Planning and Financing County Bridge Programs

Purdue University—Engineering Experiment Station
in cooperation with
The County Commissioners of Indiana

County Highway Series—No. 6

March 1963
HIGHWAY EXTENSION AND RESEARCH PROJECT FOR INDIANA COUNTIES

The Highway Extension and Research Project for Indiana Counties (HERPIC) was organized at Purdue in 1959 to implement legislation by the Indiana General Assembly authorizing programs of extension and research for county highway departments throughout the state.

The financial support for these programs of extension and research is derived from 3/8 of 1% of the funds made available to the 92 counties from gas taxes and license fees collected by the State of Indiana. The legislation by the General Assembly also designated Purdue University through its Engineering Experiment Station and School of Civil Engineering to develop and coordinate these programs.

The HERPIC program of extension and research provides for the preparation of manuals and bulletins setting forth recommended procedures and for regional workshop conferences with county road officials throughout the state to review typical road problems for their area. All of these activities are designed to assist and guide county highway officials in their problems of management, planning, design, and operation of county highway departments.

The HERPIC project operates as a cooperative effort between the county commissioners of Indiana and Purdue University. The program of extension and research is guided and approved by a 12-man advisory board, consisting of six county commissioners from over the state and six members from the staff of Purdue’s School of Civil Engineering. The current membership of the HERPIC Advisory Board is listed below.

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(July 1961—July 1963)

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INTRODUCTION

Bridges have historically constituted one of the continuing problems of highway development and operation, and particularly so with county highways. In Indiana, as with most other states in the Midwest, the majority of the existing county bridges were built at the turn of the century, following the laying out and opening of the county road system. While the early bridges were adequate for the traffic needs of the times, thousands of them now constitute a threat to today's traffic because of their weak, narrow condition. Current estimates indicate there are approximately 15,000 county bridges in Indiana and that fully 50 per cent of these are totally inadequate.

Fig. 1. There are over 15,000 bridges on Indiana county roads. The narrow, weak, unsafe bridge shown here is typical of thousands of them.
The imminent collapse of weak, obsolete bridges threatens many communities with the possibility of isolation; likewise, many otherwise serviceable county bridges are doomed to failure unless immediate steps are taken to restore crumbling foundations and to strengthen and repair bridge floors. The need for an active county bridge improvement program is further intensified by the increasing demands of local traffic. Heavier construction traffic and wider farm machines are much more common than in years past—the same is true of the increasingly heavier and wider school buses.

The great need for an active bridge improvement program is generally recognized by county commissioners throughout Indiana. As a matter of fact, county road officials in Indiana commonly identify bridges as one of the major problems in county highway operation and management. The basic problem lies not so much with recognizing the needs, but with the general lack of an improvement program and a sustaining financial plan that has the support of the local public. County road officials and the local citizens alike need a better insight into planning methods and their benefits to the management and operation of county roads.

This manual has been developed, therefore, to review several different areas of information related to county bridge improvement programs, including (1) the authority and jurisdiction over county bridges (Section II), (2) the various sources of funds for construction and repair of county bridges (Section III), and (3) the fiscal process of making appropriations and expenditures for construction and repair of bridges (Section VI). These topics are presented in terms of the current Indiana statutes, and for this reason should be of considerable assistance to county road officials as a guide to the official duties of their office.

One of the main features of the manual is the suggested outline of planning and programming methods for county bridge improvement, including the taking of county-wide inventory of bridges (Section III), a condition and priority rating of bridges (Section IV), and the formulation of county-wide programs for bridge improvements (Section V).

The application of these steps to Indiana’s county bridges will unquestionably upgrade and improve their safety and capacity and, in turn, will improve the local communities of the state. Action and progress are contingent upon the basic policy
decisions of county road officials and upon having competent, qualified personnel to translate these decisions into comprehensive bridge improvement programs that can and will be understood and supported by the local communities.
I—AUTHORITY AND JURISDICTION OVER COUNTY BRIDGES

General

The primary authority and responsibility for county bridges rests historically with the board of county commissioners. The broad scope of this authority and responsibility appears throughout all of the laws dealing with county bridges and county roads alike from territorial times to the present. Indiana statutes applicable at the present time contain numerous references to the authority of the boards of county commissioners with respect to roads and bridges.

