FHWA's Long-Term Bridge Performance (LTBP) Program

The LTBP Protocols

Long-Term Bridge Performance Workshop
Transportation Research Board
93rd Annual Meeting
January 16, 2014

Long-Term Bridge Performance Program

Outline

- Purpose of Protocols
- Sample Protocol - Key Features
- LTBP Protocol Hierarchy
- Future Activities
- Future Challenges

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Protocol, definition

a detailed plan of a scientific or medical experiment, treatment, or procedure; for example

Test procedure for concrete compressive strength

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Purpose of the Protocols

To meet the needs of the LTBP program for high quality data to support LTBP goals; protocols ensure

- That the right types of data are collected
  - From the right locations and elements on the bridge
  - In the right format and units, and
  - With the prescribed level of accuracy

- Consistency in testing procedures, including
  - Numbering of components and segments
  - Location of sampling & testing points
  - Locating, measuring and characterizing defects.

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Purpose of the Protocols

To meet the needs of the LTBP program for high quality data to support LTBP goals; protocols ensure

- Tests are repeatable
  - From year to year by the same team
  - And by different teams

- Conformity with existing standard tests such as ASTM (as appropriate); for example

ASTM C 39 Compressive Strength of Concrete

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Sample Protocol – Steel Superstructure Deterioration - General

FLD-DC-VI-001 - Steel Superstructure Deterioration (General)

Data Collected:

General condition of a steel superstructure

References:

Bridge Inspector's Reference Manual (February 2012)
FLD-MD-002 Structure Segmentation & Element Numbering System
FLD-DC-VI-002 Steel Superstructure Corrosion
FLD-DC-VI-003 Steel Superstructure Section Loss
PST-AR-002 Data Import

Process description/Data collection principle:

A bridge superstructure is defined as that portion of a bridge structure that receives and supports traffic loads (distributed by the bridge deck) and in turn transfers these loads to the bridge substructure, including the bridge bearings. A steel superstructure can consist of girders (single or multi-cell box), floorbeams and stringers (concrete encased, rolled, and welded or bolted plates), cross frames and diaphragms. In addition, truss structures may have built-up sections for top and bottom chords, vertical and diagonal members, and lateral and sway frame bracings.

Depending on the site conditions, access to the superstructure members will involve the use of ladder(s), access platform(s) and/or a snooper.

Steel members shall be inspected primarily for paint peeling, pitting, corrosion (See Protocol FLD-DC-VI-002), section loss (See Protocol FLD-DC-VI-003), and cracking (future protocol). In particular, locations of high stress zones shall be thoroughly inspected. Also, any damages from vehicle or vessel strikes shall be noted.

The bearings for the superstructure will be inspected according to the relevant protocol: FLD-DC-VI-004, FLD-DC-VI-005, or FLD-DC-VI-006.

Photo:

Inspector on a steel truss superstructure

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Sample Protocol – Steel Superstructure Deterioration - General

On-site Equipment and Personnel Requirements:

- Ladder, Access Platform, and/or snooper
- Tape measure
- Laser Distance Measure
- Digital Camera
- Temporary Marker
- Pencil/Sketch pad

Data Collection / Data Analysis / Data Validation / Data Reduction Methodology:

- Measurement, characteristics, and pictures: locate defects by span number, according to the segmentation and numbering system for the superstructure (See Protocol PST-AR-002);
- Take pictures, allowing the entire defect to be seen as well as any surrounding information that would identify extent and cause of the defect.
- Take several pictures with scale reference when appropriate.
- Use sketches to document section loss and supplement the photographs.
- Reporting: Defect information shall be entered into the LTBP database.

Criteria for Data Validation:

Measurement, photo documentation, and comparison against previous condition

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Sample Protocol – Steel Superstructure Deterioration - General

Subdivision of the Structure for Inspection and Recordkeeping:
Superstructure: Span – example - Span 1

Next Process(es):
PST-AR-002

Full References:
FHWA. (2012). *Bridge Inspector's Reference Manual* – Report No. FHWA-NHI-12-053, Federal Highway Administration, Washington, DC.

