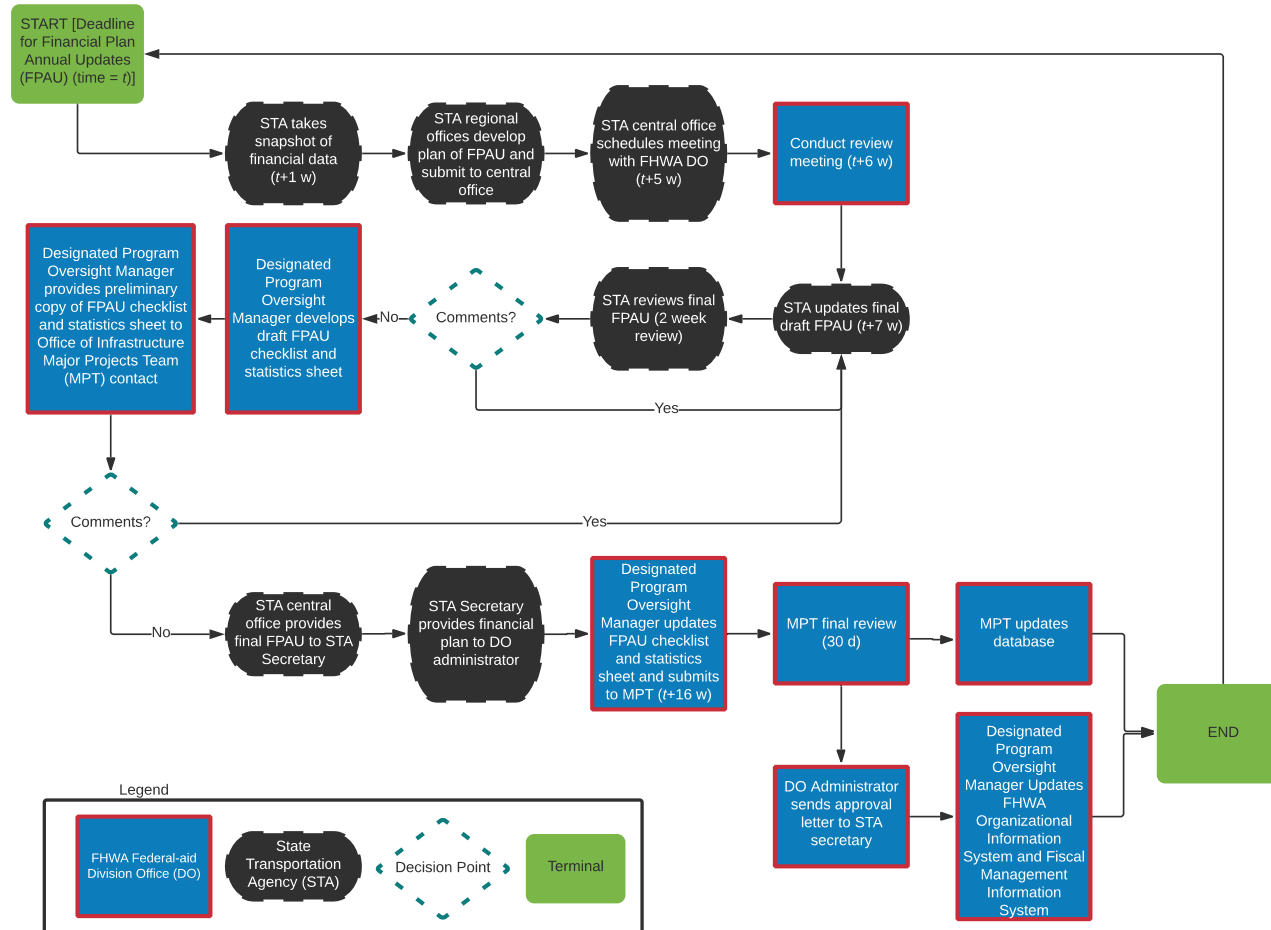
# Diagrams and Checklists



U.S. Department of Transportation  
