Indiana Historic Bridge Inventory

Volume 3: Methodology to Identify Select and Non-Select Bridges

INDOT CC No. 050108

Prepared for

Indiana Department of Transportation

Prepared by

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1. Executive Summary

In fulfillment of Stipulation II.B of the Indiana Historic Bridge Programmatic Agreement (PA) executed August 11, 2006, this report presents a structured methodology "to identify historic bridges that are most suitable for preservation and are excellent examples of a given type of historic bridge." These bridges are referred to as Select Bridges. The multi-step methodology relied on several data inputs to evaluate each historic bridge in a way that is both transparent and replicable. In keeping with Stipulation II.B of the PA, the Indiana Department of Transportation (INDOT), with input from the Historic Bridge Task Group, County Commissioners, and the public, determined each historic bridge as either Select or Non-Select following this methodology. The Federal Highway Administration (FHWA) and Indiana State Historic Preservation Office (INSHPO) subsequently issued a final list of Select and Non-Select Bridges.

As directed by the PA, this methodology balances engineering and historical considerations to provide a means of classifying bridges as Select or Non-Select. Identification of bridges that are "most suitable for preservation" is based on a Condition Score that measures the functionality, safety, feasibility, and cost-effectiveness of preservation for continued vehicular use. Identification of bridges that are "excellent examples of a given type" is based on a bridge's historical significance and integrity compared with other bridges of the same structural type, as measured by its Eligibility Score. Eligibility Scores result from evaluations of bridges conducted in 2007 and 2008 to fulfill another requirement of the PA. Historic bridges are documented in the *Indiana Historic Bridge Inventory Volume 1: National Register Eligibility Results and Volume 2: Listing of Historic and Non-Historic Bridges* (February 2009), and the scores are provided in the *Historic Bridge Inventory Database*. Both Condition and Eligibility Scores are used to prioritize bridges for Select consideration. Where specified by the prioritization process, individual reviews are conducted for bridges to further assess preservation potential.

This methodology prioritizes historic bridges for preservation in comparison to other bridges of the same type. Bridges determined as Select are relatively better candidates for preservation based on their present condition and potential to remain in use for years into the future without a significant rehabilitation effort. Non-Select Bridges are relatively poor candidates for preservation based on their present condition and would require a more significant rehabilitation effort. Non-Select status does not preclude a bridge from being preserved, but it does indicate that a greater effort would be required to restore the bridge to vehicular service. Non-Select Bridges, even if rehabilitated, may not achieve the required functionality and/or meet safety standards. It should also be recognized that some Select Bridge candidates may require design exceptions to remain in vehicular use.

The methodology to identify Select Bridges is a tool to fulfill certain requirements of the PA. The PA was executed pursuant to the regulations implementing Section 106 of the National Historic Preservation Act of 1966 (Section 106) (16 U.S.C. 470f). Neither the PA nor this methodology is intended to fulfill requirements of Section 4(f) of the U.S. Department of Transportation Act of 1966 that apply to historic bridges. Application of this methodology, together with the *Treatment of Historic Bridge on Low-Volume Local Road* standards (April 2007), may provide some of the information considered under the Section 4(f) analysis that will be undertaken for an individual bridge during implementation of the project development process defined in the PA.

2. Definitions

Bridge type – A grouping of bridges with similar structural members and material composition. A multi-span structure may include more than one bridge type and/or subtype. For the Indiana Historic Bridge Inventory, bridges are analyzed by their main span type. See Table 1 for a list of bridge types and subtypes.

Character-defining features – Prominent or distinctive aspects, qualities, or characteristics of a historic property that contribute significantly to its physical character. For historic bridges, such features may include structural or decorative details and materials.

Condition Score – Calculated for a historic bridge to assess whether or not the bridge can prudently and economically be preserved in vehicular use. The Condition Score was developed for this methodology to isolate and measure controlling elements to understand if a bridge can be rehabilitated (see Appendix A for more information on Condition Score). It draws from National Bridge Inventory (NBI) data as defined below to measure the functionality, safety, feasibility, and cost-effectiveness of preservation for vehicular use based on their condition, as inspected. This score is used to identify bridges that are "most suitable for preservation" by ranking bridges as High, Medium, or Low (see *Figure 2. Selection Matrix* for more information).

Eligibility Score – Used to identify bridges that are "excellent examples of a given type," this measures a bridge's historic significance as compared to other bridges of its type. The Eligibility Score results from applying the points system to evaluate the National Register of Historic Places (National Register) eligibility of bridges as part of the Indiana Historic Bridge Inventory. See Appendix C for more information on Eligibility Score. This score is used to rank bridges as High, Medium, or Low (see Figure 2 *Selection Matrix* for more information). Subtypes within a type that have important design features or represent unusual variations receive a higher Eligibility Score in the points system. For example, the assignment of a higher Eligibility Score distinguishes subtypes such as the Whipple and Luten within the metal thru truss and concrete arch types, respectively. Bridges that were previously National Register listed or determined eligible receive a "high" Eligibility Score.

Functional obsolescence – The FHWA classification of a bridge that cannot meet current traffic needs because of inadequate horizontal or vertical clearance, inadequate load-carrying capacity, and/or insufficient opening to accommodate water flow under the bridge. While structural deficiencies are generally the result of deterioration of bridge components, functional obsolescence results from changing traffic demands on the structure.

Historic bridge – A bridge that has been listed in or determined eligible for the National Register. According to the methodology used for this project, bridges with an Eligibility Score of 1 or greater are considered eligible for listing in the National Register.

Low volume road – A road that is projected to carry future Average Daily Traffic (ADT) less than 401.

National Bridge Inventory (NBI) – Bridge inventory and appraisal data collected by the FHWA to fulfill the requirements of the National Bridge Inspection Standards. Each state maintains an inventory of its bridges subject to these standards and sends an annual update to the FHWA. During a bi-annual inspection, components of bridges are assigned ratings by a certified bridge inspector. NBI ratings of 5 or better indicate satisfactory condition. The NBI includes county and state owned bridges for which INDOT has some jurisdiction.

Non-vehicular bridge – Non-vehicular bridges include:

- Non-National Bridge Inventory (NBI) bridges that were identified through public involvement efforts for this project that do not carry motorized traffic

- NBI bridges that are open for pedestrian or other non-vehicular use but do not carry motorized traffic

No Select/Non-Select determinations were made for non-vehicular bridges unless the owner indicated an intent to re-open the crossing. An exception is made for non-vehicular bridges with a preservation commitment, as described below.

Preservation – As used in this report, this term refers to historic preservation that is consistent with the Secretary of the Interior's *Standards for the Treatment of Historic Properties*. Historic preservation means saving historic bridges from destruction or deterioration, and providing for their continued use by means of restoration, rehabilitation, or adaptive reuse. It is the act or process of applying measures to sustain the existing form, integrity, and material of a historic bridge, and its site and setting. The FHWA's Highway Bridge Replacement and Rehabilitation Program (HBRRP) describes preservation differently, focusing on repairing or delaying the deterioration of a bridge whether classified as historic or not.

Preservation commitment – Bridges with both documented and undocumented preservation commitments as follows:

Documented commitments: A bridge with a Memorandum of Agreement (MOA) signed by the FHWA, INDOT, and INSHPO; and a bridge with an executed Transportation Enhancement grant with a designation number.

Undocumented commitments: A bridge with evidence of a preservation commitment based on recent rehabilitation project as reported through public involvement efforts conducted for this project. For covered timber truss bridges only, preservation commitments were also recorded based on visual appearance that a bridge is actively maintained.

The methodology provides for historic bridges with preservation commitments to be automatically considered Select Bridges whether currently in vehicular or non-vehicular use.

Structurally deficient – Classification indicating poor structural condition for any of the following: deck, superstructure, substructure, or culvert (if applicable). A structurally deficient bridge is restricted to lightweight vehicles; requires immediate maintenance or rehabilitation to remain open to traffic or replacement.

Vehicular bridge – A bridge that actively carries motorized traffic on the local or state roadway system.

