



COLORADO

Department of
Transportation



Innovative Bridge Designs in Colorado

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ABC Project SME, CDOT Staff Bridge



ABC History in Colorado

1. Promote Using Prefabricated Bridge & CBC Members since Early 1990 (Partnership with Local Fabricators)

- Design Policy: To Allow Deck Replacement
- Standard Sections: Precast Box, BT & Spliced Curved Tub
- Non-standard Sections: Precast Super. & Substructure
- Precast Deck: Deck Form & Full-Depth Deck Panel

2. ABC Projects & Seminars completed Up-to-Date

- 73 Bridges & CBCs: Lifting-on, Sliding-in and Moving-in
- Webminar, “Sliding-In Bridge Construction” (w/ FHWA)
- Seminar, “ABC Evaluation & Decision” & More to Come
- Workshop, “Pecos & I-70 Bridge Move Workshop”

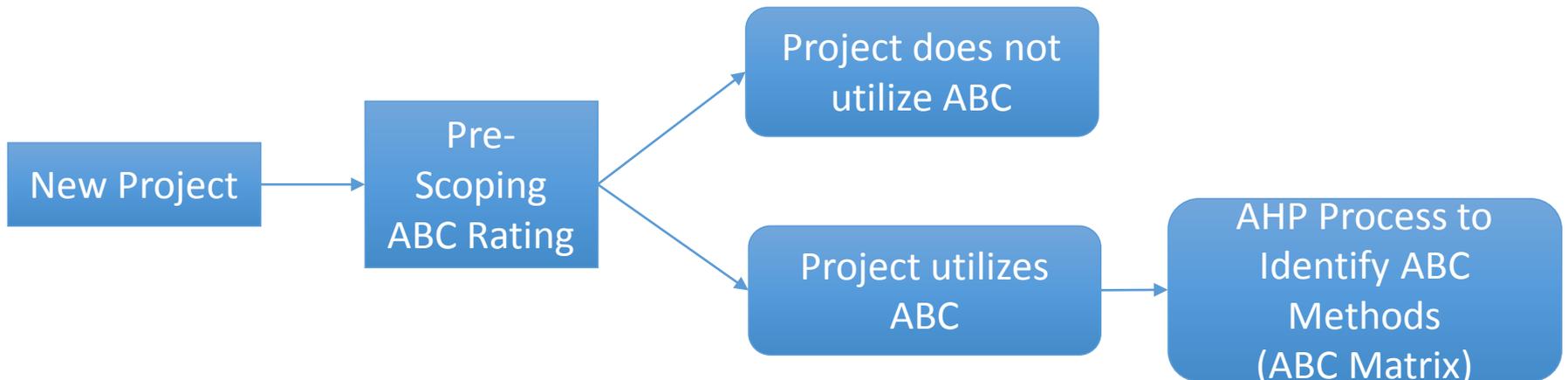
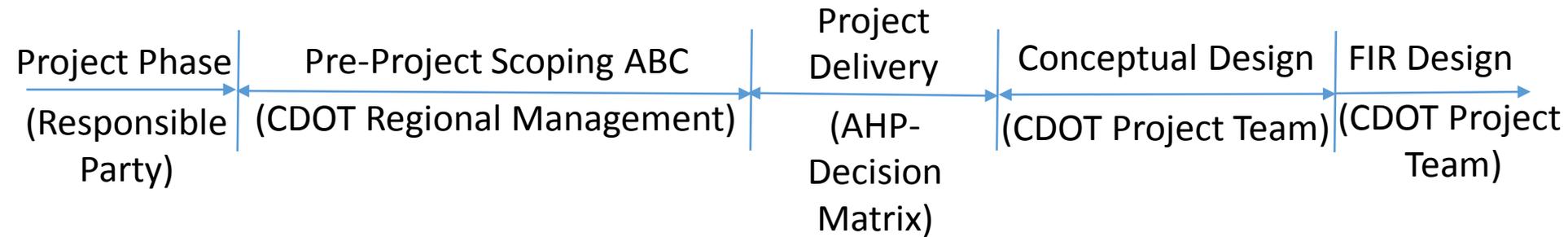


ABC Implementation Plan Activities

Activity 1 Develop & Implement ABC Evaluation Procedures

>> Completed 02/1/2013

ABC Evaluation and Decision Matrix Workflow



(AHP = Analytic Hierarchy Process)



ABC Implementation Plan Activities

ABC Pre-Scoping Evaluation Factors Needed

1. Average Daily Traffic
2. Delay/Detour Time
3. Bridge Classification (Normal, Essential & Critical Bridges)
4. User Costs (Finance Impact of a Project on Travelling Public)
5. Economy of Scale (Repetition of Elements: 1, 2, or more spans)
6. Safety (To Travelling Public and Work Force)
7. Railroad Impacts
8. Site Conditions (Physical Constraints: Alignment Shifts & Envir.)