Federal Highway Administration

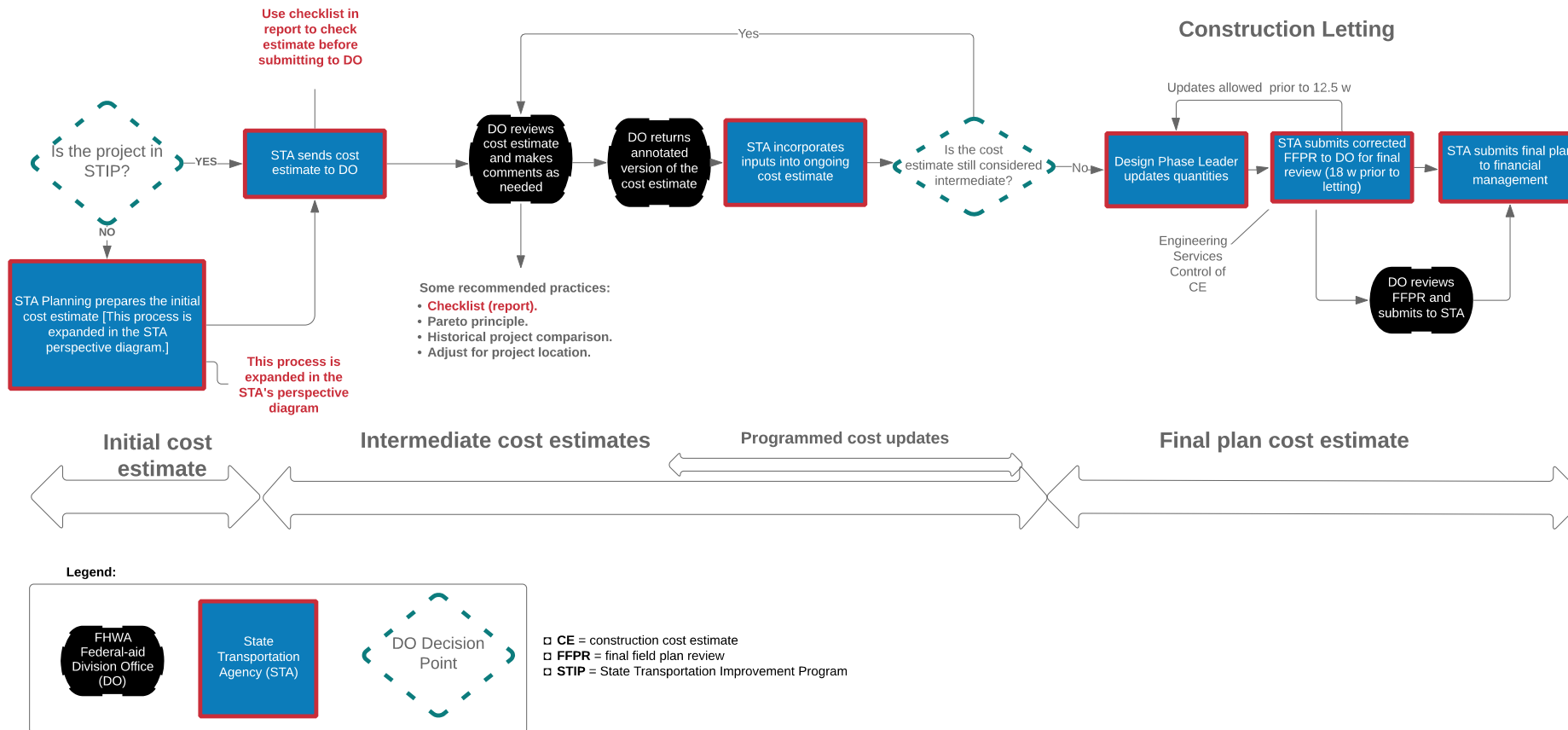
Turner-Fairbank  
Highway Research Center