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Sample Protocol – Steel Superstructure Deterioration - General

LTBP Data Collection Table for Protocol FLD-DC-VI-001						
#	Field Name	Data Type	Format / Accuracy	Unit	Required	Field Description
1	State	Text	Text		Yes	State Code, e.g., Virginia - VA
2	NBI Structure #	Text	Text		Yes	Item 8 - Structure Number from NBI Coding Guide
3	Structure name	Text	Text		Yes	Descriptive name for the bridge, e.g., Route 15 SB over I-66
4	Protocol name	Text	Text		Yes	Title of the protocol
5	Personnel performing inspection activities	Text	Text		Yes	First name(s), last name(s)
6	Date of inspection	Text	Date / Exact date		Yes	mm/dd/yyyy
7	Span number	Text	Text		Yes	
8	Paint peeling/	Text	Yes / No		Yes	
9	Pitting rust / corrosion	Text	Yes / No		Yes	
10	Loss of section	Text	Yes / No		Yes	
11	Cracking	Text	Yes / No		Yes	
12	Collision damage	Text	Yes / No		Yes	
13	Presence of a concrete defect at the interface	Text	Yes / No		Yes	
14	Defect photos	BLOB	BLOB		Optional	If defects present, document typical defects with photos and/or sketches
15	Comments	Text	Unlimited		Optional	

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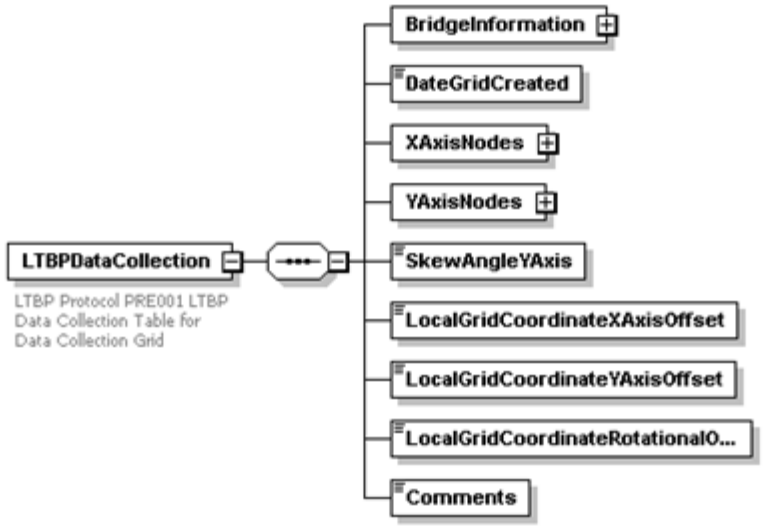
XSD Templates

element **LTBPDataCollection**

diagram	
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children	BridgeInformation DateGridCreated XAxisNodes YAxisNodes SkewAngleYAxis LocalGridCoordinateXAxisOffset LocalGridCoordinateYAxisOffset LocalGridCoordinateRotationalOffset Comments
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LTBP Protocol Hierarchy

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Protocol Hierarchy

- LTBP Protocols
  - Pre-visit (PRE)
    - Sampling and Selection (SS)
      - Design of Experiments (DE)
      - Sampling Algorithm (SA)
    - Existing Documentation (ED)
      - Bridge Documentation (BD)
      - Paper Studies (PS)
    - Planning and Logistics (PL)
      - Logistics (LO)
      - Test Design (TD)
      - Finite Element Modeling (FE)
  - Field Visit (FLD)
    - Meta-Data Collection (MD)
      - Spatial Context (SC)
      - Environmental Context (EC)
      - Photography (PH)
    - Field Data Collection (DC)
      - Site Preparation (SP)
      - Visual Inspection (VI)
      - Non-Destructive Evaluation (ND)
      - Material Sampling (MS)
      - Structural Testing (ST)
    - Data Storage (DS)
      - Local Storage (LS)
      - Remote Storage (RS)
  - Post-visit (PST)
    - Data Reduction and Processing (DR)
      - Reduction (RE)
      - Processing (PR)
    - Data Interpretation (DI)
      - Direct (DT)
      - Comparative (CO)
      - Model-based (MB)
    - Archiving and Reporting (AR)
      - Data Archiving (DA)
      - Reporting (RE)