ABC Implementation Plan Activities

ABC Pre-Scoping Evaluation - Rating

 <small>DEPARTMENT OF TRANSPORTATION</small>	Project: Number		
	By: Initials	Checked:	Initials
	Date: 0/0/00		0/0/00
	Sheet No. 1	of	3
Pre-Scoping ABC Rating		May 2012	
Enter values for each aspect of the project. Attach applicable supporting data.			
Average Daily Traffic	<input type="text" value="0"/>	0	No traffic impacts
Combined on and under		1	Less than 5000
Enter 5 for Interstate Highways		2	5000 to 10000
		3	10000 to 15000
		4	15000 to 20000
		5	More than 20000
Delay/Detour Time	<input type="text" value="0"/>	0	No delays
		1	Less than 5 minutes
		2	5-10 minutes
		3	10-15 minutes
		4	15-20 minutes
		5	More than 20 minutes
Bridge Importance	<input type="text" value="0"/>	1	Normal Bridge - minimal access impacts
		3	Essential Bridge - impacts to locals and business
		5	Critical Bridge - only access to community or business
User Costs	<input type="text" value="0"/>	0	No user costs
		1	Less than \$10,000
		2	\$10,000 to \$50,000
		3	\$50,000 to \$75,000
		4	\$75,000 to \$100,000
		5	More than \$100,000
Economy of Scale (repetitive work or standard details)	<input type="text" value="0"/>	0	1 span
		1	2 to 3 spans
		2	4 to 5 spans
		3	> 5 spans or multiple structures
Safety	<input type="text" value="0"/>	1	Short duration impact with simple MOT scheme
		2	Short duration impact with multiple traffic shifts
		3	Normal duration impact with multiple traffic shifts
		4	Extended duration impact with multiple traffic shifts
		5	Extended duration impact with complex MOT scheme
Railroad Impacts	<input type="text" value="0"/>	0	No railroad or minor railroad spur
		3	One mainline railroad track
		5	Multiple mainline railroad tracks
Site Conditions	<input type="text" value="0"/>	0	Inhibiting site constraint (e.g. > 1 ft. profile shift)
		3	Time sensitive constraint (e.g. utility schedules)
		5	Favorable site conditions



ABC Implementation Plan Activities

ABC Pre-Scoping Evaluation - Rating

	Project: Number	
	By: Initials	Checked: Initials
	Date: 0/0/00	0/0/00
	Sheet No. 2	of 3
Pre-Scoping ABC Rating		May 2012

Note: Do not adjust weight factors without prior consultation with CDOT Project Development Manager

ABC RATING SCORE FACTORS AND WEIGHTS					
	Score	Weight Factor	Adjusted Score	Maximum Score	Adjusted Score
Average Daily Traffic	0	10	0	5	50
Delay/Detour Time	0	10	0	5	50
Bridge Importance	0	5	0	5	25
User Costs	0	10	0	5	50
Economy of Scale	0	3	0	3	9
Safety	0	10	0	5	50
Railroad Impacts	0	5	0	5	25
Site Conditions	0	5	0	5	25
Total Score			0	Max. Score	284

ABC Rating Score: 0 % of Maximum Score

The ABC Rating Score is driven by the four most heavily weighted factors: Average Daily Traffic, Delay/Detour Time, User Costs and Safety. For a detailed explanation, review the narrative on page 4 of the ABC Decision Making Process.

Cost Considerations:

Calculate the following costs for use in determining the lowest total project cost

TOTAL PROJECT COST EVALUATION		
	Traditional Const.	ABC Construction
*Construction Costs	\$0	\$0
User Costs	\$0	\$0
Total Project Cost	\$0	\$0

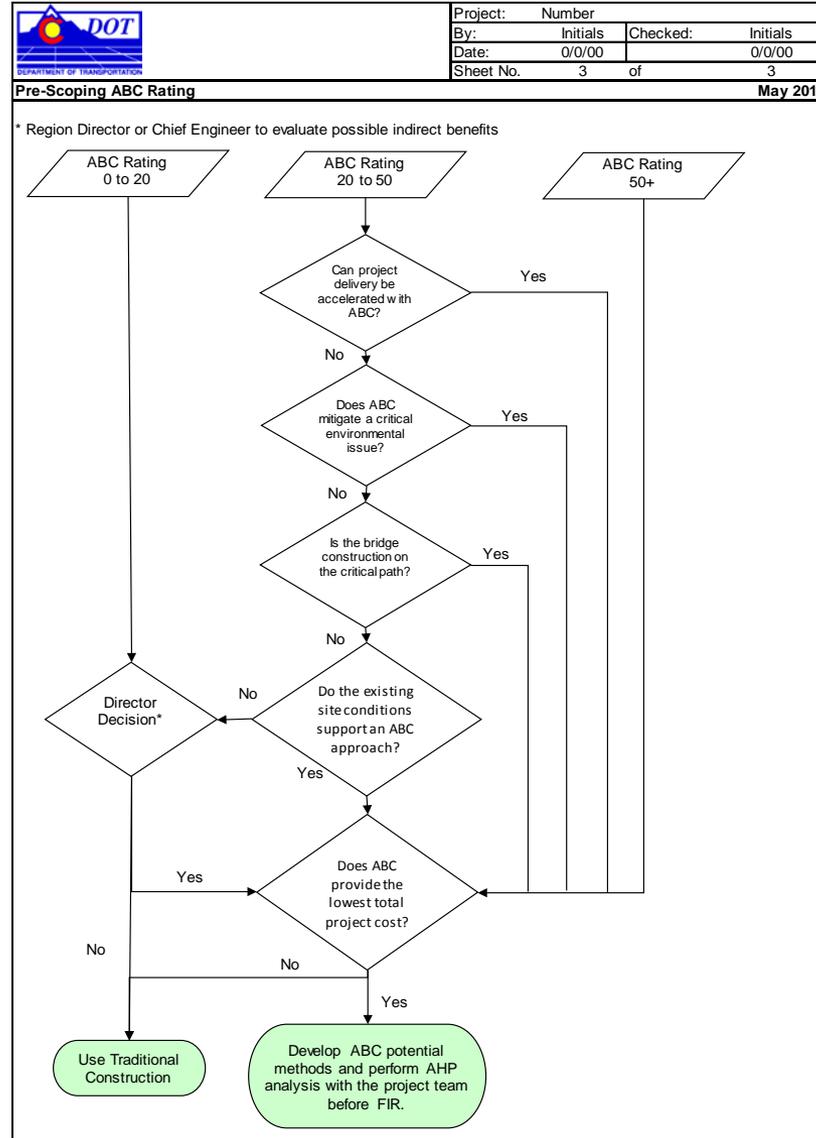
* Account for the following Construction Costs that can be dramatically reduced with ABC construction:

- Detour**
- Traffic Control**
- Railroad flagging**
- Railroad shoefly**
- Increased Contractor and/or CDOT safety**



ABC Implementation Plan Activities

ABC Pre-Scoping Evaluation – Flow Chart





ABC Implementation Plan Activities

ABC Decision Making–AHP Software customized for CDOT

The screenshot shows the AHP Decision Making Software interface. At the top, there is a menu bar with 'File' and 'Help'. Below it is a 'Main Menus' section with four tabs: 'Decision Hierarchy', 'Pairwise Comparison', 'Results', and 'Cost Weighted Analysis'. A red arrow points to these tabs with the label 'Tab Views'. The main area is divided into two panes. The left pane is a 'Hierarchy Editor Window' (indicated by a purple arrow) showing a tree structure of decision elements. The right pane is a 'Control Buttons' area (indicated by a blue arrow) containing several buttons: 'Add Child', 'Remove', 'Reset to Default', 'Save Hierarchy', 'Load Hierarchy', 'Check All', 'Set AIts.', 'Save State', and 'Load State'. A yellow box highlights the control buttons area.

Main Menus

Tab Views

Control Buttons

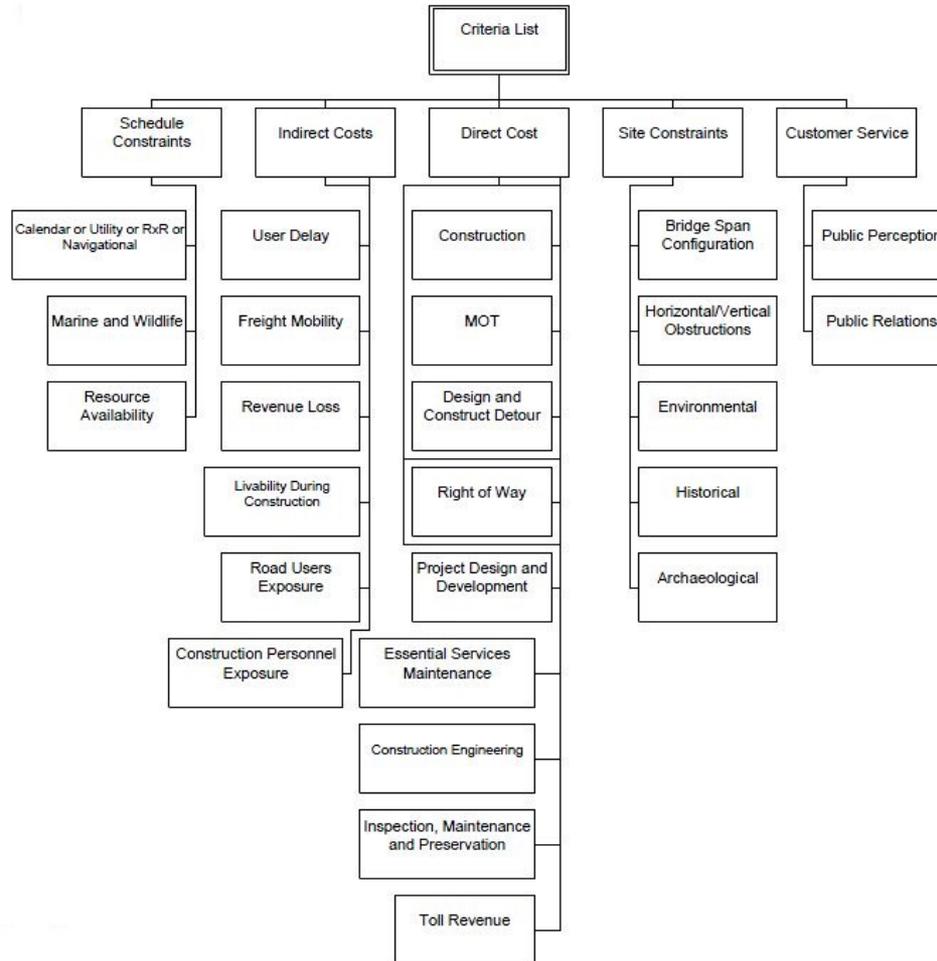
Hierarchy Editor Window

- Goal
 - Schedule Constraints
 - Calendar or Utility or FxR or Navigational Constraints
 - Marine and Wildlife Constraints
 - Resource Constraints
 - Indirect Costs
 - Loss of Revenue to Local Business
 - Impact to Neighborhood Livability during Construction
 - Costs of Users Delay
 - Costs of Truckers Delay
 - Direct Costs
 - MOT Costs
 - Right of Way Costs
 - Detour Costs
 - Project Design and Development Costs
 - Essential Services Maintenance Cost
 - Construction Costs
 - Agency Construction Management Costs
 - Inspection and Maintenance and Preservation Costs
 - Site Constraints
 - Horizontal/Vertical Obstructions
 - Span Design
 - Archaeological Constraints
 - Historical Constraints
 - Customer Service
 - Workzone Safety



ABC Implementation Plan Activities

ABC Decision Making–AHP Software customized for CDOT



Criteria Hierarchy



ABC Implementation Plan Activities

ABC Decision Making–AHP Software customized for CDOT

Intensity	Definition	Explanation
1	Equal importance	Two activities contribute equally to the objective
3	Weak importance of one over another	Experience and judgment slightly favor one activity over another
5	Essential or strong importance	Experience and judgment strongly favor one activity over another
7	Demonstrated importance	An activity is strongly favored, and its dominance demonstrated in practice
9	Absolute importance	The evidence favoring one activity over another is of the highest possible order of affirmation
2, 4, 6, 8	Intermediate values between the two adjacent judgments	When compromise is needed