# Cost Estimate Oversight—Program Level



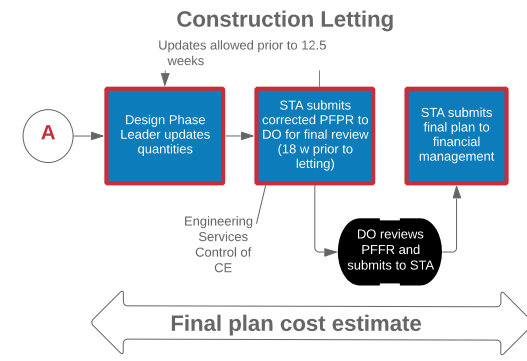
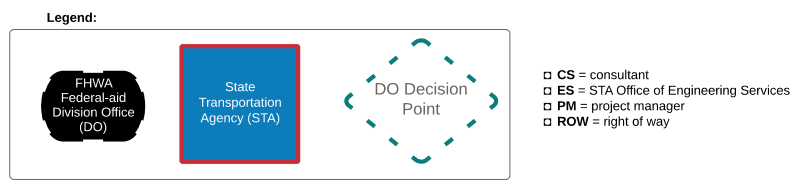
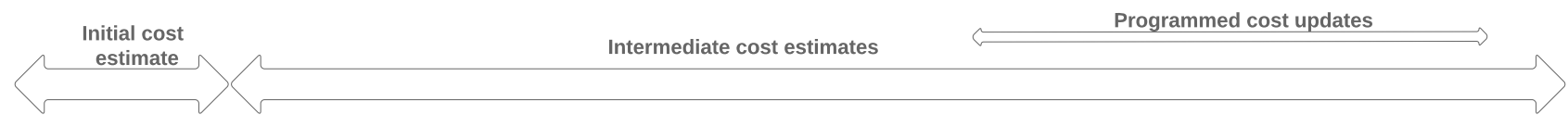
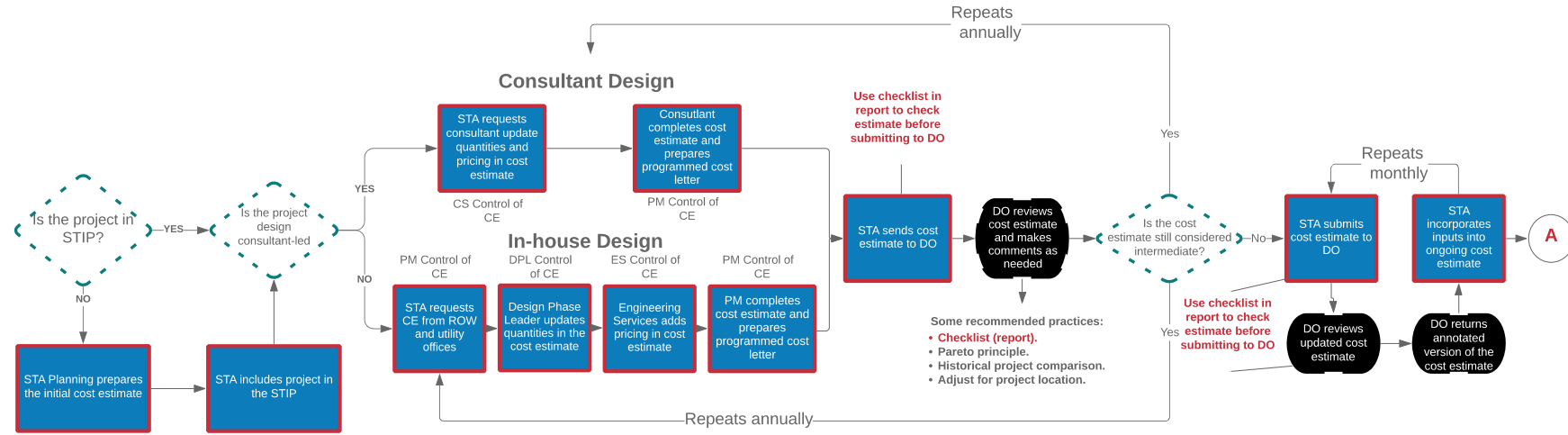
Source: FHWA.

# Project Level—DO Perspective



Source: FHWA.