Other state and federal agencies having areas of mutual interest, as well as limited statutory authority over county bridges include:

- Indiana Flood Control and Water Resources Commission
- U. S. Army, Corps of Engineers
- Indiana State Highway Commission
- Bureau of Public Roads

A brief review of the interest and authority of these several agencies is outlined in this section.

County Commissioners

The 1905 County Road Law, many sections of which are still applicable, (Acts 1905, Chap. 167, p. 521; Burns’ 36-1901) outlines the authority of the boards of county commissioners with respect to county bridges as follows:

“Whenever in the opinion of the board of commissioners of any county the public convenience shall require that a bridge upon any highway shall be repaired or built, the board shall cause surveys and estimates therefor to be made and plans and specifications to be prepared and filed in the office of the county auditor, and shall direct such bridge to be erected or such repairs to be made. . . .”

Later, the 1919 County Unit Road Law (Acts 1919, Chap. 112, p. 531; Burns’ 36-301) outlined this authority somewhat more specifically, as follows:

“The board of county commissioners of each county of the state is hereby authorized and empowered to locate, establish, widen, change, construct, reconstruct and im-
prove, maintain, and repair all public highways, bridges and culverts in the county. . . .”

Thus we see that the Indiana statutes give the boards of county commissioners of the respective counties a wide latitude of authority with respect to county bridges (also roads). However, we should also note that a considerable amount of discretion is left to the boards with respect to when, where, and how this authority is to be invoked or applied.

Special applications of this authority are set forth in Indiana statutes for (a) county line bridges, (b) bridges in cities and towns, and (c) interstate bridges, outlined as follows:

**County Line Bridges**

*In the case where a bridge is located on a road forming the boundary between two or more counties,* the authority for the construction, maintenance, and repair is basically the same as for any other county bridge except that joint action is required of the two or more boards of county commissioners involved. The 1905 County Road Law and amendments thereto (Burns’ 36-2001) cover the procedure for joint action between the two or more boards of county commissioners and further provide that the “. . . apportionment to each county of the whole costs of construction, repair, or purchase of such bridge shall be in proportion to the taxable properties of such counties.”

![Fig. 2. Cumulative bridge funds should be sufficient to handle emergency repairs or replacement.](image)
In the case where the bridge crosses a stream forming the boundary between two or more counties, the procedure for the “erection, repair, or purchase” is much the same as where the bridge is on the county-line road; however, the procedure for the joint action of the two or more boards of county commissioners is set forth in a 1903 bridge law as amended (Burns’ 36-2002 through 2006).

Bridges in Cities and Towns

In addition to the authority over bridges located on county roads, the boards of county commissioners are also empowered with discretionary authority to construct and repair bridges located within the corporate limits of cities and towns within their county. A section from the 1905 County Road Law (Acts 1905, Chap. 167, p. 521; Burns’ 36-1905) sets forth this authority as follows:

“The board of commissioners of any county may build or repair any bridge within the corporate limits of any city or town in such county; and any such bridge, if built or repaired by order of such board shall be built or repaired in the same manner and paid for out of the same funds that other bridges without such corporate limits are by law built or repaired and paid for. Nothing in this section, however, shall be so construed as to take away from any such city or town the right to build or repair any bridge within its corporate limits, nor to take away the jurisdiction of such city or town over all bridges within such limits, whether built or repaired by such city or town or by the county board.”

Interstate Bridges

For the construction and maintenance of bridges crossing rivers or streams that form a boundary between the state of Indiana and any adjoining state, the now existing statutes provide two possible procedures.

The simplest and somewhat abbreviated procedure (Acts 1920, Spec. Sess., Chap. 25, p. 81; Burns’ 36-2401 through 2404) authorizes any county or municipality, acting through its board of county commissioners, to build and maintain such interstate bridges in cooperation with any contiguous county or municipality. This statute further authorizes the board of county com-
missioners to pledge to the payment of one-half of the expense for the construction and maintenance, subject to the appropriation of funds by the county council.