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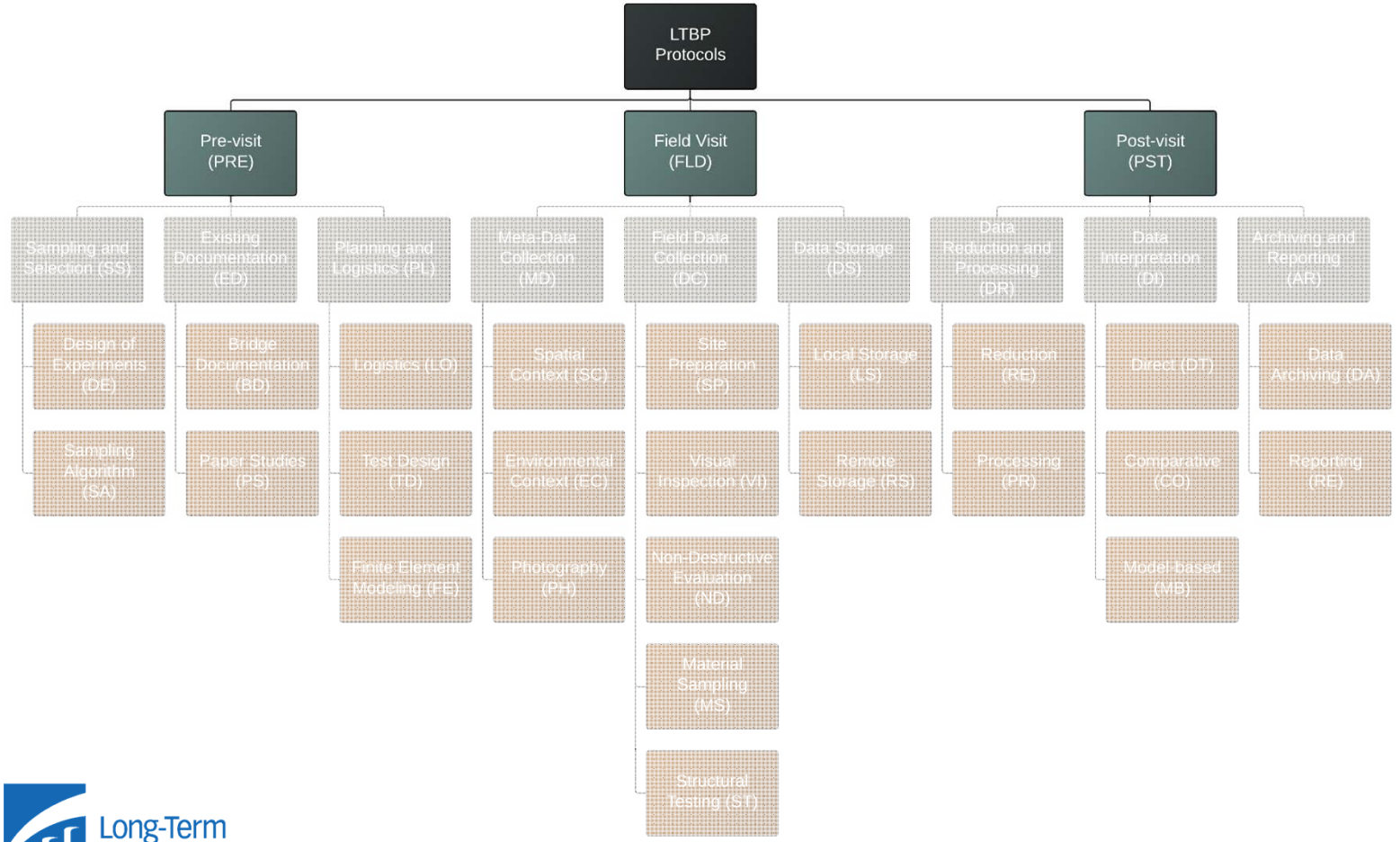
Naming Convention