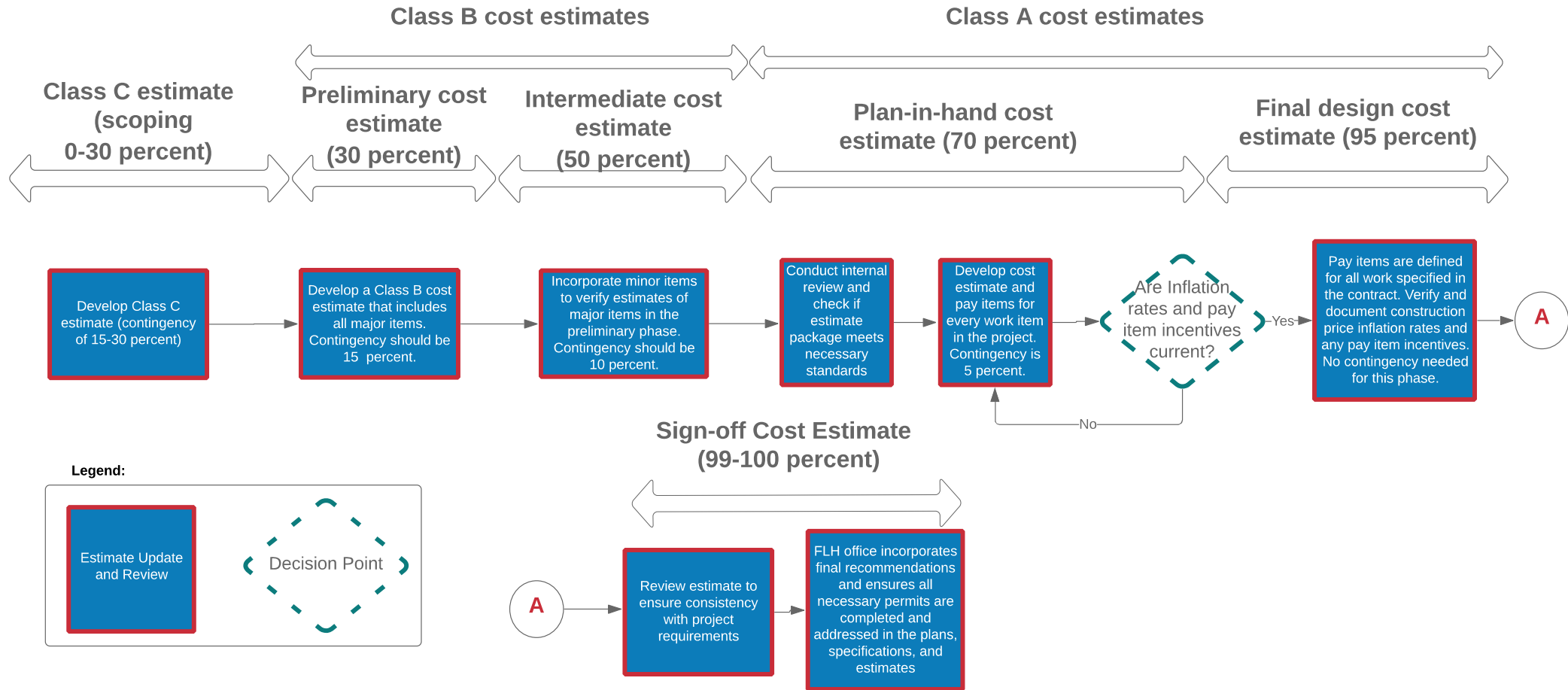
# Project Level—STA Perspective



Source: FHWA.



# Project Level—FLH Perspective



Source: FHWA.

# Oversight Checklists—Guidance Items

<b>Guidance Items. These items are used to inquire about general aspects of a cost estimate. They are related to the general purpose of the estimate and not to specific items of an estimate.</b>	<b>Yes</b>	<b>No</b>	<b>N/A</b>
<b>Has the purpose of the estimate been defined?</b>	-	-	-
<b>Estimating method is identified.</b>	-	-	-
<b>Estimating method is available for review.</b>	-	-	-
<b>Estimate is written down and available.</b>	-	-	-
<b>Allowances and factors were validated and are appropriate for the level of estimate.</b>	-	-	-
<b>Oversight team is knowledgeable about the estimating method used.</b>	-	-	-
<b>Estimate was prepared using a typical cost model (e.g., bid item codes).</b>	-	-	-
<b>Has the basis of estimate been completed/updated with explanation of changes?</b>	-	-	-
<b>Is a basis of estimate document available?</b>	-	-	-
<b>Estimate was independently validated.</b>	-	-	-

-No data.



# Oversight Checklists—Uncertainty Items

<b>Uncertainty Items. These items refer to the unknowns (known unknowns and unknown unknowns) of the estimate and their respective assessments.</b>	<b>Yes</b>	<b>No</b>	<b>N/A</b>
<b>Risk assessment was conducted to identify, analyze, and evaluate risks.</b>	-	-	-
<b>Estimate is adjusted for inflation to year of expenditure dollars for each element of the project.</b>	-	-	-
<b>Project complexity is considered in the estimate.</b>	-	-	-
<b>Process includes risk-based assessments of unknown and all uncertain costs.</b>	-	-	-
<b>Risk contingencies are sufficiently removed from unit bid-item prices in the base-cost estimate.</b>	-	-	-

-No data.

# Oversight Checklists—Construction Items

Construction Items. These items are associated with the quantities and elements related to the physical execution of the projects.	Yes	No	N/A
Estimate of unit prices are reasonable for the areas, times, and characteristics of the work to be done.	-	-	-
Incentive/disincentive or escalation clauses have been considered in determining the estimated unit costs.	-	-	-
All costs and durations were checked for conformity between amounts of work (item quantities) and the schedule durations to determine correctness.	-	-	-
Estimate is consistent with project scope.	-	-	-

-No data.

