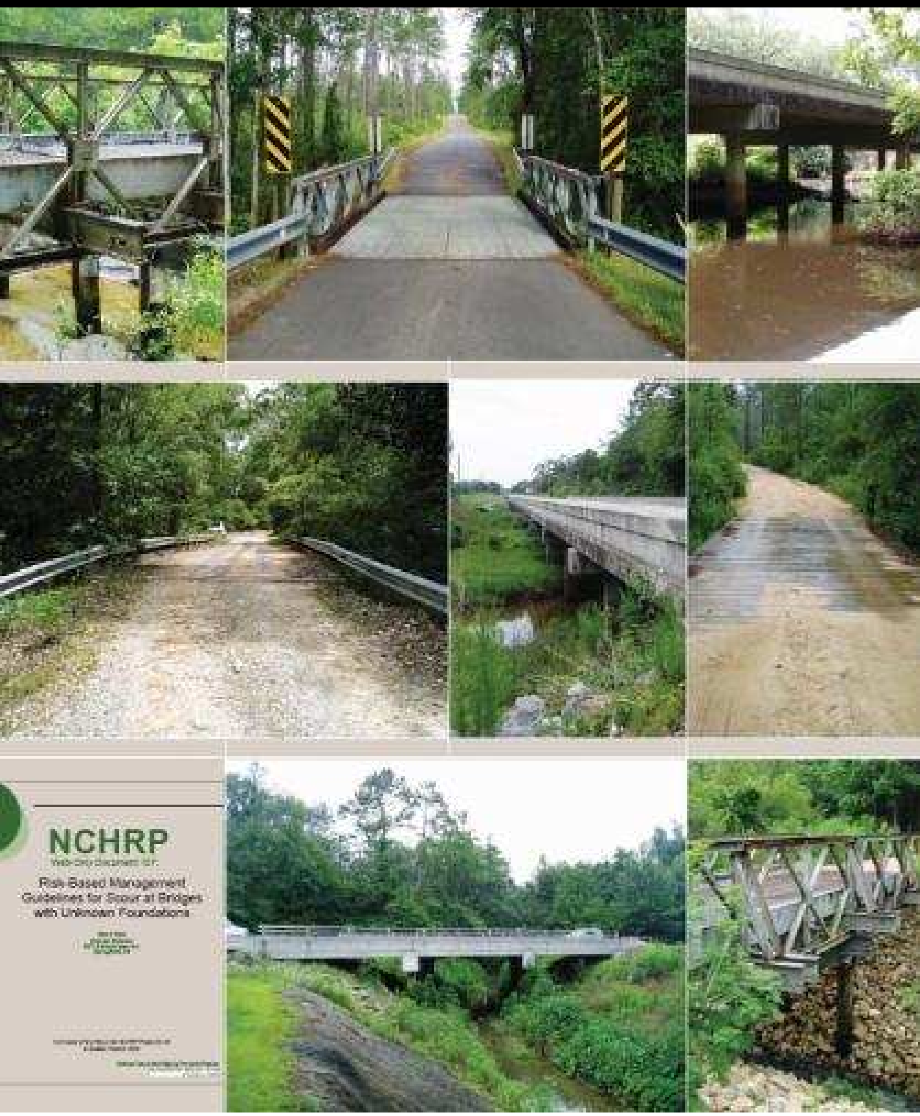
Florida Department of Transportation's Approach to Investigating and Resolving Unknown Foundations



Southeast Bridge Preservation Partnership Annual Meeting

Orlando, Florida

April 27, 2010

U.S. Department of Transportation Federal Highway Administration

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EGS, OEA & PSI

Unknown Foundation Background

Early 1990's the FHWA required all states to evaluate all bridges over water for scour susceptibility.

January 2008, Florida resolved all their bridges over water except for a number of Tidal, Scour Susceptible, and bridges with Unknown Foundations.

Florida committed to resolve all Remaining Tidal, Scour Susceptible bridges and bridges with Unknown Foundations on the interstate system by November, 2008.

FHWA issued a letter dated January 9, 2008 with a target date of November, 2010 to resolve all bridges with Unknown Foundations.

Unknown foundation inventory generally involves bridges built before 1985.

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Florida Unknown Foundation Bridge Statistics

On Federal Aid			Off Federal Aid			On State System Total	Off State System Total	Grand Total
On State System	Off State System	Total	On State System	Off State System	Total			
297	740	1037	2	1503	1505	299	2243	2542

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Pre-Production

Due to the “unknown” nature of the work FDOT decided to sequence the project into three phases.

1. Conduct Workshop to develop a Pilot Program.

2. Implement a Pilot Program evaluating the bridges in two counties (Collier and Alachua) to clarify and finalize the best procedure to address the remainder of the bridges, and also to secure the approval of the FHWA prior to statewide implementation.