3. Applicability

This methodology applies to Indiana's historic bridges located on public roads and within the public right-of-way that are in vehicular use, will be re-opened for vehicular use, or have an existing preservation commitment (see Section 2 – Definitions). Historic bridges in Indiana include bridges recommended eligible as part of the Indiana Historic Bridge Inventory and bridges that were previously determined eligible or listed in the National Register, including contributing resources in historic districts. The following categories of bridges are excluded:

1. Bridges built after 1965

2. Bridges that are privately or railroad owned

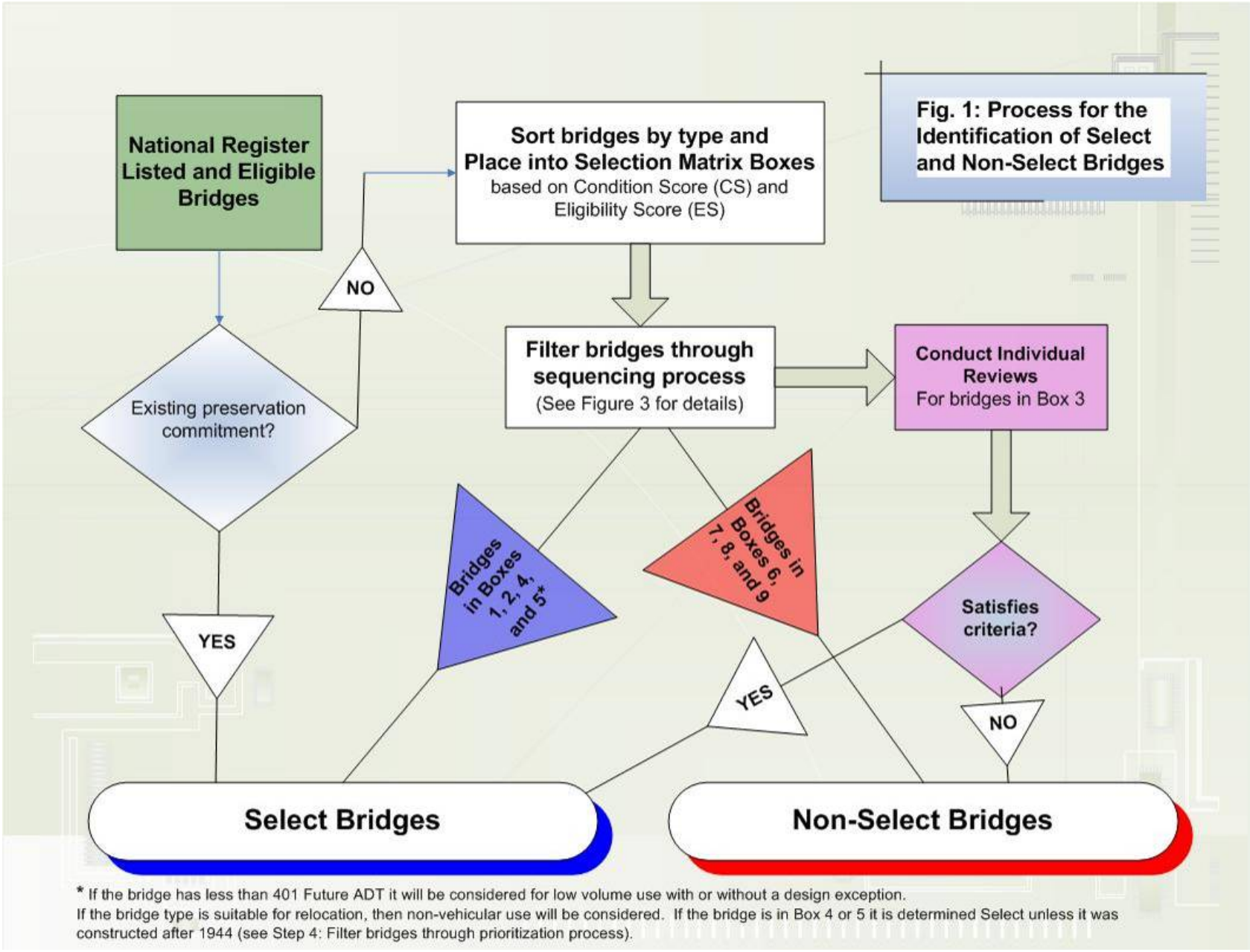
3. Bridges for which INDOT does not have primary maintenance responsibility (including bridges maintained by other state and federal agencies)

4. Border bridges with shared jurisdiction

5. Non-vehicular or closed bridges (unless owners have stated that they will be re-opened for motorized traffic following rehabilitation)

4. Methodology

As stipulated in the PA for Indiana's historic bridges, this methodology is used to "identify historic bridges that are most suitable for preservation and are excellent examples of a given type of historic bridge." Such bridges are referred to as Select Bridges. To achieve balance between engineering and historical considerations, two scores are used to determine Select Bridge candidates. The Condition Score identifies bridges within each type that are "most suitable for preservation" based on functionality, safety, feasibility, and cost-effectiveness of preservation for continued vehicular use. The Eligibility Score identifies bridges that are "excellent examples of a given type" based on historic significance and integrity as compared to other bridges of the same type. These scores are used to prioritize historic bridges for preservation in comparison to other bridges of the same type. Where specified by the prioritization process, individual reviews are conducted to determine if a bridge is suitable for preservation for continued vehicular use. If its structural type is suitable for relocation, it is also considered for preservation as a non-vehicular bridge when vehicular use may not be appropriate. *Figure 1* illustrates the overall process for identifying Select and Non-Select Bridges.



* If the bridge has less than 401 Future ADT it will be considered for low volume use with or without a design exception. If the bridge type is suitable for relocation, then non-vehicular use will be considered. If the bridge is in Box 4 or 5 it is determined Select unless it was constructed after 1944 (see Step 4: Filter bridges through prioritization process).

Step 1: Prepare data for review

- Identify historic bridges where replacement of this historic bridge has already been determined and documented in an approved Memorandum of Agreement that concludes the Section 106 process. These bridges do not receive Select/Non-Select determinations.

- Identify historic bridges currently in non-vehicular use that do not have preservation commitments and where the owner has not indicated intent to re-open the crossing. These bridges do not receive Select/Non-Select determinations.

- Identify historic bridges with an existing preservation commitment. Such bridges are categorized as Select Bridges and no additional evaluation is conducted.

- Compute Condition Score according to the *Condition Score Calculation* illustrated in Appendix A for each bridge. The Condition Score isolates factors that typically control whether a bridge can be prudently and economically rehabilitated for vehicular use.

- Collect Eligibility Score from the *Indiana Historic Bridge Database* for each historic bridge. The Eligibility Score of each bridge is used to rank its historic merit so that excellent examples of a given type can be given priority (see *Appendix C. Eligibility Score Ranking Method* for details).

Step 2: Conduct quality review of data

- Historic bridges with poor NBI condition ratings (e.g. superstructure or substructure rated 4 or below) were reviewed to assess appropriateness of these component ratings. During the assessment, images taken during the field survey and INDOT bridge inspection files were reviewed by bridge inspectors. If this data did not provide sufficient information to make an assessment, the inspector went on-site to assess the poorly rated component. In most cases, inspectors agreed with the poor ratings. In other cases, a recent rehabilitation project had improved the components but the new NBI ratings were not yet reflected in the NBI data. The new data was then applied to facilitate an individual review of the subject bridge.

- For a small number of bridges, certain NBI data needed to calculate a bridge's Condition Score was unavailable. With each case, the necessary assessment could be made with substitute data. For example, deck geometry (NBI Item 68) is not provided in the NBI for structures that are constructed with under fill; in this case, the approach roadway alignment appraisal rating (NBI Item 72) was substituted. Waterway adequacy is not provided for bridges that do not span waterways. In this case, a positive value was inserted so that this data would not lower a bridge's Condition Score. In a handful of cases where bridges had no structural evaluation, NBI data was supplemented by photographs or inspection information provided by the county or INDOT.

- For some bridges, certain NBI data inputs (Items 68 and 71) into a bridge's Condition Score were recorded as zero, indicating a closed structure. After confirming that the structure was not

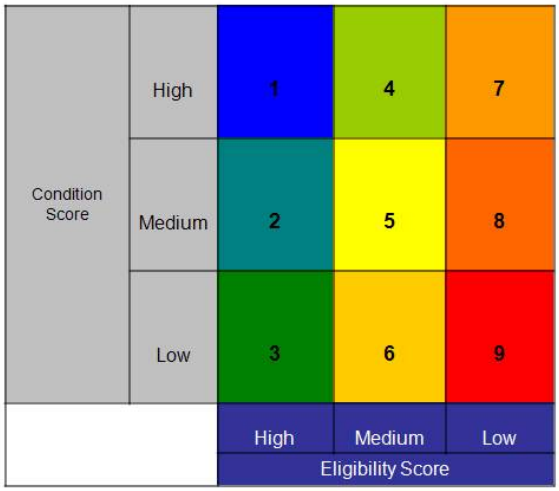
closed, inspectors reviewed the bridge to see if it could meet applicable standards including low volume. Due to the quality review process, the incorrect data did not influence the outcome. Results are included in the notes field that describes the Select considerations for each bridge.