# Oversight Checklists—Finance Items

Finance Items	Yes	No	N/A
Force account work is adequately justified.	-	-	-
Salvage credit shown (if applicable).	-	-	-
Market conditions are being taken into consideration.	-	-	-

-No data.



# Oversight Checklists—Nonconstruction Items

<b>Nonconstruction Items. These items refer to items that are not part of the physical execution of the project but should be considered part of the estimates.</b>	<b>Yes</b>	<b>No</b>	<b>N/A</b>
<b>Utility and railroad force account work covered.</b>	-	-	-
<b>Estimate includes all right-of-way and administrative costs.</b>	-	-	-
<b>Estimate includes all transportation system management/transportation demand management costs.</b>	-	-	-
<b>Nonparticipating work shown.</b>	-	-	-

-No data.

# Oversight Checklists—Regulation Items

<b>Regulation Items—Analyzing Bids. These items refer to the general quality and adherence to regulations of the estimate (letting).</b>	<b>Yes</b>	<b>No</b>	<b>N/A</b>
<b>Estimate is materially balanced.</b>	-	-	-
<b>Estimate is mathematically balanced.</b>	-	-	-
<b>Noncollusion statement included.</b>	-	-	-

-No data.

# Oversight Checklists—Risk Items

<b>Risk-Based Estimates. These items are relevant for projects not developed using conventional estimating methods and involving high risks.</b>	<b>Yes</b>	<b>No</b>	<b>N/A</b>
<b>Is the risk assessment process documented and available?</b>	-	-	-
<b>If a consultant produced the risk assessment, what process is the consultant following, and are they willing to share the model they used to produce the final results?</b>	-	-	-
<b>Did the state hold a risk workshop to provide input to the final results? If so, is a risk workshop final report available?</b>	-	-	-
<b>What is the date on the risk workshop report compared to the date the estimate was last updated?</b>	-	-	-
<b>Did the staff responsible for developing the risk registry have the right level of subject matter experts attending to develop a robust risk register? If so, were subject matter experts in attendance representing design, ROW, roadway, structure, environment, permitting, utilities, lighting, etc.?</b>	-	-	-

-No data.

# Oversight Checklists—Risk Items (Continued)

<b>Risk-Based Estimates. These items are relevant for projects not developed using conventional estimating methods and involving high risks.</b>	<b>Yes</b>	<b>No</b>	<b>N/A</b>
<b>Did the group identify minor risks or significant risks to the project cost and schedule?</b>	-	-	-
<b>What risks were identified as most significant in terms of driving cost and schedule completion?</b>	-	-	-
<b>Is a project risk tornado diagram available?</b>	-	-	-
<b>Were the risks in the risk register ranked?</b>	-	-	-
<b>Did the staff responsible for developing the risk registry use the risk expected value, by cost impact, by schedule impact, etc.?</b>	-	-	-

-No data.

# Oversight Checklists—Risk Items (Continued)

<b>Risk-Based Estimates. These items are relevant for projects not developed using conventional estimating methods and involving high risks.</b>	<b>Yes</b>	<b>No</b>	<b>N/A</b>
<b>If risks are ranked by expected value, how are low-probability, high-impact risk events addressed?</b>	-	-	-
<b>How was the project budget and completion date determined from the probability cost and schedule forecast curves?</b>	-	-	-
<b>Does the State have a reliability level to establish budget and schedule completion? How was this level determined?</b>	-	-	-
<b>For the risk workshop forecast curves, are the curves wide or narrow?</b>	-	-	-
<b>How does the State account for market conditions in the risk assessment model?</b>	-	-	-

-No data.





© 2015 USchools / iStock.

# Summary



U.S. Department of Transportation  
Federal Highway Administration

Turner-Fairbank  
Highway Research Center

# Summary

**To improve alignment and consistency, the research team:**

- ▶ Identified and ranked practices for cost estimate oversight.
- ▶ Created diagrams to follow for the oversight process:
  - ▷ At a program level.
  - ▷ At a project level:
    - For DOs.
    - For STAs.
    - For FLH.
- ▶ Created checklists to provide guidance on cost estimate oversight.





---

Matthew Corrigan

[Matthew.Corrigan@dot.gov](mailto:Matthew.Corrigan@dot.gov)

(202) 493-3365



U.S. Department of Transportation  
Federal Highway Administration

Turner-Fairbank  
Highway Research Center