3. Using the procedure in the Pilot Program initiate the Statewide Production Phase to address the remainder of the bridges.

Currently, FDOT has completed the Pilot Program Phase and has begun the Production Phase.

Florida Bridges

Famous Florida Bridges

Infamous Florida Bridges

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Unknown Foundation Bridges

Unknown Foundations

	Rural	Urban
Principal Arterial – Interstate	0	0
Principal Arterial - Other Freeways or Expressways	NA	32
Principal Arterial – Other	106	84
Minor Arterial	112	163
Major Collector	218	NA
Minor Collector	193	NA
Collector	NA	316
Local	841	449

- 51% on Local Roads
- Only 9% on Principal Arterials

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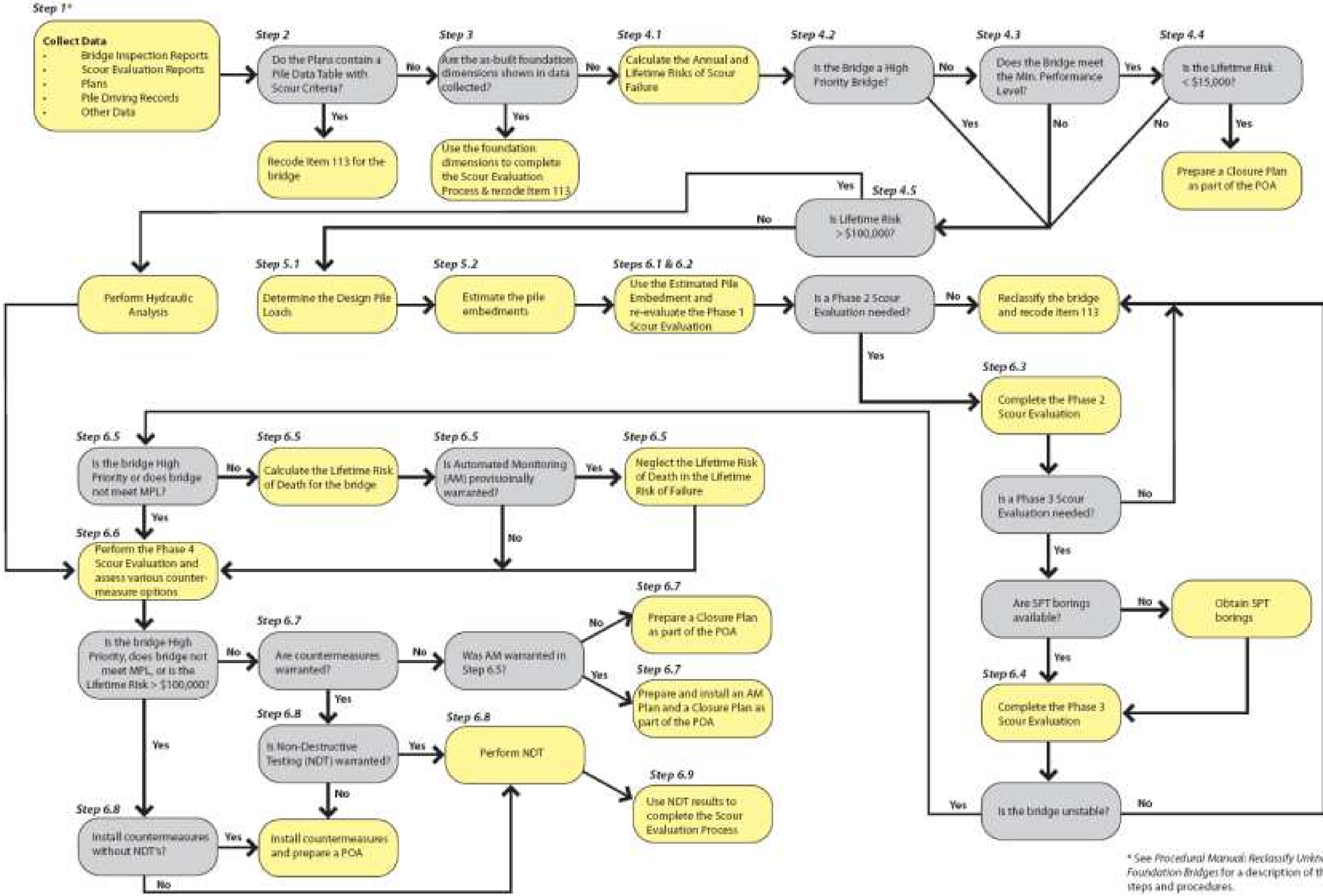
Unknown Foundations

- Bridge Length
  - 5% are 25’ or less
  - 34% are 50’ or less
  - 66% are 100’ or less
- Traffic
  - 14% have 50 or less ADT
  - 25% have 100 or less ADT
  - 39% have 500 or less ADT

Unknown Foundations Process



* See *Procedural Manual: Reclassify Unknown Foundation Bridges* for a description of these steps and procedures.