Step 3: Sort bridges into Selection Matrix

- Sort the pool of historic bridges within each bridge type (see *Table 1. Bridge Types*) based on a combination of each bridge's Condition and Eligibility Scores. The matrix defines high, medium, and low values for both Condition and Eligibility Scores (see *Figure 2. Selection Matrix*). It was developed for this methodology as a tool to determine a bridge's priority for consideration as a Select Bridge.

- For each bridge type, place bridges into the appropriate Selection Matrix Box. For example, a bridge with both a high Condition Score and a high Eligibility Score is placed into Box 1. Likewise, a bridge with both a low Condition Score and a low Eligibility Score is placed into Box 9.

Figure 2. Selection Matrix



Eligibility Score:
High values are more than 1 standard deviation above the mean Eligibility Score value for the bridge type

Medium values are within 1 standard deviation of the mean Eligibility Score value for the bridge type

Low values are less than 1 standard deviation below the mean Eligibility Score value for the bridge type

Condition Score:
High values have a Condition Score >=40

Medium values have a Condition Score = 35-39

Low values have a Condition Score < 35

Table 1
Bridge Types

Bridge Type	Subtype
Concrete arch	Reinforced concrete arch
	Open spandrel reinforced concrete arch
	Unreinforced concrete arch
	Thru reinforced concrete arch
	Reinforced concrete arch - under fill
	Precast concrete arch - under fill
	Continuous reinforced concrete arch
Metal arch	Metal pipe arch (round pipe)
	Thru steel arch
	Multiplate - under fill
	Aluminum arch
	Aluminum multiplate arch - underfill
Metal pony truss	Warren
	Parker
	Pratt
	Other variations
	Bailey truss
	Iron pony truss
Metal thru truss	Baltimore
	Other variations - Double-intersection Warren, Triple-intersection Pratt (Whipple), Camelback
	Parker
	Pennsylvania
	Pratt
	Warren
	Iron thru truss
Prestressed concrete box beam	Prestressed concrete box beams - multiple
	Prestressed concrete box beams - spread
	Continuous prestressed concrete box beams - multiple
	Continuous prestressed concrete box beams – spread
Prestressed concrete I-beam	Prestressed concrete I-beam
	Prestressed concrete tee beam
	Continuous prestressed I-beam

Table 1
Bridge Types

Bridge Type	Subtype
Reinforced concrete girder and beam	Reinforced concrete girder
	Reinforced concrete beam
	Reinforced concrete girder – transverse girder/floor beam system
	Reinforced concrete tee beam
	Reinforced concrete box girder - multiple
	Reinforced concrete girder - under fill
	Precast concrete beam
	Continuous reinforced concrete girder
	Continuous reinforced concrete girder – transverse girder/floor beam system
	Continuous reinforced concrete tee beam
Reinforced concrete rigid frame and box	Reinforced concrete rigid frame
	Reinforced concrete box - under fill
	Continuous reinforced concrete rigid frame
	Continuous reinforced concrete rigid box
	Continuous reinforced concrete box - under fill
Reinforced concrete slab	Reinforced concrete slab
	Reinforced concrete slab - under fill
	Continuous reinforced concrete slab
Steel beam	Encased steel beam
	Simple steel beam
	Composite steel beam
	Welded steel thru girder-floor beam system
	Steel beam floor beam system
	Continuous steel beam
	Continuous encased steel beam
	Composite continuous steel beam
Steel deck truss	Steel deck truss
Steel girder	Riveted plate girder
	Simple steel girder
	Composite steel girder
	Simple steel girder-floor beam system
	Riveted plate girder-floor beam system
	Continuous riveted plate girder - floor beam system
	Composite continuous riveted plate girder - floor beam system
	Continuous steel girder
	Composite continuous steel girder
	Continuous riveted plate girder
	Continuous steel girder - floor beam system

Table 1
Bridge Types

Bridge Type	Subtype
Steel movable	Bascule
Stone arch	Stone arch
	Masonry culvert - under fill
Timber other	Timber slab
	Timber beam
	Timber girder
	Timber trestle
Timber truss	Timber covered bridge

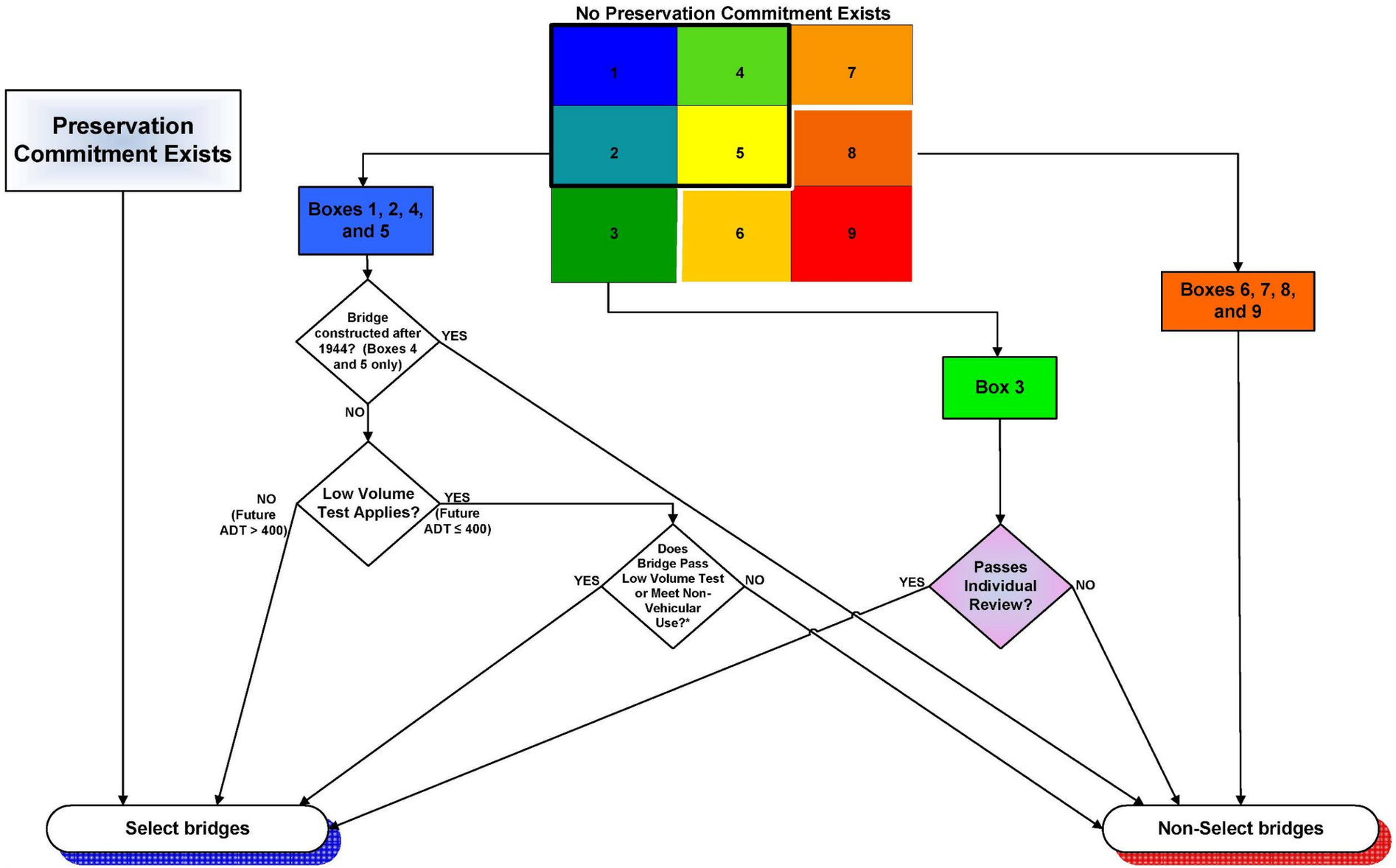
Step 4: Filter bridges through prioritization process

This step involves filtering bridges through a process designed to identify excellent examples of each type that are the most suitable bridges for preservation. Historic bridges are prioritized using the filtering process described below and illustrated in Figure 3. The first priority is bridges in Boxes 1, 2, and 3 that have a high Eligibility Score. Box 1 and 2 are programmatically determined Select and Box 3 requires individual review to confirm Select status (see Step 5). The second priority is bridges in Boxes 4 and 5 that have a medium Eligibility Score and high or medium Condition Score. These are programmatically determined Select unless they were constructed after 1944.[1] Bridges in Boxes 6, 7, 8, and 9 are programmatically determined Non-Select due to their low priority through combination of Eligibility and Condition Scores.