AHP Pairwise Comparison Scale



ABC Implementation Plan Activities

ABC Decision Making–AHP Software customized for CDOT

AHP Decision Making Software

File Help Left / Right

Decision Hierarchy Pairwise Comparison Results Cost Weighted Analysis

Direct Costs	<input type="radio"/> 9	<input type="radio"/> 7	<input type="radio"/> 5	<input type="radio"/> 3	<input type="radio"/> 1	<input type="radio"/> 3	<input type="radio"/> 5	<input type="radio"/> 7	<input type="radio"/> 9	Indirect Costs	<input type="text"/>
Direct Costs	<input type="radio"/> 9	<input type="radio"/> 7	<input type="radio"/> 5	<input type="radio"/> 3	<input type="radio"/> 1	<input type="radio"/> 3	<input type="radio"/> 5	<input type="radio"/> 7	<input type="radio"/> 9	Schedule Constraints	<input type="text"/>
Direct Costs	<input type="radio"/> 9	<input type="radio"/> 7	<input type="radio"/> 5	<input type="radio"/> 3	<input type="radio"/> 1	<input type="radio"/> 3	<input type="radio"/> 5	<input type="radio"/> 7	<input type="radio"/> 9	Site Constraints	<input type="text"/>
Direct Costs	<input type="radio"/> 9	<input type="radio"/> 7	<input type="radio"/> 5	<input type="radio"/> 3	<input type="radio"/> 1	<input type="radio"/> 3	<input type="radio"/> 5	<input type="radio"/> 7	<input type="radio"/> 9	Customer Service	<input type="text"/>
Indirect Costs	<input type="radio"/> 9	<input type="radio"/> 7	<input type="radio"/> 5	<input type="radio"/> 3	<input type="radio"/> 1	<input type="radio"/> 3	<input type="radio"/> 5	<input type="radio"/> 7	<input type="radio"/> 9	Schedule Constraints	<input type="text"/>
Indirect Costs	<input type="radio"/> 9	<input type="radio"/> 7	<input type="radio"/> 5	<input type="radio"/> 3	<input type="radio"/> 1	<input type="radio"/> 3	<input type="radio"/> 5	<input type="radio"/> 7	<input type="radio"/> 9	Site Constraints	<input type="text"/>
Indirect Costs	<input type="radio"/> 9	<input type="radio"/> 7	<input type="radio"/> 5	<input type="radio"/> 3	<input type="radio"/> 1	<input type="radio"/> 3	<input type="radio"/> 5	<input type="radio"/> 7	<input type="radio"/> 9	Customer Service	<input type="text"/>
Schedule Constraints	<input type="radio"/> 9	<input type="radio"/> 7	<input type="radio"/> 5	<input type="radio"/> 3	<input type="radio"/> 1	<input type="radio"/> 3	<input type="radio"/> 5	<input type="radio"/> 7	<input type="radio"/> 9	Site Constraints	<input type="text"/>
Schedule Constraints	<input type="radio"/> 9	<input type="radio"/> 7	<input type="radio"/> 5	<input type="radio"/> 3	<input type="radio"/> 1	<input type="radio"/> 3	<input type="radio"/> 5	<input type="radio"/> 7	<input type="radio"/> 9	Customer Service	<input type="text"/>