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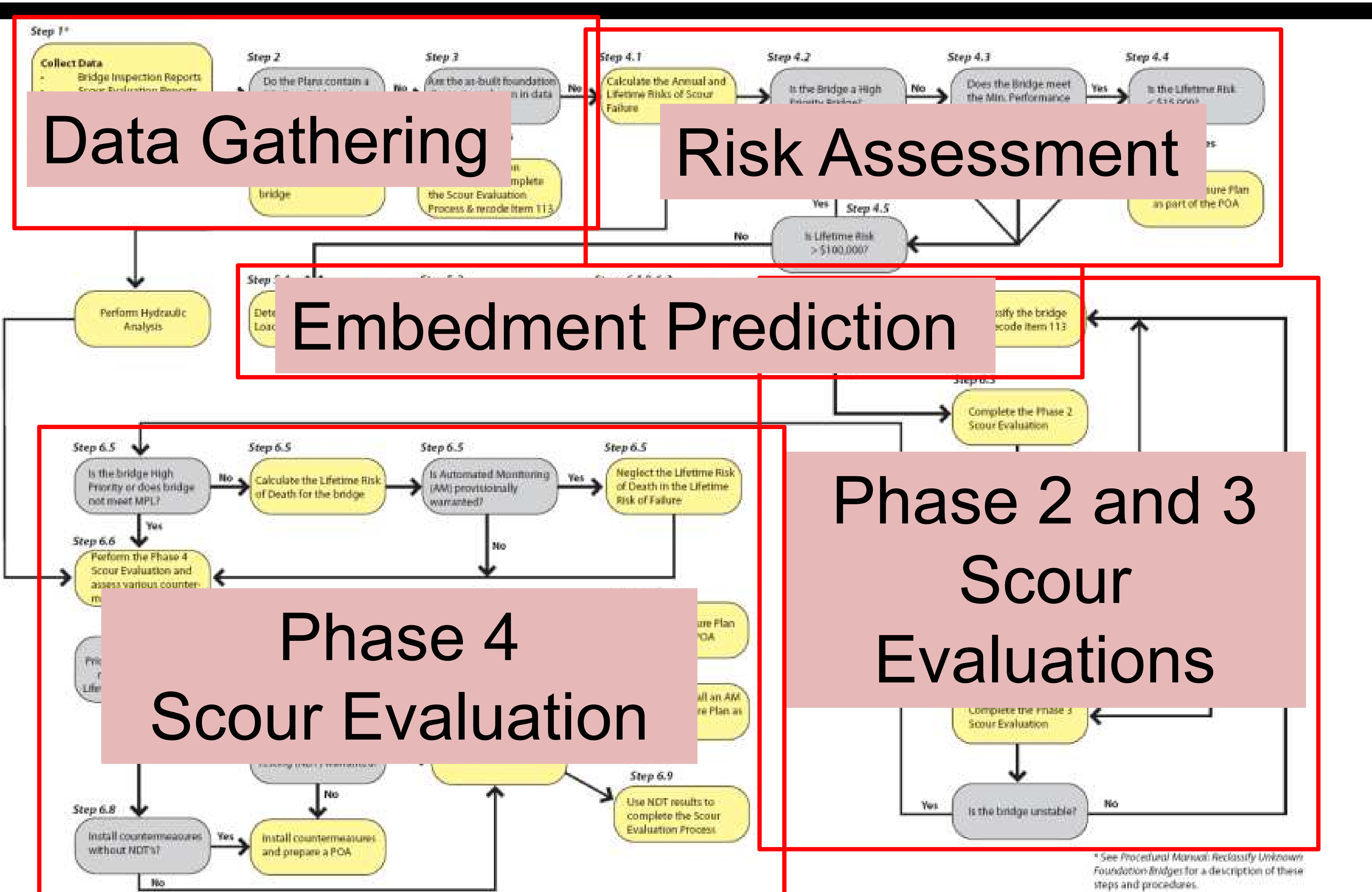
Unknown Foundations Process



* See Procedural Manual: Reclassify Unknown Foundation Bridges for a description of these steps and procedures.