Programmatically determined Select Bridges with a Future ADT of less than 401 are subjected to the Low Volume Road Test (see *Appendix B. Low Volume Road Test*). If a bridge carries a low volume of traffic, it must meet the Low Volume Road Test with or without exception to be considered a Select Bridge. If a bridge cannot meet an exception to the Low Volume Road Test, but its type is suitable for relocation, that bridge is considered for preservation in a non-vehicular use.

[1] Bridges constructed during the post World War II period (1945-1965) must have a high Eligibility Score to be considered Select.

Figure 3. Bridge Filtering Process



* Bridges may pass Low Volume Test with or without exception. If the bridge type is suitable for relocation, then non-vehicular use will be considered.

Step 5: Individual review

For bridges in Box 3, which possess a low Condition Score, individual review is conducted to determine if the bridge is suitable for preservation based on functionality, safety, feasibility, and cost-effectiveness of preservation for continued vehicular use. If its structural type is suitable for relocation, it is also considered for preservation as a non-vehicular bridge when vehicular use may not be acceptable based on accepted standards for load capacity and roadway width. Sample Individual Review Forms are included in Appendix E.

The following assessment is made for each bridge requiring individual review to determine if it is a Select or Non-Select Bridge:

- Identify deficiencies that affect serviceability leading to low Condition Score.

- Identify character-defining features from the *Historic Bridge Inventory Database* and field survey photos.

- Apply the series of checks, as outlined in *Figure 3. Bridge Filtering Process*, to individually review the candidate bridge. The maximum number of points a candidate bridge can receive is 100. The points are determined from the Condition Score (multiplied by 0.25), the Eligibility Score (multiplied by 0.5), and points awarded based on the outcome of five checks (see Figure 4. Individual Review Process). The point total serves as a guide for assessing suitability for preservation as compared to other bridges within the type. Suitability for vehicular preservation is considered in the following five checks:

    1. Determine the capability to bring the primary components of the bridge (superstructure and substructure) to a satisfactory condition (NBI condition 5 or better). This check assesses if the superstructure and substructure are either already satisfactory or can be prudently rehabilitated to meet this condition based on the NBI rating guidelines. If the primary components are in poor condition, it will take more resources to preserve the bridge.

    2. Identify if the bridge has adequate load capacity for the roadway system. This check assesses if the capacity is either already satisfactory or can be rehabilitated to meet the required capacity for the functional classification of roadway. A bridge may be in excellent condition but has poor load capacity. Bridges with adequate load capacity are better candidates for vehicular use. If the bridge is on a low volume road, determine if it has adequate load capacity per the Low Volume Road Test (see *Appendix B. Low Volume Road Test*).

    3. Determine whether or not the bridge is functionally adequate based on its geometrics. This check assesses if the clearances, lane widths, and shoulder widths are appropriate for the roadway system. Functionally obsolete bridges are more difficult to maintain on a vehicular system. If the bridge is on a low volume road, this check also includes consideration of whether a bridge can meet the functional standards for low volume roads with or without a

design exception (see *Appendix B. Low Volume Road Test)*. It was determined that there is reasonable likelihood that a design exception can be obtained if the roadway width or capacity are slightly less than specified, or detour length or Future ADT are slightly more than the defined standard. In these cases, bridge owners will be required to apply for a design exception from INDOT. Section 5 - *Special Circumstances and Periodic Updates* provides further information on this process.

4. Determine if deficiencies of the bridge are associated with the character-defining features. The potential for rehabilitation to address deficiencies is considered in this check. Any needed improvements, such as widening or strengthening, are assessed to see if they can be accomplished without negatively affecting character-defining features and thus compromising a bridge's historic integrity and eligibility. If major deficiencies are associated with the character-defining features, there is a greater likelihood the historic integrity of the bridge would be lost through required preservation efforts.

5. To assess additional factors relevant for preservation, nominal consideration was given to the following factors. Counties were contacted to obtain information on salt use and joint details. For a small number of bridges, counties could not be reached; therefore a "no" result was assumed.

    - Use of salts – Bridges that have been salted to prevent icy conditions during the winter are likely to be contaminated with chlorides, leading to premature decay and a shorter life expectancy. This applies to both concrete and steel bridges.

    - Sag vertical curves – Bridges located in sag vertical curves are likely to have additional roadway drainage, which may accelerate deterioration of components. Sag vertical curves connect the roadway grades on each side of a depressed feature (e.g. a valley). They typically contain the "low point" of a section of roadway that receives roadway drainage from two directions. The presence or absence of sag curves was discerned from review of bridge photographs.

    - Open deck joint details – Permit roadway drainage to accelerate the deterioration of components. The presence or absence of open deck joints was discerned from review of bridge photographs and/or owner information.

    - Unusually high accident rates – Indicate safety issues that need to be addressed. Indiana Local Technical Assistance Program (LTAP) provided accident history data based on reports of injury, property, and fatality accidents, if any, occurring on or near the bridge in the last five years. Since very few bridges had any accident history, any reported accidents were considered to be a high rate. Accident history was further assessed to determine whether or not a bridge's geometry could be a contributing factor to accident occurrence. If no accident exists, the field is blank and bridges were awarded points to not be penalized.

  - Long detours – Bridges with inadequate load capacity requiring long detours for emergency vehicles are less attractive for preservation due to the increased response time if the bridge was load posted or closed. The detour length is obtained from NBI data, and INDOT's *Low Volume Road Standard* is applied.

- If a bridge is not acceptable for vehicular use and its structural type is suitable for relocation, it is considered for preservation as a non-vehicular bridge. Types that are suitable for relocation are metal arch, steel beam, metal thru and pony truss, steel girder, and timber truss. Non-vehicular use on-site may also be feasible but would need to be determined during planning for a specific project and was not considered as part of this methodology. If primary components of the structure can be restored to an acceptable level for non-vehicular use without destroying character-defining features and the bridge has adequate capacity for pedestrian loading, the bridge is considered a Select Bridge. See Appendix D for details on how pedestrian load capacity was assessed. This final consideration allows bridges that are suitable for relocation and that are the best examples within a type to be thoroughly considered for preservation as non-vehicular bridges. This option does not preclude a future vehicular use if the owner wishes to pursue appropriate rehabilitation work.

Figure 4. Individual Review Process

Candidate Bridge

Identify bridge deficiencies leading to low cond. score (points = 0.25 x CS, max 10)

Review eligibility scoring (points = 0.5 x ES, max 10), Identify character-defining feat.

Maximum individual review score is 100 points.
* Consider non-vehicular preservation for certain types

Check 1: Can the existing superstructure and substructure be restored to an NBI condition 5?
- yes → Better candidate for long-term preservation (25 points)
- no → Less desirable candidate for long-term preservation (0 points)*

Check 2: Does the bridge meet minimum load capacity standards for the functional class of the roadway?
- yes → Better candidate to carry vehicles (20 points)
- no → Less desirable candidate to carry vehicles (0 points)*

Check 3: Is the bridge functionally obsolete?
- no → Better candidate to carry vehicles (15 points)
- yes → Less desirable candidate to carry vehicles (0 points)*

Check 4: Are major deficiencies tied to character-defining features?
- no → Rehabilitation less likely to compromise historic integrity (15 points)
- yes → Rehabilitation more difficult to execute to retain historic integrity (0 points)

Check 5: Additional factors: salted roadway, sag vertical curve, open deck joints, high accident rate, long detour?
- no → 1 point for each factor answered no
- yes → 0 points

Step 6: Agency review

In accordance with the PA, the Historic Bridge Task Group, County Commissioners, and the public reviewed and commented on the draft list of Select and Non-Select Bridges that resulted from the application of this methodology. The 60-day review period for Volume 4 extended from September 4, 2009, to November 6, 2009. The purpose of this comment period was to receive public comment on the recommended Select and Non-Select status for individual bridges. INDOT, FHWA, and INSHPO met on three occasions in December 2009 and January 2010 to consider public comments and to provide a final determination on Select and Non-Select status for each historic bridge in accordance with the PA.