Goal
├ Direct Costs
├ Indirect Costs
├ Schedule Constraints
├ Site Constraints
└ Customer Service

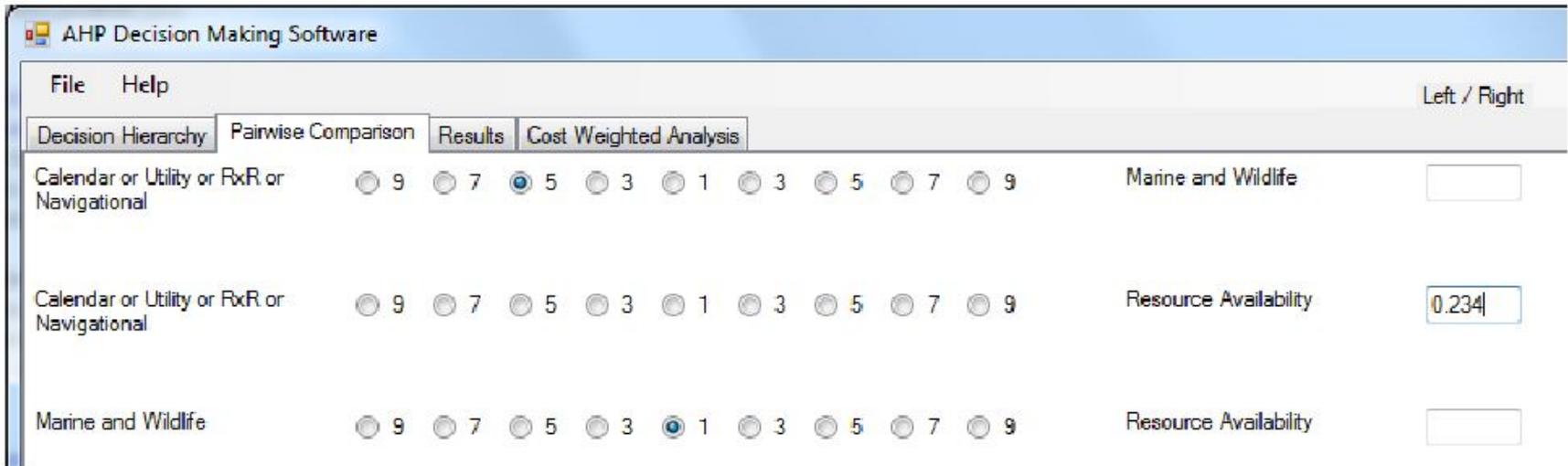
Next Node
Process

AHP Decision Making Software Pairwise Comparison Form



ABC Implementation Plan Activities

ABC Decision Making–AHP Software customized for CDOT

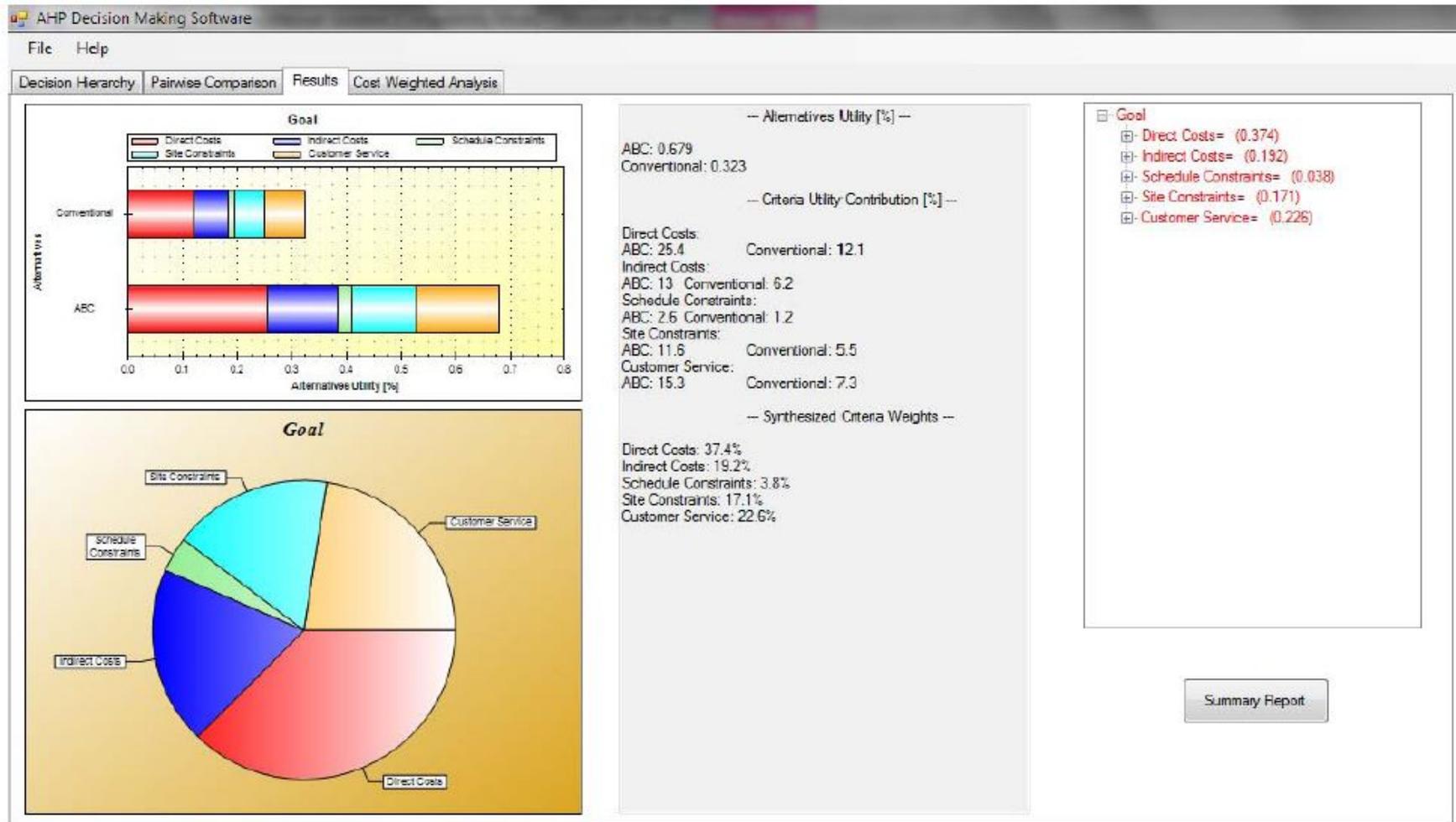


Pairwise Comparison Process



ABC Implementation Plan Activities

ABC Decision Making–AHP Software customized for CDOT



AHP Analysis Result



ABC Implementation Plan Activities

ABC Decision Making–AHP Software customized for CDOT

AHP Decision Making Software

File Help

Decision Hierarchy Pairwise Comparison Results Cost Weighted Analysis

Warning: Benefit-Cost ratios should be used only when the costs criteria are excluded from the decision model. Try to use the most accurate cost estimations for this purpose.

AHP Results

Alternatives Utility [%]:
ABC: 0.671
Conventional: 0.329

ABC Costs: Calculate

Conventional Costs: Clear

Alternatives Cost Weighted Ratios:
ABC: 0.897
Conventional: 1.305

The preferred alternative is: Conventional

AHP Benefit-Cost Analysis



ABC Implementation Plan Activities

ABC Decision Making–AHP Software customized for CDOT



Accelerated Bridge Construction Matrix

This matrix is to provide suggestions and previously utilized methods for accelerated bridge construction, it is not all inclusive nor intended to dictate any particular method.