Risk Calculation

- Follows the Procedure in NCHRP Web Only Document 107
  - Cost of failure
  - Probability of failure
  - Risk of failure

- Basic Equation:

  Risk = Cost of Failure x Probability of Failure

Modifications to NCHRP Process

- Florida Costs
  - Including duration of detour
- Rate of Failure due to Scour
  - Florida Failure Rate
  - Correction for Scour Vulnerability of 5
- Tidal Bridges

Cost of Failure

- Component Costs are:
  - Bridge replacement cost
  - Detour cost
  - Loss of life
- NBI data used to calculate
  - Bridge Length
  - Bridge Width
  - Maximum Span Length
  - Average Daily Traffic
  - Average Daily Truck Traffic (% of ADT)
  - Detour Length

Probability of Failure

- National Failure Rate:

  Approximately 1 in 5000 annually

- Florida Failure Rate based on survey

  Approximately 1 in 13,500 annually

- Florida Failure Rate based on procedure

  Approximately 1 in 8,000 annually

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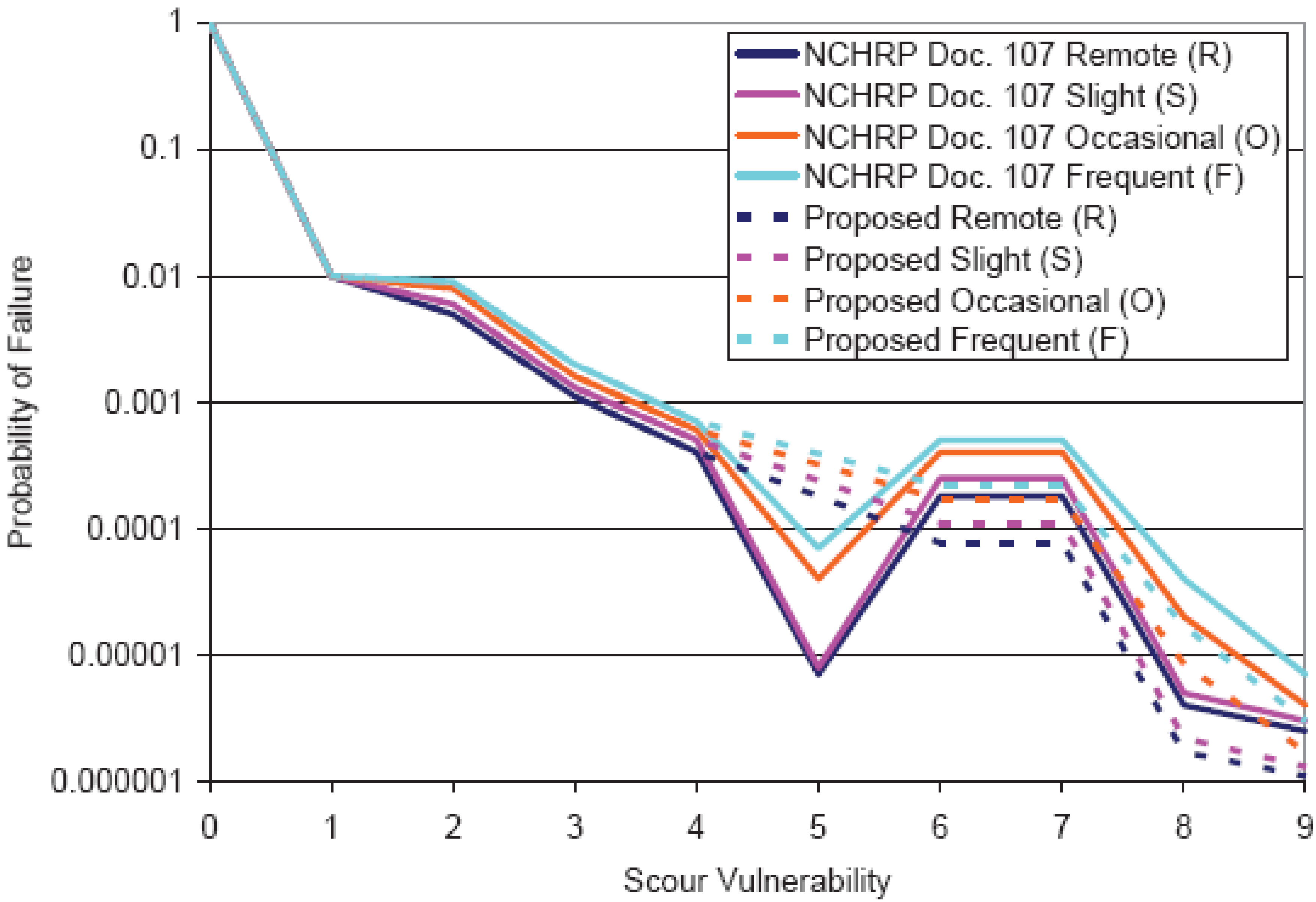
Annual Probability of Failure

	Overtopping Frequency / Scour Event Frequency			
Scour Vulnerability	Remote (R)	Slight (S)	Occasional (O)	Frequent (F)
0	1	1	1	1
1	0.01	0.01	0.01	0.01
2	0.005	0.006	0.008	0.009
3	0.0011	0.0013	0.0016	0.002
4	0.0004	0.0005	0.0006	0.0007
5	0.00018	0.00024	0.00032	0.00039
6	0.000077	0.00011	0.00017	0.00022
7	0.000077	0.00011	0.00017	0.00022
8	0.0000017	0.0000022	0.0000085	0.0000170
9	0.0000011	0.0000013	0.0000017	0.0000030