The agencies, including engineers from FHWA and INDOT, reviewed each bridge that received a comment and its Select/Non-Select determination. Ultimately, the resolution of Select/Non-Select status of the bridges receiving comments was based on the condition and/or roadway characteristics of the bridge. The interplay of the Condition Score, roadway width, ADT, and structural capacity were the primary factors in determining if these bridges met safety standards to be considered Select. In this review, special consideration was given to truss bridges with Condition Scores of 30 to 34.

The status of bridges that received comments assigned under the preservation commitment or replaced bridges categories was verified. Non-vehicular bridges with a confirmed preservation commitment remained as Select bridges. Bridges confirmed to have been replaced did not require Select/Non-Select determinations, nor did non-vehicular bridges without a confirmed preservation commitment.

At the conclusion of the agency review, the FHWA and INSHPO issued a final list of Select and Non-Select bridges as presented in *Volume 4: List of Select and Non-Select Bridges*.

5. Special Circumstances and Periodic Updates

This report provides a methodology to identify Select and Non-Select Bridges as stipulated in Indiana's PA for historic bridges. The methodology provides a consistent and replicable approach to identifying the best candidates for preservation. However, there may be rare situations when the status of an individual bridge will require reconsideration. The methodology identifies certain Select bridges that would require an exception to INDOT's *Low Volume Road Standard* if rehabilitated for vehicular use. For these bridges, the owner is required to apply for a design exception. In the event that the exception to standards is applied for and not granted, the bridge must be considered for non-vehicular use. If non-vehicular use is not viable, the owner may submit a request for change of Select status following the process below. Stipulation II.C of the PA provides for the reevaluation of a Select Bridge if unusual circumstances lead to the bridge no longer being able to meet the criteria outlined in this methodology. This stipulation reads:

1. In unusual circumstances, a Select Bridge may no longer meet the Select Bridge criteria. Examples of unusual circumstances may include, but are not limited to, the bridge collapsing due to a flood or an overweight vehicle. A bridge owner may request that FHWA and the Indiana SHPO re-evaluate the Select Bridge determination if an unusual circumstance occurs. The following process will be followed to determine if re-classification of the Select Bridge is appropriate:

    a. The bridge owner must submit the request in writing to INDOT. The bridge owner should describe the unusual circumstance that has occurred and explain why the Select Bridge criteria no longer apply to the bridge.

    b. If INDOT determines the request has merit, then INDOT will notify FHWA, the Indiana SHPO, the Task Group, and the public of the request to re-classify the Select Bridge. INDOT will accept comments from the Task Group and the public for thirty (30) days.

    c. INDOT will provide a copy of all comments received to FHWA and the Indiana SHPO. FHWA and the Indiana SHPO will consult to evaluate the request and consider the comments received from the Task Group and the public.

    d. If FHWA and the Indiana SHPO agree on the classification of the bridge, then FHWA will notify INDOT of the decision within 30 days after receiving the documentation from INDOT. INDOT will notify the bridge owner, the Task Group and all individuals that provided comments on the bridge of the decision. If FHWA and the Indiana SHPO do not agree on the classification of the bridge, then the parties will invoke the Dispute Resolution provision, Stipulation IV.B. If necessary, INDOT will update the Select/Non-Select list by removing the Select Bridge from the list.

2. At least every ten (10) years, FHWA, INDOT, and the Indiana SHPO will consult to determine if conditions have changed that would require updating the list of bridges eligible for the NRHP, the criteria for identifying Select and Non-Select Bridges, and the list of Select and Non-Select Bridges. Any signatory may request that an update be completed more frequently if there have been substantial changes to the population of bridges identified in the Bridge Survey. If FHWA, INDOT and the Indiana SHPO agree that conditions have changed and an update is required, then the survey will be completed as described in Stipulation II of this Agreement. The FHWA, INDOT and the Indiana SHPO will consult to determine if the survey should be expanded to include bridges built after 1965. If FHWA, INDOT and the Indiana SHPO determine the existing survey is still valid, then INDOT will notify the Task Group, County Commissioners, and the public of the decision.

The PA does not provide any provisions to reclassify Non-Select Bridges as Select Bridges. In rare situations when the Select/Non-Select status of an individual historic bridge may require reconsideration, the FHWA, INDOT, and the INSHPO agree to adhere to a similar process to that outlined in Stipulation II.C of the PA as follows:

1. In rare circumstances, a Non-Select Bridge may warrant reconsideration to determine if the bridge meets the Select Bridge criteria. Examples of rare circumstances may include, but are not limited to current inspection data that positively affects a bridge's Condition Score or other demonstrated improvement to the condition of the bridge. A request may be made that FHWA and the Indiana SHPO re-evaluate the Non-Select Bridge determination if such a circumstance occurs. The following process will be followed to determine if re-classification of the Non-Select Bridge is appropriate:

    a. The request must be submitted in writing to INDOT. The request should describe the circumstance that has occurred and explain why the Non-Select Bridge now meets Select Bridge criteria.

    b. If INDOT determines the request has merit, then INDOT will notify, via email when available, FHWA, the bridge owner, the Indiana SHPO, the Task Group, consulting parties that would normally be invited to participate in a FHWA-sponsored project for the bridge (per the INDOT Cultural Resources Manual procedures), and the public (through a notice in a local newspaper) of the request to re-classify the Non-Select Bridge. INDOT will accept comments from the Task Group and the public for thirty (30) days.

    c. INDOT will provide a copy of all comments received to FHWA and the Indiana SHPO. FHWA and the Indiana SHPO will consult to evaluate the request and consider the comments received from the Task Group and the public.

    d. If FHWA and the Indiana SHPO agree on the classification of the bridge, then FHWA will notify INDOT of the decision within 30 days after receiving the documentation from INDOT. INDOT will notify the bridge owner, the Task Group and all individuals that provided comments on the bridge of the decision. If FHWA and the Indiana SHPO do not agree on the classification of the bridge, then the parties will invoke the Dispute Resolution provision, Stipulation IV.B. If necessary, INDOT will update the Select/Non-Select list by removing the Select bridge from the list.

In Stipulation II.A.2, the PA provides the following provision regarding reclassifying a non-NRHP eligible bridge as NRHP eligible:

> Bridges determined not to be NRHP eligible require no further consideration by INDOT and FHWA, unless later determined eligible for the NRHP in response to a nomination, or based on additional information or changed circumstances.

In the above stipulation, the PA does not specify any procedures for reclassifying a bridge outside the NRHP nomination process (i.e., based on additional information or changed circumstances), nor does it provide any provisions to reclassify NRHP Bridges as not eligible for the NRHP. In rare situations when the NRHP status of an individual bridge may require reconsideration, the FHWA, INDOT, and the INSHPO agree to adhere to a similar process to that outlined in Stipulation II.C of the PA as follows:

1. In rare circumstances, a bridge may warrant reconsideration to determine if the bridge meets the NHRP criteria. Examples of rare circumstances may include, but are not limited to additional information regarding the historical or engineering significance (or lack thereof) of the bridge. A request may be made that FHWA and the Indiana SHPO re-evaluate the bridge's NRHP determination if such a circumstance occurs. The following process will be followed to determine if re-classification of the bridge is appropriate:

    a. The request must be submitted in writing to INDOT. The request should describe the circumstance that has occurred and explain why the non-NRHP eligible bridge now meets the NRHP criteria or why the NRHP eligible bridge does not meet the NRHP criteria.

    b. If INDOT determines the request has merit, then INDOT will notify, via email when available, FHWA, the bridge owner, the Indiana SHPO, the Task Group, consulting parties that would normally be invited to participate in a FHWA-sponsored project for the bridge (per the INDOT Cultural Resources Manual procedures), and the public (through a notice in a local newspaper) of the request to re-classify the bridge. INDOT will accept comments from the Task Group and the public for thirty (30) days.

    c. INDOT will provide a copy of all comments received to FHWA and the Indiana SHPO. FHWA and the Indiana SHPO will consult to evaluate the request and consider the comments received from the Task Group and the public.

    d. If FHWA and the Indiana SHPO agree on the classification of the bridge, then FHWA will notify INDOT of the decision within 30 days after receiving the documentation from INDOT. INDOT will notify the bridge owner, the Task Group and all individuals that provided comments on the bridge of the decision. If FHWA and the Indiana SHPO do not agree on the classification of the bridge, then the parties will invoke the Dispute Resolution provision, Stipulation IV.B. If necessary, INDOT will update the Select/Non-Select list by removing the Select bridge from the list.