PROJECT COMPLEXITY	Substructure	Approach, Embankment & Backfill	Superstructure	Super Structure placement
		Pre-fabricated approach slabs	Adjacent Girders ²	
		Flowfill	Precast Deck Panels (partial depth) ²	
	Pre-fabricated Pier Caps	Expanded Polystyrene (EPS) Geofoam	Pre-fabricated pedestrian bridge ²	
	Pre-fabricated columns		Pre-fabricated box culvert ²	
	Pre-fabricated foundations		Precast Deck Panels (full depth) ²	
	Geosynthetic Reinforced Soil (GRS) Abutment ¹		Modular Girder and Deck elements ²	
	Pre-fabricated wingwalls/backwalls ²		Post-tensioned concrete through beams ²	Heavy Lift Cranes
	Continuous Flight Auger Piles (CFA)		Pre-fabricated truss or arch span ²	Skid or Slide In
				Longitudinal Bridge Launch
			Self Propelled Modular Transport (SPMT)	

¹FHWA Every Day Counts Initiatives

²Prefabricated Bridge Elements and Systems (PBES)

ABC Costs ABC method construction costs generally increase with project complexity. However many methods of ABC may reduce the over all project cost. Specifically where ABC methods can eliminate or reduce detours, or traffic control.

ABC Matrix – Suggested Construction Methods



ABC Implementation Plan Activities

ABC Decision Making–AHP Software customized for CDOT

Accelerated Bridge Construction Matrix

This matrix is to provide suggestions and previously utilized methods for accelerated bridge construction, it is not all inclusive nor intended to dictate any particular method.