Annual Probability of Failure



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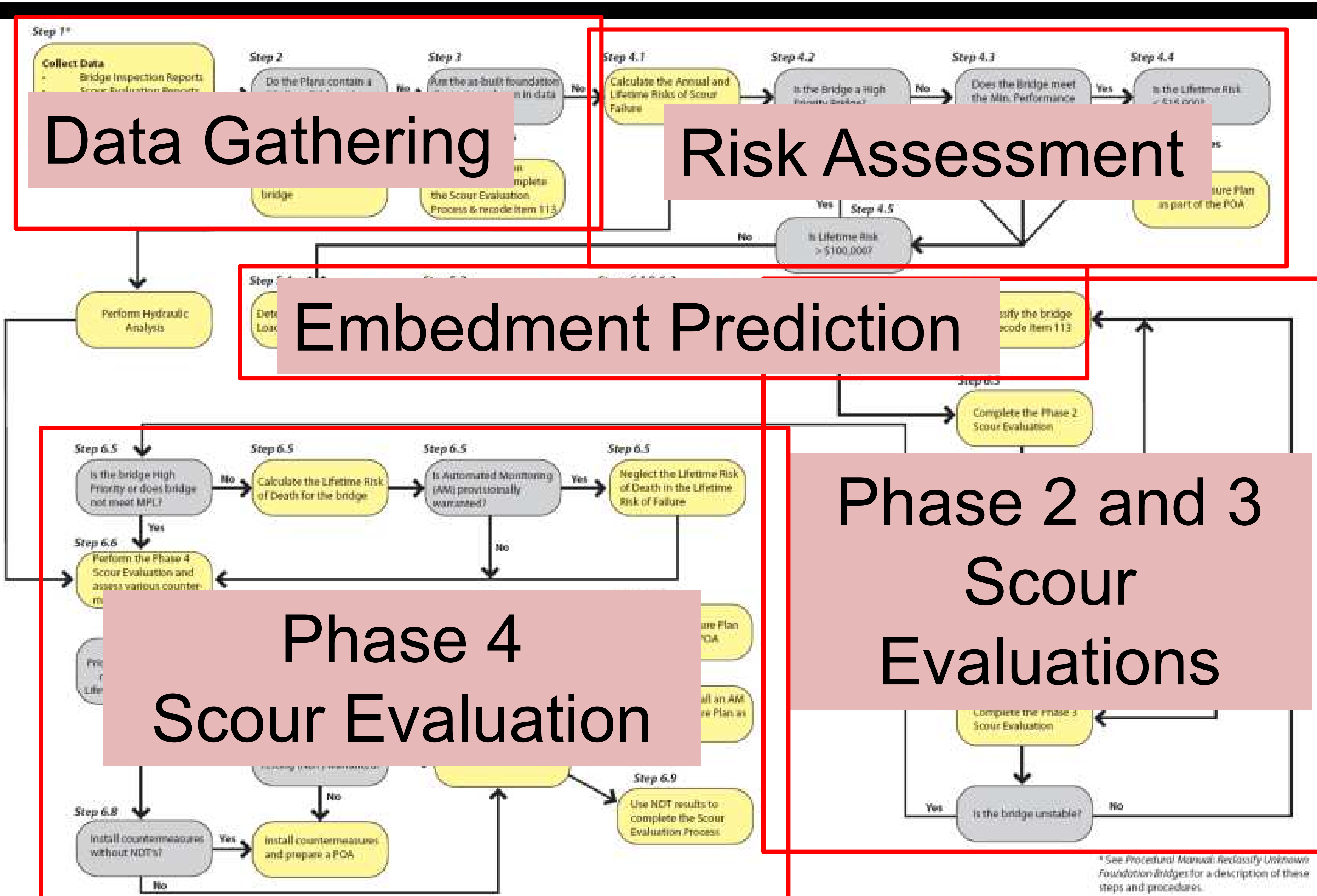
Risk Thresholds

- Lifetime Risk < $15,000
  - The minimum cost to provide any kind of protection at a bridge is at least $15,000.
  - Prepare a Plan of Action that includes a Closure Plan for the bridge.

- Lifetime Risk > $100,000
  - Do not estimate embedment depths with the techniques in Step 5
  - Recommend either Countermeasures or Non Destructive Testing

Unknown Foundations Process



* See *Procedural Manual: Reclassify Unknown Foundation Bridges* for a description of these steps and procedures.