The PA is available on the INDOT project website at http://www.in.gov/indot/files/HistoricBridgePA.pdf.

Appendix A Condition Score Calculation

Condition Score Calculation

The *Condition Score Calculation* was developed for this project as a tool to estimate the potential for preservation of historic bridges based on the current conditions that carry vehicular traffic. The calculation automates the screening process by isolating factors that typically control whether a bridge can be prudently and economically rehabilitated and therefore preserved. The Condition Score also serves as an indicator of the condition of a bridge by isolating controlling elements. Values utilized in the Condition Score are extracted from the National Bridge Inventory (NBI) database as follows:

1. Structural capacity
2. Overall structural evaluation
3. Superstructure condition
4. Substructure condition
5. Roadway width compared to future ADT
6. Roadway width compared to approach width
7. Deck geometry evaluation
8. Waterway adequacy
9. Approach roadway alignment evaluation

The *Condition Score Calculation* reviews the NBI values and assigns a score for each item listed to arrive at a composite score (see the following pages for information on calculating the Condition Score and a sample). See the FHWA's *Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges* for more information on NBI component ratings. The highest possible value that a bridge can receive for its Condition Score is 45 points, which is based on a maximum of five points for each of the nine factors listed above. Four factors involve structural adequacy for a total of 20 points (see 1-4), three involve functional adequacy for a total of 15 points (see 5-7), one involves waterway adequacy (5 points), and one involves approach roadway (5 points). These factors are tabulated to arrive at a bridge's Condition Score.

Values of 40 or more are considered high and indicate a greater potential for preservation. The value of 40, which was calculated from the population of historic bridges, is the mean plus one standard deviation. Bridges with a Condition Score value of 40 or greater place in the upper 16 percent of the population. Lower values for the Condition Score indicate a bridge that has elements in less acceptable condition and, therefore, may be less suitable for preservation. For example, if the condition of the bridge resulted in individual categories having four points, indicating less than ideal but adequate conditions, the Condition Score for that bridge would be 36. The *Guidelines for Historic Bridge Rehabilitation and Replacement* (March 2007), accepted by AASHTO, notes that "experience has demonstrated time and again that a [NBI] condition rating of 4 or higher suggests that structural condition is conducive to rehabilitation."[2]

[2] Lichtenstein Consulting Engineers, Inc., *Guidelines for Historic Bridge Rehabilitation and Replacement*, March 2007.

Condition Scores in the range of 35 to 39 are considered medium. Bridges with a high or medium Condition Score are considered acceptable for preservation based on professional judgment after examining the entire population of historic bridges that are subject to select consideration. Condition Scores of 35 or less are considered low due to the bridges having one or more factors that affect their serviceability rated less than poor. Bridges with a low Condition Score may be considered for Select status due to their prioritization in this methodology. These bridges require individual review to determine potential for preservation.

Condition Score Calculation

NBI Item	NBI Item description	Formula to calculate Condition Score
64B	Structural Capacity (Tons)	If capacity is greater than or equal to 36 tons, value = 5, otherwise value = 5X Capacity/36
67	Structural Evaluation	If greater than or equal to 5 then value = 5; If 4 than value = 4 otherwise value = 0
59	Superstructure Condition	If greater than or equal to 5 then value = 5; If 4 than value = 4 otherwise value = 0
60	Substructure Condition	If greater than or equal to 5 then value = 5; If 4 than value = 4 otherwise value = 0
51/114	Roadway Width Compared to Future ADT (NBI Factor H)*	IF NBI SR Factor H = 0, then value = 5, otherwise value = 5 - 5xH/15
51/32	Approach Width Compared to Bridge Roadway Width	If bridge roadway width +2 ft < approach width, value = 0, otherwise value = 5
68	Deck Geometry Evaluation	If greater than or equal to 5 then value = 5; If 4 than value = 4 otherwise value = 0
71	Waterway Adequacy	If greater than or equal to 5 then value = 5; If 4 than value = 4 otherwise value = 0
72	Approach Roadway Alignment Evaluation	If greater than or equal to 5 then value = 5; If 4 than value = 4 otherwise value = 0

**The H factor is Line 2B in the NBI Sufficiency Rating Formula. It is a defined method of comparing clear roadway width with ADT.*

INDOT - Indiana Historic Bridge Inventory Condition Score Calculation

NBI Field Number	Structure Number 00227 3200173 StructureType 111A REINFORCED CONCRETE ARCH Location Hendricks County Criteria	NBI Value	Assessment Calculations
64A	Structural Capacity (Tons)	16	2.22
67	NBI Structural Evaluation	4	4
59	NBI Superstructure Rating	4	4
60	NBI Substructure Rating	5	5
51/29	Roadway Width Compared to ADT (NBI Factor H)	1.125	4.625
51/32	Approach Width Compared to Bridge Roadway Width		5
68	NBI Deck Geometry Evaluation	0	0
71	Waterway Adequacy	5	5
72	NBI Approach Roadway Alignment Evaluation	4	4

Total Condition Score	33.845
Sufficiency Rating	43.8
Eligibility Score	99

DATA INPUT FROM NBI RECORDS

28	Number of Lanes	1
29	ADT (Average Daily Traffic)	198
30	ADT Year	2002
32	Approach Width	17
51	Roadway Width	17.7
59	NBI Superstructure Rating:	4
60	NBI Substructure Rating:	5
64A	Structural Capacity (Tons)	16
67	NBI Structural Evaluation	4
68	NBI Deck Geometry Evaluation	0
71	Waterway Adequacy	5
72	Approach Alignment Evaluatio	4
114	Future ADT	318
115	Future ADT Year	2026

SR Factor H 1.125

(X) ADT/Lane = 198

(Y) Width/Lane = 17.7

Assessment Legend

Indicates User Input Required or Values Read from NBI

Indicates assigned values corresponding to the NBI rating with a maximum value of 5 to a lower value of 0

If Future ADT is less than 400, also complete *Low Volume Road Intial Screening* matrix

Appendix B Low Volume Road Test

Low Volume Road Test

The *Low Volume Road Test* was created to provide screening for bridges with a future Average Daily Traffic (ADT) less than 401 to determine if the bridge would pass the structural capacity and bridge width criteria listed in the *Indiana Design Manual Section 72-7.0, Treatment of Historic Bridge on Low Volume Local Road.* The future ADT is the measure used in these low-volume road standards and is also the same value as design year ADT. The test considers both the structural and functional criteria shown in Figures 07-05A and 07-05B of the *Indiana Design Manual (see below)*.

Figure 07-5A. Historic Bridge Structural Capacity

	Detour Length < 5 mi		5 mi ≤ Detour Length < 10 mi		Detour Length ≥ 10 mi	
Design Year ADT	< 100	100 ≤ ADT ≤ 400	< 100	100 ≤ ADT ≤ 400	< 100	100 ≤ ADT ≤ 400
AASHTO Loading	H-15	HS-15	HS-15	HS-15	HS-15	HS-20
Required Capacity	15 tons	27 tons	27 tons	27 tons	27 tons	36 tons

Figure 075- B. Historic Bridge Minimum Clear-Roadway Width

Lanes on Bridge	Design Year ADT < 100	100 ≤ Design Year ADT ≤ 400
One	15 ft	16 ft
Two	18 ft	20 ft

If a “yes” value is returned from both tests, that particular bridge will satisfy the criteria for load capacity and width without need for a design exception to remain in vehicular use. If a “no” value is returned, the bridge is reviewed to identify if an exception to the low volume road standard could be recommended. It was determined that a design exception could be reasonably obtained if the roadway width or capacity was slightly less than specified or detour length or ADT was slightly more than the defined standard. Also note that in considering the functional criteria for a bridge on a low-volume road, it was assumed that a bridge could be configured for one-lane use, allowing for a lesser width to be accepted.

An example of the application of the Low Volume Road Test follows.