	Construction Contracting	Substructure	Approach, Embankment & Backfill	Superstructure	Super Structure placement
Tier 1 Methods	A+B Contract Provision	Pre-fabricated Pier Caps	Pre-fabricated approach slabs	Adjacent Girders ³	
	Contract in Calendar Days	Pre-fabricated columns	Expanded Polystyrene (EPS) Geofoam	Precast Deck Panels (partial depth) ³	
	Fixed Completion Date Contract	Pre-fabricated foundations	Flowfill	Pre-fabricated pedestrian bridge ³	
	Incentive-Disincentive Provision	Geosynthetic Reinforced Soil (GRS) Abutment ²		Pre-fabricated box culvert ³	
	Lane Rental Provision	Pre-fabricated wingwalls/backwalls			
	Value Engineering Specification	Continuous Flight Auger Piles (CFA)			
Tier 2 Methods	CM/GC Contract Delivery ^{1,2}			Precast Deck Panels (full depth) ³	Longitudinal Bridge Launch
	Design Build Contract Delivery ^{1,2}			Modular Girder and Deck elements ³	Self Propelled Modular Transport (SPMT)
				Orthotropic Deck ³	Skid or Slide In
				Steel grid deck (open or filled) ³	Heavy Lift Cranes
				Post-tensioned concrete through beams ³	
				Pre-fabricated truss or arch span ³	

¹ Utilize the Delivery Selection Matrix developed by ICAC to determine delivery method

² FHWA Every Day Counts Initiatives

³ Prefabricated Bridge Elements and Systems (PBES)

ABC Method Matrix – Suggestions of Contracting Methods



ABC Implementation Plan Activities

Activity 2 Communicate Goals and Documents to All

>> **Completed 03/6/2013**

1. Develop ABC Design Bulletin to All:

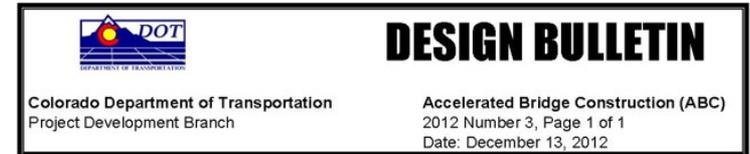
- All bridges are ABC, unless proved to not be practical or economical by ABC - AHP Evaluation Software.

2. Level of ABC:

Tier 1: Prefabricated Deck on Girders

Tier 2: Prefabricated Superstructure
w/ Deck Composite Sections

Tier 3: Prefabricated Superstructure
& Substructure Elements



Accelerated Bridge Construction (ABC)

In order to further strengthen CDOT's role as stewards of the taxpayers' dollars, and to minimize the impact to the traveling public, CDOT has developed a tool for evaluating accelerated bridge techniques, to determine whether or not they are appropriate for a given project.

This design bulletin provides general guidance as to the use of accelerated bridge construction techniques on a project that contains one or more bridges.

Applicable Materials:

All applicable materials for ABC evaluation can be downloaded at the internet link given below. The materials are compressed in a Zip file. Download the materials, unzip the files, and save the files to your local machine.

<http://intranet/engineering/staff-bridge/accelerated-bridge-construction/view>

Guidance:

The accelerated bridge construction methodology is to be evaluated for all projects that will contain one or more bridges and a justification letter written to the project file as to why or why not an ABC technique will be used on a project. The justification letter should include materials completed during the ABC evaluation. The design team may choose to work with the designated Staff Bridge Engineer for guidance and information regarding the use of the ABC materials.

The document "CDOT_ABC_Selection_Overview" contains an overview of the ABC process. The process is a two-phase approach. One phase is a cursory evaluation as to whether or not ABC is appropriate for a given project. The second phase is an in-depth evaluation as to what type of ABC technique will be employed. This cursory evaluation is to be done during the scoping phase using the spreadsheet "CDOT_Prescoping_ABC_Rating_Attachment_B". If the results of the cursory evaluation show that an ABC technique is appropriate for the project, the design team may move on to a more in-depth evaluation using the "ABC Decision Making Software" to determine which ABC method best meets the project's goals and constraints. If the in-depth evaluation is required, the design team shall schedule a meeting with all specialty groups including but not limited to: Staff Bridge, Utilities, Environmental, Traffic, Hydraulics, etc. to execute the ABC Decision Making Software. The results of the software are to become part of the project files.

The above information is represented graphically in the document titled, "ABC_Workflow_Attachment_A"



ABC Implementation Plan Activities

Activity 3 Develop ABC Examples for CDOT & Consultants to Utilize

>> Completed 08/31/2013



Pecos Street over I-70 Bridge Replacement Project

Pre-Bridge Move
Technical Workshop
July 17, 2013





ABC Implementation Plan Activities

Activity 4 Report and Track Number of ABC Projects in 2013

>> **Completed 01/31/2014**

CDOT Innovative Structure Design and Accelerated Bridge Construction

List of Prefabricated Bridge Element & System Projects (PBES)

Date: 1/13/2014 (The projects updated in this quarter are highlighted with Gray)