Embedment Predictions

- Two methods:
  - Artificial Neural Network (ANN)
  - Geotechnical Analysis
- Design Pile Load
  - Plan Value
  - ANN
  - Reverse Engineering

Artificial Neural Networks

- Computational Tool That Mimics Pattern Recognition Capabilities of Human Brain
- Concept Initiated in 1943 by McCulloch and Pitts
- Used in Many Fields Including:
  - Engineering
  - Science
  - Business

Artificial Neural Networks

- How They Work
  - Like the brain, the ANN has to be trained
    - Requires cases where the answers are known

      (for this application must have number of bridges with known foundations)
    - Resulting program can be tested
      - Known foundation data set divided, 80% for training 20% for testing/verification

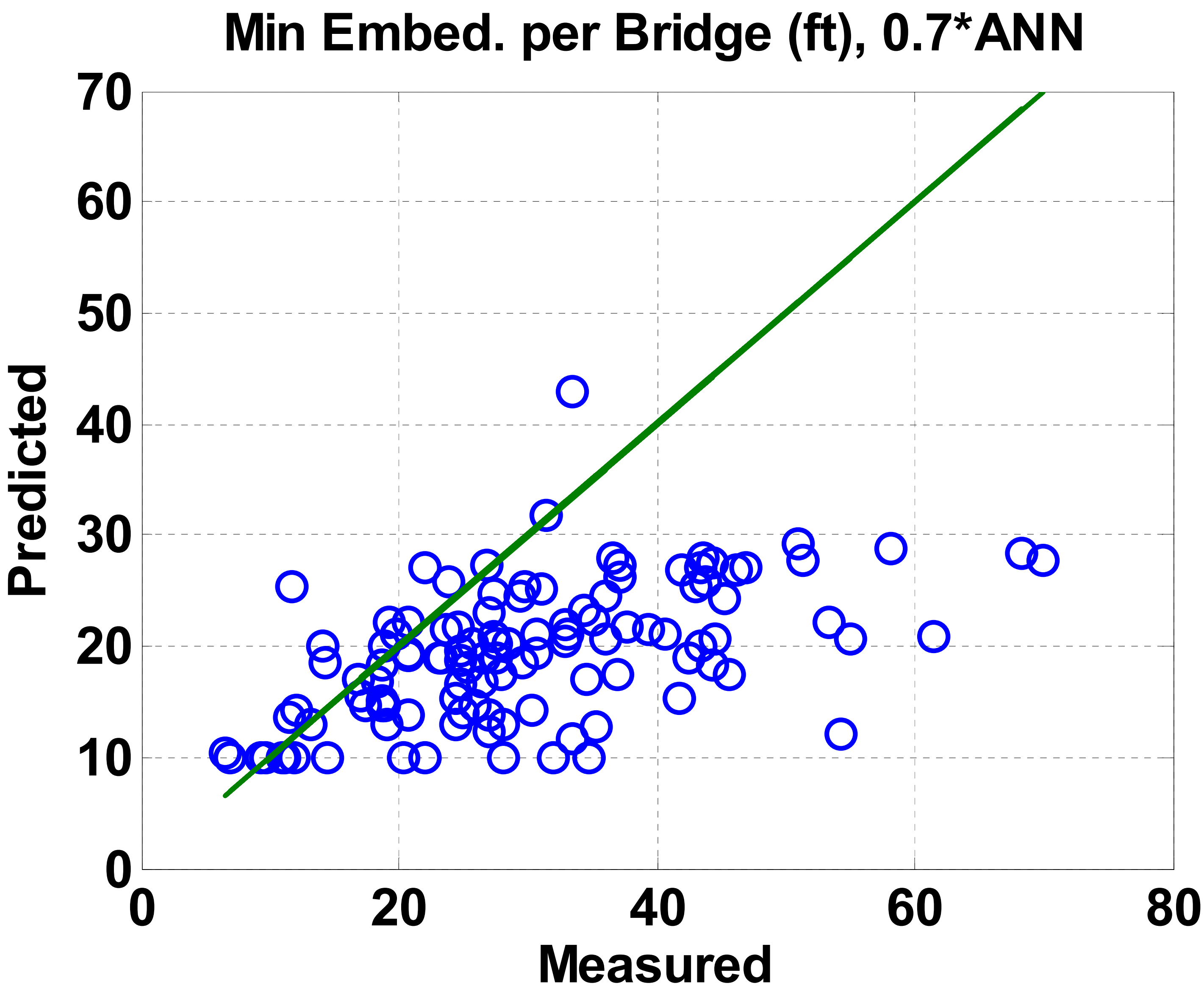
CPILE

- Properties:
  - Trained using 113 bridges from four FDOT districts
  - Embedments deeper than 70 ft are capped at 70 ft
  - Minimum embedment depth is 10 ft
  - Requires bridge and boring information
  - Outputs minimum embedment per bridge and per bent