XXX-YY-ZZ-###



XXX

YY

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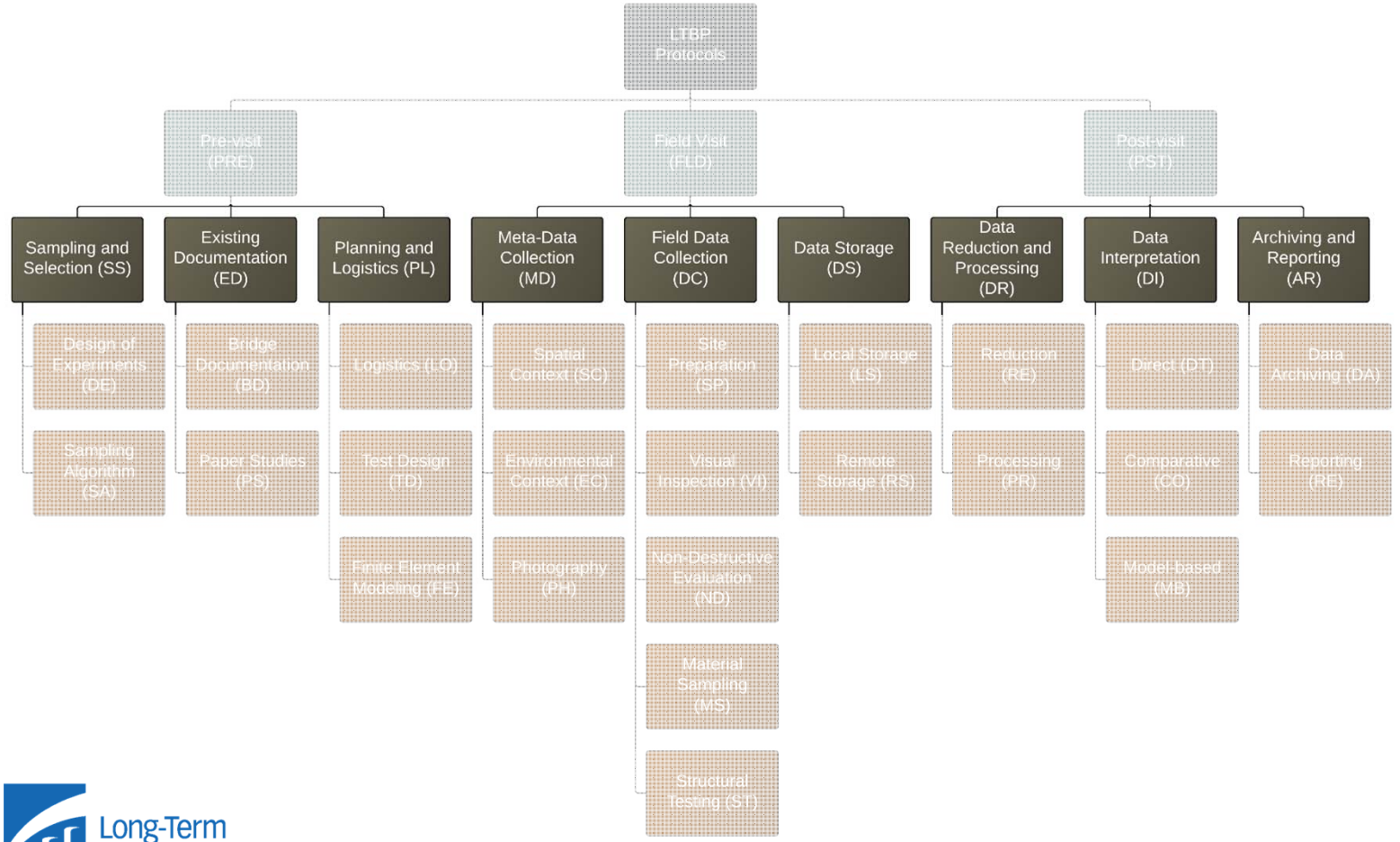
Stage Level