INDOT - Indiana Historic Bridge Inventory Low Volume Road Standard Test

NBI Field Number	Structure Number 00227 County: Hendricks NBI#: 3200173 StructureType 111A REINFORCED CONCRETE ARCH **Structural Criteria**	Detour Length <5 miles	5 Mi <= Detour Length <10 Mi	Detour Length >= 10 Mi
64A	Structural Capacity (Tons)	15-27	27	27-36
114	Future ADT <100	no	no	no
114	100 <= Future ADT <=400	no	no	no
	Functional Criteria			
64A	Bridge Width (feet)	15-16	18-20	
28	Lanes on Bridge	1	2	
114	Future ADT <100	no	no	
114	100 <= Future ADT <=400	yes	no	

DATA INPUT FROM NBI RECORDS

19	Detour Length	002
51	Roadway Width	17.7
28	Number of Lanes	1
114	Future ADT	318
64A	Structural Capacity (Tons)	16

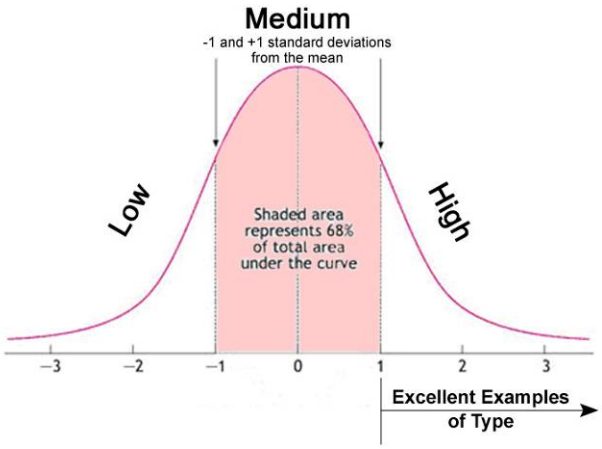
Appendix C Eligibility Score Ranking Method

Eligibility Score Ranking Method

The Eligibility Score ranks a bridge's historical significance and integrity compared with other bridges of the same type (see Table 1 for a listing of bridge types). Bridges were evaluated for eligibility for listing in the National Register following the evaluation system outlined in *Indiana Historic Bridge Inventory, Volume 1: National Register Eligibility Results* (February 2009). Within a bridge type, the relative values of the Eligibility Scores distinguish the variations that exist. In the evaluation system, bridges received additional eligibility points for significant variations and important design features, such as Whipple or Camelback configurations within the metal thru truss type and the Luten or Melan reinforcing systems within the concrete arch type. Relatively higher scores are given priority for select consideration as outlined in the methodology. Points are deducted due to a loss of historic integrity.

In this methodology, the concept of normal distribution is applied to estimate the relative rank of Eligibility Scores within each bridge type. By applying a normal distribution to the population of bridges within a type, the Eligibility Scores are relatively ranked as high, medium, or low, to identify excellent examples within each bridge type. Bridges that were previously determined eligible for or listed in the National Register, including those that are contributing resources in historic districts, were not evaluated during the inventory project and did not factor into the analysis or distribution of scores. Rather, each bridge that was previously determined eligible or each listed bridge automatically receives a high value (denoted by a "99" in the Selection Matrix Box as shown in *Volume 4: List of Select and Non-Select Bridges*) for purposes of applying this methodology.

A normal distribution curve, also referred to as a bell-curve, defines a normally distributed set of data (see figure below). Within a normal distribution of scoring data, an average score and a standard deviation from that average score can be calculated. A standard deviation is a measure of the variation among data points, such that the majority of data points cluster around the "average," while relatively few extend to one extreme or the other. As shown in the pink shaded area, approximately 68% of any given bridge population will have a score within one standard deviation of the average of all scores (indicating medium scores within a type), while approximately 16% will be have scores greater than the average score plus one standard deviation (indicating high scores within a type) and approximately 16% will have scores less than the average score minus one standard deviation (indicating low scores within a type). The table below shows the mean and standard deviation values for each bridge type; the range for high, medium and low scores; and the percentage of bridges within each range. The percentages approximate a normal distribution within each bridge type: adhering more closely to a bell-curve for types with larger populations and less closely with smaller populations. In either event, the distribution of rankings allows for the relative merits of bridges within each type to be recognized.



Normal Distribution Curve

(Source: C.P. Dancey and J. Reidy, *Statistics without Math for Psychology*, 2nd ed. (Harlow, Pearson Education, 2002).

This table reflects the historic bridge population resulting from agency resolution of public comments on List of Select and Non-Select Bridges as of April 2010. Changes in the National Register eligibility status of five bridges (NBI Nos. 27860, 27870, 27880, 9210, and 19420) occurred after April 2010 during additional agency review under Step 6 of the methodology. These changes are not reflected in the table.

Eligibility Score (ES) Values and Normal Distribution By Type

Bridge Type	Mean ES	Standard Deviation	High ES	Percentage	Medium ES	Percentage	Low ES	Percentage
Concrete arch	5.47	2.89	> 8	12%	3-8	78%	< 3	10%
Metal arch	7.86	4.67	> 12	29%	4-12	57%	< 4	14%
Metal pony truss	6.22	3.61	> 9	21%	3-9	76%	< 3	3%
Metal thru truss	10.48	6.60	> 17	19%	4-17	68%	< 4	13%
Prestressed concrete box beam	3.25	0.87	> 4	8%	3-4	92%	< 3	0%
Prestressed concrete I-beam	3.33	1.00	> 4	11%	3-4	89%	< 3	0%
Reinforced concrete girder and beam	4.22	1.84	> 6	18%	3-6	78%	< 3	4%
Reinforced concrete rigid frame and box	5.80	1.64	> 7	0%	5-7	100%	< 5	0%
Reinforced concrete slab	4.29	2.97	> 7	17%	2-7	83%	< 2	0%
Steel beam	3.37	1.38	> 5	16%	2-5	74%	< 2	10%
Steel deck truss	14.00	1.83	> 15	25%	13-15	75%	< 13	0%
Steel girder	5.57	4.01	> 9	14%	2-9	86%	< 2	0%
Steel movable	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Stone arch	7.33	3.45	> 10	22%	4-10	67%	< 4	11%
Timber other	3.75	1.50	> 5	25%	3-5	75%	< 3	0%
Timber truss	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Appendix D Assessment of Pedestrian Load Capacity

Assessment of Pedestrian Load Capacity

A load test was developed is to assess whether or not a vehicular bridge in service has potential to carry pedestrian loads. A sample *Assessment of Pedestrian Load Capacity* form is provided in this appendix. The inventory and operating rating capacity from the NBI is used. This check assesses the potential for pedestrian use based on the structure's current structural capacity. This check is intended to identify bridges that will not require strengthening or may require minor strengthening to be placed in pedestrian service. This test is used to approximate the distribution of pedestrian live load (weight of pedestrians) on the structure from the known HS20 load capacity.[1] This test was devised as a means to screen the bridge for structural adequacy for pedestrian use without conducting a detailed structural analysis. A detailed structural analysis may be needed to determine the suitability for pedestrian use.

A 65 pound per square foot pedestrian live load was used for this check. This value is appropriate for longer pedestrian bridges that live load reduction can be applied in accordance with AASHTO's *Guide Specifications for Design of Pedestrian Bridges* (1997).[2]

$Pedestrian\_LL_{intensity} := 65psf$

Input values from the bridge being checked (Bridge 5900013, Orange County, Iron through truss)

$Roadway\_width := 11.9ft$	This is the distance between curbs or railings on the bridge—NBI Item 51
$Span : = 94ft$	Use NBI Item 48—this is the length of the maximum span in the NBI
$Inv\_tonnage := 17.8\ kip$	This is the inventory live load capacity of the bridge in NBI Item 66 multiplied by two to convert tons to kips (kilo pound; 1 kip = 1000 pounds).
$Oper\_tonnage := 24\ kip$	This is the operating live load capacity of the bridge in NBI Item 64 multiplied by two to convert tons to kips

Compute the moment associated with a single point load and reduce it based on the span length and the length of the HS20 rating vehicle. Because the structure capacity is determined and recorded in the NBI database according to the standard HS20 loading, this step is utilized to create a simple equation to account for load distribution on a footprint greater than a point load. The standard HS20 truck load is spread out among a minimum of three axles and is not concentrated at one single point load. The following equations utilize the dimensions of the standard HS20 truck load to account for this load distribution.

[1] This check only applies to simple spans.

[2] AASHTO, *Guide Specifications for Design of Pedestrian Bridges*, 1st Ed., 1997.