CPILE ANN Input Parameters

- Pile size
- Pile Design Load
- Slope of the bearing capacity curve between 0 and 20 ft
- Slope of the bearing capacity curve between 20 and 40 ft
- Pile construction year

CPILE Testing Per Bridge



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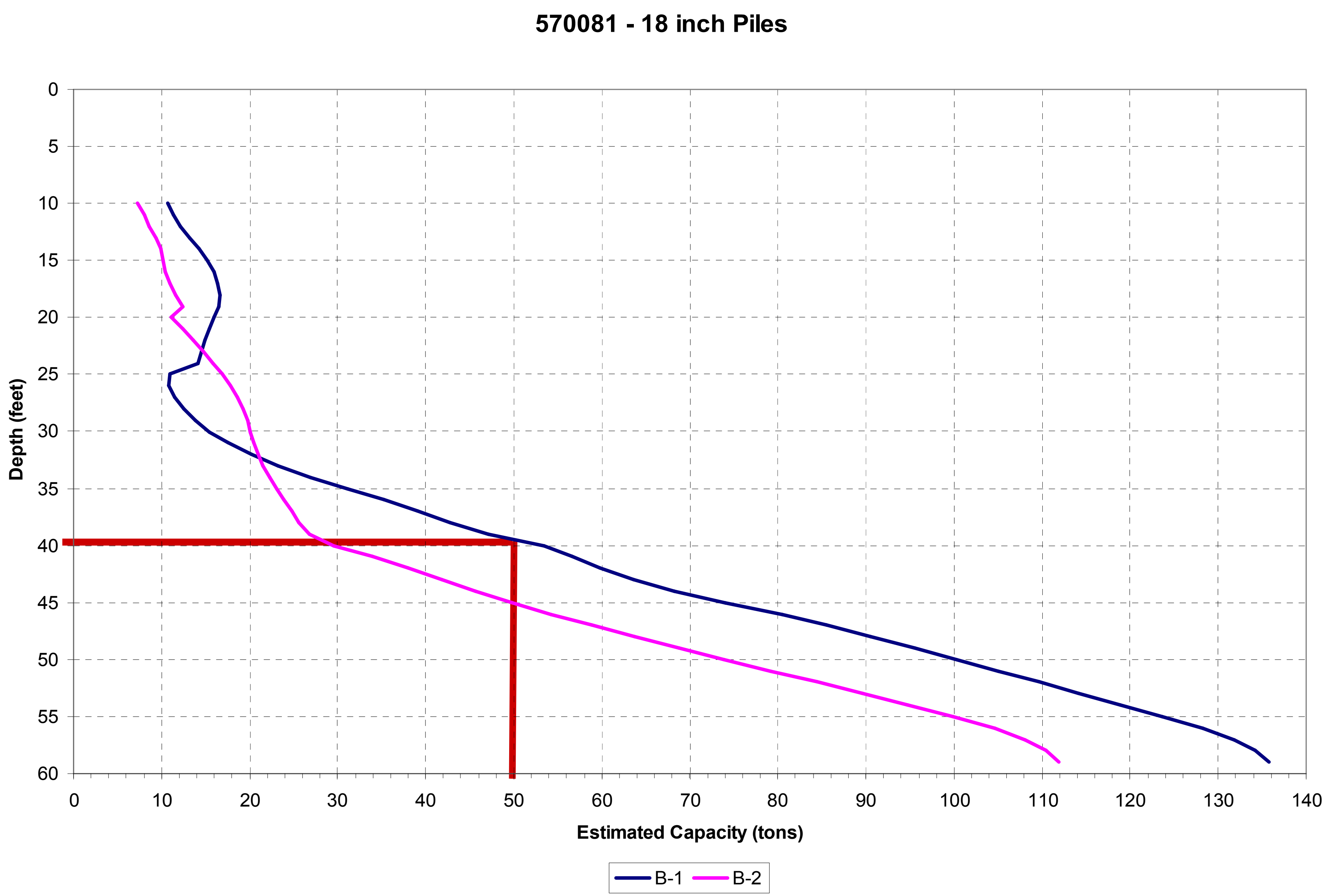
Geotechnical Considerations

- Geotechnical Aspects
  - Collect and Review Existing Bridge Foundation Data
  - Analyze the Existing Soils Information
    - SPT Boring Data
    - Wash Borings
    - No Boring Data