Naming Convention

XXX-YY-ZZ-###



XXX

YY

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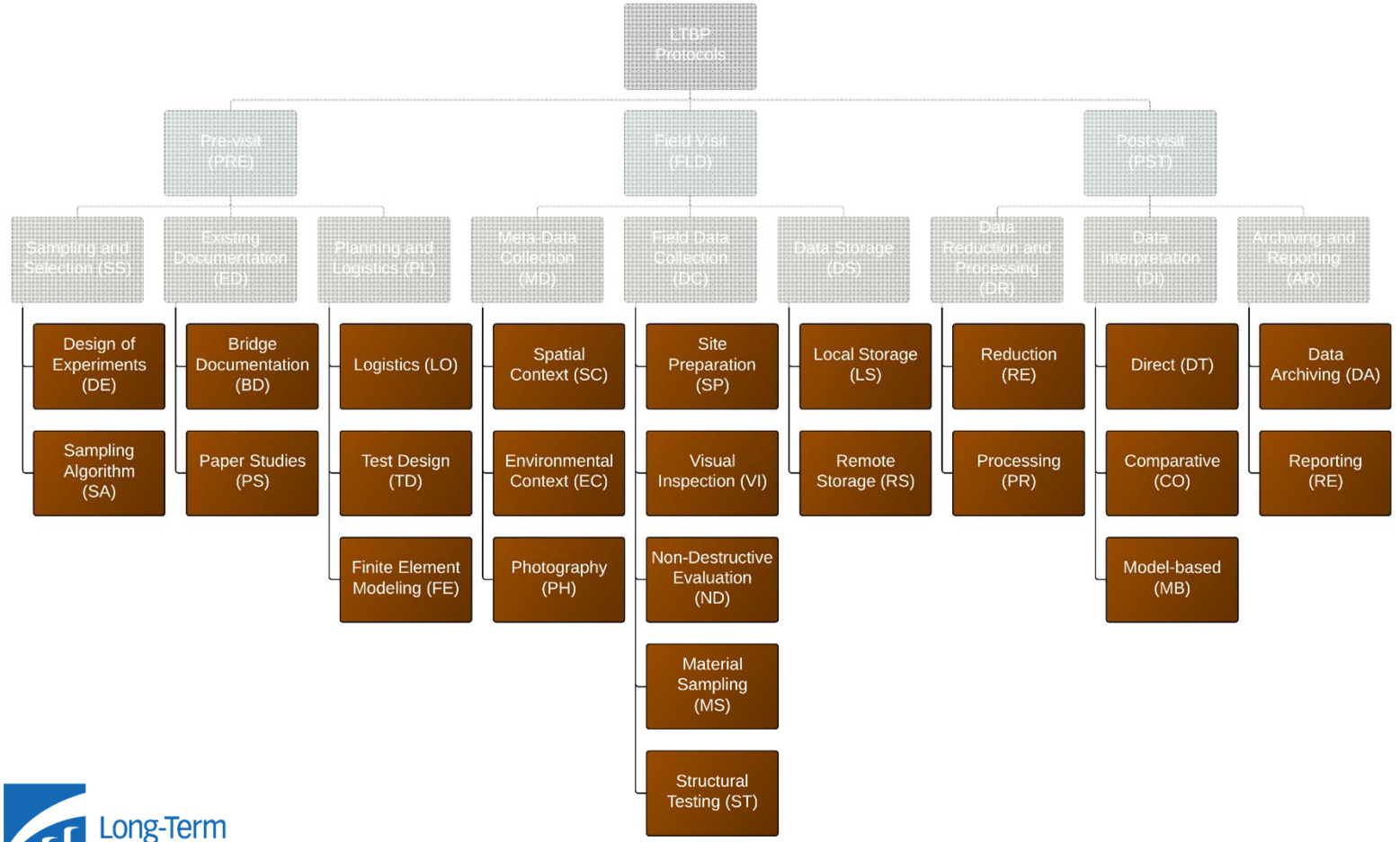
Category Level