Begin by computing the moment at the inventory rating level:

$$\text{Inv\_Vehicle\_moment} := \text{Inv\_tonnage}\ \frac{\text{Span}}{4} = 418.3\,\text{kip}\,\text{ft}$$

Next compute the moment at the operating rating level:

$$\text{Oper\_Vehicle\_moment} := \text{Oper\_tonnage}\ \frac{\text{Span}}{4} = 564\,\text{kip}\,\text{ft}$$

Assume that the rating vehicle used to compute the capacity was an HS truck and not the standard HS20 lane loading. Assume the rating vehicle is 28 feet long (short HS truck) 14 feet between 1st two axles and 14 feet between the second and third axles

$$\text{rating\_vehicle}_{\text{length}} := 28\text{ft}$$

Two of the three axles are significantly heavier than the first axle—8 kips versus 32 kips for the 2nd and 3rd axles. For this check it is assumed that the simple span moment is produced by two axles separated by 14 feet. Assume the two axles are centered about midspan. To arrive at an "efficiency" value, compare the offset of one of the axles as a fraction of one half of the span. This basically says the full single point load moment will not be produced because the HS truck has multiple axles. Consequently there is more live load capacity in the superstructure. The distance between axles has a larger influence on shorter span bridges. Compute a moment efficiency factor.

$$\text{Moment}_{\text{efficiency}} := \frac{\left(\frac{\text{Span}}{2} - \frac{\text{rating\_vehicle}_{\text{length}}}{4}\right)}{\left(\frac{\text{Span}}{2}\right)} = 0.85$$

Estimate the amount of live load moment capacity by multiplying the single point load moment by the efficiency factor. The resulting value will be used in the determining the "permitted" width of 65 psf pedestrian load on the bridge

Start by calculating the moment at the inventory rating level:

$$\text{Effective\_vehicle\_moment\_inv} := \text{Inv\_Vehicle\_moment}\,\text{Moment}_{\text{efficiency}} = 356\,\text{kip}\,\text{ft}$$

Next compute the moment at the operating rating level:

$$\text{Effective\_vehicle\_moment\_oper} := \text{Oper\_Vehicle\_moment}\,\text{Moment}_{\text{efficiency}} = 480\,\text{kip}\,\text{ft}$$

Use this live load moment value to back into a width of deck that can be loaded with pedestrian live load. Assume that the calculated width needs to be at least 8 feet wide. The back calculation simply assumes the moment is wl^2/8 where w is the pedestrian live load intensity multiplied by the permitted width.

Start by calculating the deck width that can carry pedestrian live load at the inventory rating level:

$$\text{Inv\_Permitted\_width} := \frac{\text{Effective\_vehicle\_moment\_inv}}{\left(\text{Pedestrian\_LL}_{\text{intensity}} \frac{\text{Span}^2}{8}\right)} = 4.96\text{ft}$$

Next, compute the deck width that can carry pedestrian live load at the operating rating level:

$$\text{Oper\_Permitted\_width} := \frac{\text{Effective\_vehicle\_moment\_oper}}{\left(\text{Pedestrian\_LL}_{\text{intensity}} \frac{\text{Span}^2}{8}\right)} = 6.69\text{ft}$$

A bridge could contain one or more lanes, the permitted width values are the width per "lane" on the bridge, multiple lane bridges would be evaluated with multiple lanes load for the inventory rating.

Result

Calculations of inventory rating or operating rating need to be greater than or equal to 8 feet for a bridge to be considered a candidate for pedestrian use. This value is consistent with the minimum width required for the safe use as a pedestrian bridge as defined in the AASHTO *Guide Specifications for Design of Pedestrian Bridges* (1997). In this example, the bridge does not pass the non-vehicular/pedestrian use test.

NBI Number: 3800190

Indiana Historic Bridge Inventory

NBI Number: 3800190 **State Bridge Number:** **County:** Jay
County Bridge Number: 00008

Assessment of Pedestrian Load Capacity (if applicable)

Assessment of Pedestrian Load Capacity Form

County: Jay
NBI Number: **3800190**
Selection Matrix Box: 4

Input Values

NBI51_Roadway Width:	21.8	ft
Length of maximum span (#48A):	0140.0	ft
NBI66_Inventory Rating:	29	tons
NBI64_Structural Capacity (Tons):	36	tons

Assumed Values

Pedestrian live load intensity	65	psf
Rating vehicle length	28	ft

Preliminary Output

Single point load moment	2030	ft
Efficency factor	0.9	(dimensionless)
Effective moment capacity	1827	ft

Final Output

Adequate for Pedestrian Use

Inv. Permitted width for pedestrian	*11.47*	*ft*
Greater or equal to 8 feet?	yes	
Oper. Permitted with for pedestrian	*14.238620689655*	*ft*
Greater or equal to 8 feet?	yes	

Yes

Appendix E Sample Individual Review Forms

Individual Review Form

NBI Number: 1300036
County/State Bridge No: 00045
County: Crawford
Selection Matrix Box: 3 Metal Thru Truss

Points Assigned

Candidate Bridge

5.5 — Condition Score 22 — Identify bridge deficiencies leading to low condition score (points = 0.25 x CS, max. 10 points)

10 — Eligibility Score 99 — Review eligibility scoring (points = 0.5 x ES, max. 10 points), Identify character-defining features

Low Volume Test
Refer to if applicable
Passes? No
Exception to LVS Applies? No
Structural: yes
Functional: no (2 lanes) no (1 lane)
Roadway Width: 12.4
Future ADT: 294

25 — Better candidate for long-term preservation (25 points) ← **yes** — Check 1: Can the existing superstructure and substructure be restored to an NBI condition 5?
Superstructure Rating: 4
Substructure Rating: 6
Yes
no → Less desirable candidate for long-term preservation (0 points)*

20 — Better candidate to carry vehicles (20 points) ← **yes** — Check 2: Does the bridge meet minimum load capacity standards for the functional class of the roadway?
Structural Capacity (Tons): 29
Functional Class: 07
Structural Evaluation: 4
Yes
no → Less desirable candidate to carry vehicles (0 points)*

0 — Better candidate to carry vehicles (15 points) ← **no** — Check 3: Is the bridge functionally obsolete? Yes
67 4 **68** 0 **69** N **71** 5 **72** 3
yes → Less desirable candidate to carry vehicles (0 points)*

0 — Rehabilitation less likely to compromise historic integrity (15 points) ← **no** — Check 4: Are major deficiencies tied to character-defining features? Yes
yes → Rehabilitation more difficult to execute to retain historic integrity (0 points)

3 — 1 point for each factor answered no (Maximum 5 points) ← **no** — Check 5: Additional factors:

		Points:
No	Salted Roadway?	1
No	Sag Vertical Curve?	1
Yes	Open Deck Joints?	0
No	High Accident Rate?	1
Yes	Long Detour? 008	0

yes → 0 points

Select/non-select status: Select
Non-vehicular use analyzed

63.5 **Total Points**
(Maximum individual review score is 100 points.)

Individual Review Form

NBI Number: 6300061
County/State Bridge No: 00081
County: Pike
Selection Matrix Box: 3 Metal Thru Truss

Points Assigned

Candidate Bridge

Condition Score 27.7 — Identify bridge deficiencies leading to low condition score (points = 0.25 x CS, max. 10 points) — 6.9

Eligibility Score 99 — Review eligibility scoring (points = 0.5 x ES, max. 10 points), Identify character-defining features — 10

Check 1: Can the existing superstructure and substructure be restored to an NBI condition 5?
Superstructure Rating: 4
Substructure Rating: 6
Yes

yes → Better candidate for long-term preservation (25 points) — 25

no → Less desirable candidate for long-term preservation (0 points)*

Check 2: Does the bridge meet minimum load capacity standards for the functional class of the roadway?
Structural Capacity (Tons): 22
Functional Class: 09
Structural Evaluation: 4
Yes

yes → Better candidate to carry vehicles (20 points) — 20

no → Less desirable candidate to carry vehicles (0 points)*

Check 3: Is the bridge functionally obsolete? Yes
67 4 68 5 69 N 71 0 72 3

no → Better candidate to carry vehicles (15 points) — 0

yes → Less desirable candidate to carry vehicles (0 points)*

Check 4: Are major deficiencies tied to character-defining features? No

no → Rehabilitation less likely to compromise historic integrity (15 points) — 15

yes → Rehabilitation more difficult to execute to retain historic integrity (0 points)

Check 5: Additional factors:

		Points:
No	Salted Roadway?	1
No	Sag Vertical Curve?	1
No	Open Deck Joints?	1
No	High Accident Rate?	1
No	Long Detour? 003	1

no → 1 point for each factor answered no (Maximum 5 points) — 5

yes → 0 points

Low Volume Test
Refer to if applicable
Passes? Yes
Exception to LVS Applies? _____
Structural: yes
Functional: no (2 lanes) yes (1 lane)
Roadway Width: 15.3
Future ADT: 14

Select/non-select status: Select
Individual review criteria met

81.9 **Total Points**
(Maximum individual review score is 100 points.)