Prepared By: PPC

Region	Route	Mile Post	Structure Number	Intersection	Location	Description	Special Features	Construction Year	Previous Region & Remark
1	6	64.300	F-15-L	Elk Creek	SH6 over Clear Creek in Clear Creek Canyon	Bridge deck replacement on steel I-girder bridges.	Replaced decks with full depth precast decks in 12 days.	2004	
1	6	265.356	F-15-BC	Clear Creek	SH6 over Clear Creek in Clear Creek Canyon	Bridge deck replacement on steel I-girder bridges.	Replaced decks with full depth precast decks in 12 days.	2004	
1	6	267.180	F-15-BA	Clear Creek	SH6 over Clear Creek in Clear Creek Canyon	Bridge deck replacement on steel I-girder bridges.	Replaced decks with full depth precast decks in 12 days.	2004	
1	6	278.400	F-16-XG	SH6	West corridor RTD Rail / SH-6	RTD project. New tied steel arch bridge.	Launching of preconstructed arch over highway.	2010	R6 (RTD)
1	18	0.200	H-17-AV	E. Plum Creek	SH18 over Plum Creek near Larkspur, 0.2 Miles from I-25	Bridge replacement with side by side precast concrete box girders.	No deck overhangs & therefore no deck forms for partial depth CIP deck.	1995	Douglas County
1	25	186.935	G-17-AG	Happy Canyon Road	I-25 over Happy Canyon Road, North of Castle Rock	Replacement of existing bridge with GRS abutments.	Staff Bridge is preparing structure selection report of bridge replacement with GRS abutments.	2015	On-Hold
1	25	202.597	F-17-MG	Yale Avenue	I-25 over Yale Avenue, Denver	Two stage bridge replacement with precast box girders.	Extra bridge width provided to allow full speed traffic during construction.	1997	R6
1	25	210.487	F-16-XB	S. Platte River	I-25 over S. Platte River & UPRR	Replacement of Bronco Arch with precast tub girders and precast piers	Full depth precast deck. Precast Piers	2011-2013	R6
1	25	212.780	E-16-ON	Park Avenue	I-25/Park Avenue south-to-east ramp, Denver	New precast tub girder bridge.	Heavy erection - 200 ton girder segments. Contractor alternatives for using either precast or CIP construction.	1995	R6
1	25	213.626	E-16-AY	I-70	I-25 northbound to I-70 ramp	Full height panel MSE wall.	Facing and reinforcement features to minimize excavation footprint and lane	1993	R6



ABC Implementation Plan Activities

Activity 5 Present ABC Projects & Lessons Learned

>> **Completed 03/2015**

- Webminar Completed & Training Rolling-out Soon

The image is a screenshot of a video player. At the top, there is a logo for 'Slide IN' with the text 'BRIDGE LATERAL MOVE TECHNOLOGY' next to it. Below this, the text 'Accelerated Bridge Construction (ABC)' is displayed. Underneath that is the logo for the 'U.S. Department of Transportation Federal Highway Administration'. The main title of the presentation is 'SLIDE-IN BRIDGE CONSTRUCTION (SIBC) FROM THE OWNER/POLICY MAKER PERSPECTIVE'. At the bottom, the date and time are given as 'March 24, 2015; 11:00am MST'. The video player interface at the very bottom shows a play button, a progress bar at 0:00:07 / 1:01:12, a volume icon, and a full screen icon.



ABC Samples in Colorado

I-70 Grandwood Canyon Precast Segmental Bridges built by Span-by-Span Launching





ABC Samples in Colorado

I-25 at Broncos Arch Precast Spliced Tub Girder Bridge
built by Lifting-on





ABC Samples in Colorado

Pecos over I-70 Precast PS Box Girder Bridge moved-in
by SPMT





ABC Samples in Colorado

RTD Fast Tracks over US6 Steel Arch Bridge built by
Launching-in





ABC Samples in Colorado

US34 over Republican River Precast Box Girder Bridge
built by Lateral Sliding-in





ABC Samples in Colorado

SH66 over Mitchell Gulch Precast Slab Bridge built by Lifting-on & Dropping-in





ABC Samples in Colorado

US550 over Bear Creek Precast Deck on Steel-I Girder Bridge built by Lifting-on





ABC Samples in Colorado

US6 Clear Creek Steel-I Girder Bridge Deck Replacement by Lifting-on





COLORADO
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Thank you



ABC Experience & Outcomes for CDOT

1. Who does kick off the ABC discussion in CDOT or hold it?

- CDOT Regional Management

2. What has worked well and what has been more of a struggle?

- Construction time is short and on schedule
- Construction technique is great
- Cost is sometimes not compatible with conventional method

3. Have local consultants and/or bought into ABC?

- Yes, they have

Why or Why not?

- Most ABC are CM/GC Contracts (High Tech and Expert Team)

4. Is CDOT working on a program wide implement plan for ABC?

- Yes, CDOT is working on it since it has been utilized in 2013



ABC Experience & Outcomes for CDOT

5. Have CDOT let the public know about ABC projects and what they can expect?

- Yes, CDOT have let the public know the show case projects
- Public can expect to see short completion of those projects

6. Has cost estimate been an issue?

- No, it has not (Pre-scoping Evaluation and FHWA Support)

For let jobs, did the estimate reflect the bid?

- No, it did not since CDOT work out with local fabricators.



ABC Experience & Outcomes for CDOT

7. Lesson learned from past projects?

- Yes, there are new technologies, contracting and publicity methods to complete ABC on schedule

Things you would do again? Not?

- Lifting-on, Launching-in or lateral sliding-in method is simple to do again
- Moving a bridge by SPMT is costly and not suitable in some areas

Were ABC designs/specifications problematic for your agency?

- No, they were not (Normal document preparation)

What issues did come up during acquisitions and construction?

- Technique & Cost Competition

Would you do ABC construction again?

- Yes, we would do it (CDOT Design Bulletin)