Naming Convention

XXX-YY-ZZ-###



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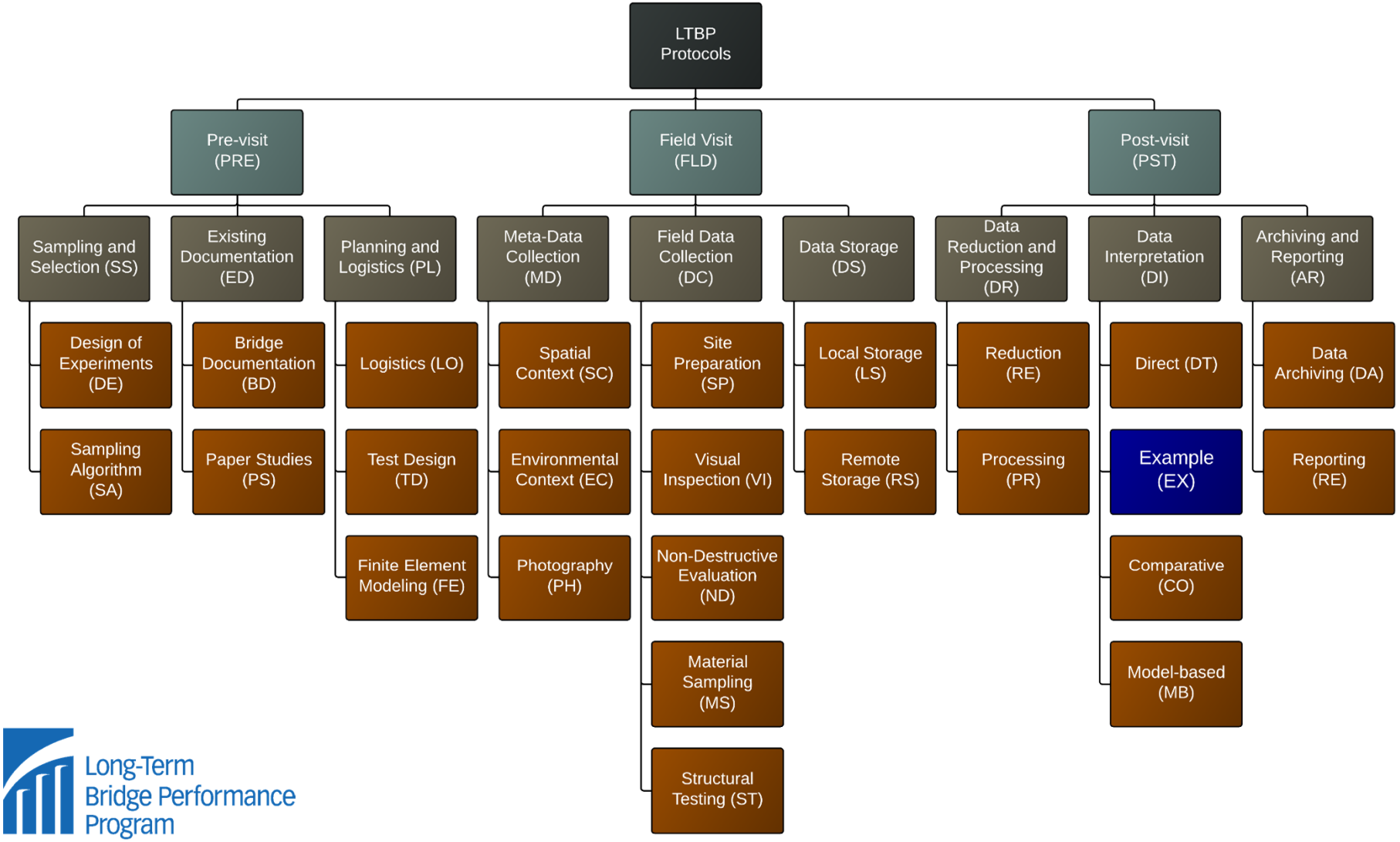
Application Level