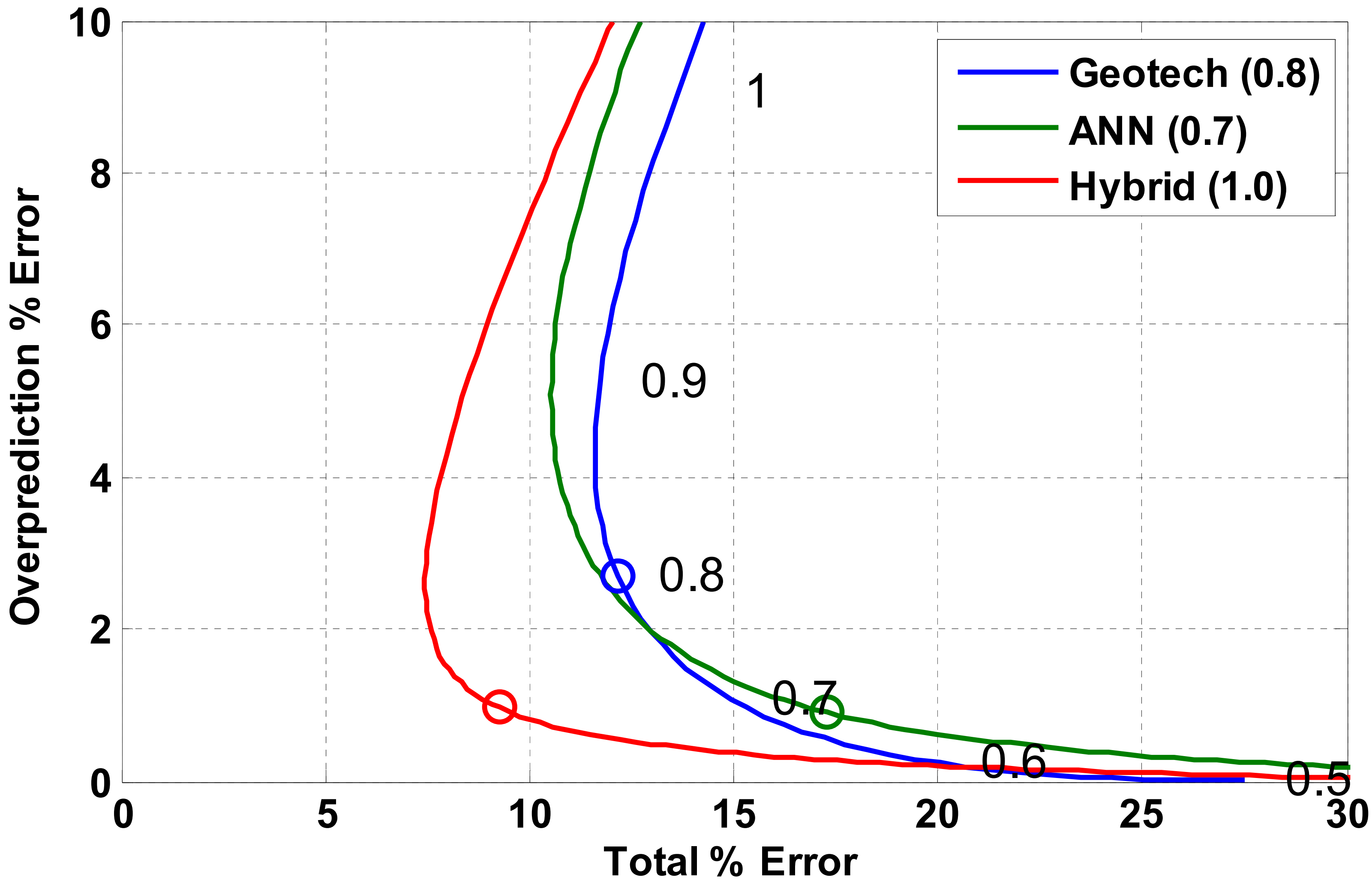
Geotechnical Considerations

- Analyze the Existing Data
  - SPT Data
    - Run FB-Deep on soils borings (adjust for boring location)
    - Use the “Allowable Capacity” curve unless LRFD was used in design, then the “Davisson Capacity” curve would be used.
    - Was hard rock/cap rock encountered?
    - Determine Estimated Pile Penetration
    - Take the Estimated Pile Penetration and multiply it by 0.8
  - Wash Borings
  - No Data

Geotechnical Considerations



Comparison of Methods



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NDT

- Data gathering
  - Literature search
  - Survey of States using NDTs
  - Survey of experts in the field
- Guidance on selecting the best NDT
- Guidance on estimating the cost of NDT

Summary of Process

- Perform Risk Analysis
  - Low risk, finished
  - High risk, NDT and/or countermeasures
  - Medium Risk
    - Analyze bridge

Summary of Process

- Analyze bridge
  - Determine pile load
    - Use plan values, PLOAD, or Reverse Engineering
  - If concrete piles, use CPILE and Geotechnical Analysis
  - If steel or timber, use Geotechnical Analysis
  - Perform Scour Evaluation

Summary

- A risk assessment is a cost effective way to prioritize unknown foundation evaluations
- Reasonably conservative pile embedment estimates can be made and used to evaluate the scour susceptibility of a bridge

Questions?