Flexibility for Additional Protocols



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Protocol Index

Primary Group	Secondary Group	Protocol Number (Tentative)	Protocol Name	Anticipated Delivery Batch
PRE	ED (Existing Documentation)	001	Plans and Specifications for Bridge Design and Construction	Batch #1
		002	Bridge Construction Records	
		003	Bridge Design and Construction Data	
		004	Bridge Site Conditions - Climate, Environment, Traffic	
		005	Bridge Inspection Records	
		006	Bridge Maintenance and Rehabilitation - Records and Cost Data	
		007	Calculations of Bridge Ratings	
		013	Untreated Bridge Deck Paper Study	
	PL (Preliminary Planning and Logistics)	005	Reference Bridge Testing	Batch #1
		006	Cluster Bridge Testing	
FLD	MD (Meta-Data Collection)	001	Data Collection Grid and Coordinate System	Batch #1
		002	Structure Segmentation and Numbering System	

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Protocol Index

	Secondary Group	Protocol Number (Tentative)	Protocol Name	Anticipated Delivery Batch
FLD	DC (Field Data Collection)	001VI	Steel Superstructure Deterioration - General	Batch #1
		002VI	Concrete - Deterioration (General)	
		004VI	Substructure (General)	
		005VI	Elastomeric Bearings	
		006VI	Pot bearings	
		007VI	Rocker Bearings	
		008VI	Expansion Joints	
		010VI	Steel Superstructure - Corrosion	
		011VI	Steel Superstructure - Section Loss	
		012VI	Concrete - Abrasion	
		013VI	Concrete - Cracking	
		014VI	Concrete - Spalls and Delamination	
		015VI	Condition Assessment of Asphalt Overlays	
		016VI	Moisture and Efflorescence	
		017VI	Sulfate Attack	
		018VI	Drainage/Ponding	
		019VI	Chain Drag	

Protocol Index

Secondary Group	Protocol Number (Tentative)	Protocol Name	Anticipated Delivery Batch
DC (Field Data Collection)	020ND	Electrical Resistivity	Batch #1
	021ND	Ground Penetrating Radar Testing	
	022ND	Half Cell Potential	
	023ND	Impact Echo Testing	
	024ND	Linear Polarization Resistance	
	025ND	Dye Penetrant Testing	
	026ND	Ultrasonic Surface Wave Testing (Concrete)	
	027ND	Ultrasonic Testing - Steel Fatigue Cracking	
	030MS	General Concrete Sampling, Testing and Analysis Plan	
	031MS	Wet Coring (Field Sampling) of Concrete Decks	
	032MS	Strength and Static and Dynamic Elastic Moduli of Concrete Cores	
	033MS	Resistance to Chloride Penetration (Permeability)	
	034MS	Sampling and Testing for Chloride Profiles	

Protocol Index

Primary Group	Secondary Group	Protocol Number (Tentative)	Protocol Name	Anticipated Delivery Batch
PST	DR (Data Reduction and Processing)	001	Spatial Correlation	Batch #3
		002	Peak Extraction	
		003	Averaging	
		004	Error Screening	
	DI (Data Interpretation)	005	Comparison of Modalities of Instrumentation	Batch #3
		006	Spatial Interpretation	
		007	Time Comparison	
		008	Structure Comparison	
		009	Cluster Comparison	
		010	Global Finite Element Modeling	
		011	Detailed Finite Element Modeling	
		012	Model-Experiment Correlation	
		013	Scenario Analysis	

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Status of LTBP Inspection Protocols

Batch #	Status
1	In final stages of review for publication in an FHWA report: Long Term Bridge Performance Program: Inspection Protocols, Version1
2	2014
3	Early 2015

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Future Activities

Protocol Development & Publication

- Publish Version 1 Protocols Report
- Complete Batch 2
- Publish as an interim to Version 1 Protocols Report
- Complete Batch 3
- Publish Version 2 Protocols Report
- Implement the protocols as they come online and when needed
- Develop other protocols as deemed necessary

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Future Challenges

- Train additional inspectors / data collectors
- Adjust (tweak) protocols as needed based on accumulated experience
- Adopt new technology – e.g., the RABIT
- Ensure compatibility of data if/when new technology implemented
- Encourage wider application beyond or in support of the LTBP programs of the protocols, e.g.,
  - State DOT research projects
  - Other

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Questions or Comments?

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