The second and more detailed procedure (Acts 1927, Chap. 238, p. 692; Burns’ 36-2405 through 2424) for constructing and maintaining interstate bridges authorizes the board of county commissioners to appoint a five-man bridge commission having the power of a corporate body to act in behalf of and for the county. These statutes further authorize them to cooperate and join with a similar commission from the adjoining state to form a joint commission to execute the several stages of financing, constructing, maintaining, and operating such interstate bridges.

**Indiana Flood Control and Water Resources Commission**

Indiana statutes also provide the flood control commission with limited yet quite specific authority over bridges and all other “structure, obstruction, deposit, or excavation to be erected, made, or maintained in or on any floodway,” as set forth in the 1945 Flood Control Act (Acts 1945, Chap. 318, p. 1480; Burns’ 27-1101 through 1123). In accordance with these statutes and the present regulations of the flood control commission, it is required and necessary to submit “Application for Approval of Construction in a Floodway” to the flood control commission for all bridges (county, city, or state) in the vicinity of urban areas and for all other bridges in rural areas crossing streams that have drainage areas of 50 square miles or more.

The flood commission’s main point of interest in reviewing and approving plans for proposed bridge construction is to minimize encroachments on or restrictions in the floodway and to determine that the floodway opening under the bridge is adequate to handle the stream flow at flood stage. While the flood control commission has no primary interest in the structural details of the bridge, it is sometimes interested in the footings for piers and abutments where high velocity flows are anticipated.

Therefore, in the preliminary planning stages for county bridge projects, the board of county commissioners (or its duly authorized representative) should submit “Application for Approval of Construction in a Floodway” (a standard application form) to the flood control commission. The application must be accompanied with preliminary engineering plans that include
(a) location map, (b) profile of roadway, (c) elevation of old and new bridges, (d) drainage area, and (e) a plan and elevation view of the proposed bridge. The approval of the preliminary plans by the flood control commission should be obtained before proceeding with the detailed design plans for the bridge project.

The application forms for approval and detailed instructions on the information required are available on request to:

Indiana Flood Control and Water Resources Commission
606 State Office Building
100 N. Senate Avenue
Indianapolis 4, Indiana

Corps of Engineers

In accordance with federal statutes and regulations the U. S. Army, Corps of Engineers has jurisdiction over all navigable streams. Within Indiana, portions of the Wabash, White, and Grand Calumet Rivers are designated by the Corps of Engineers to be navigable streams. The Wabash River is designated to be navigable as far north as Wabash, Indiana. The White River is considered to be navigable from its mouth to the junction of the East and West Forks, the East Fork White River to Portersville, Indiana, and the West Fork White River to the B. & O. Railroad bridge west of Washington, Indiana. The Grand Calumet River (and the Indiana Harbor Canal) are navigable throughout all of the portion located in Indiana.

Preliminary plans for (county, city, or state) proposed bridge crossings of those portions of the Wabash, White, or Grand Calumet Rivers considered to be navigable must be approved by the U. S. Army, Corps of Engineers. This approval may be obtained through the offices of the Indiana Flood Control and Water Resources Commission, which maintains liaison with the Corps of Engineers, or by writing directly to either of the following addresses:

The District Engineer
U. S. Army Engineer District, Louisville
Corps of Engineers
830 West Broadway
Louisville 1, Kentucky

For projects on Ohio, Wabash, or White Rivers or tributaries
Fig. 3. This map shows those portions of streams in Indiana designated as navigable by the U.S. Army, Corps of Engineers.
The District Engineer  
U. S. Army Engineer District,  
Chicago Corps of Engineers  
475 Merchandise Mart  
Chicago 54, Illinois  

All other projects located in northern Indiana  

Indiana State Highway Commission  
While there are numerous areas of cooperation between the Indiana State Highway Commission and the boards of county commissioners, the State Highway Commission, under present Indiana statutes, has no legal authority or jurisdiction, as such, over county highways. However, by federal regulation, the State Highway Commission administers the federal aid funds to counties when formally requested. Proposed county road or county bridge projects utilizing federal aid funds are subject to review and approval by the State Highway Commission to determine that they will comply with the standards and requirements of the federal regulations. Requests for information on federal aid programs should be addressed to:  

Engineer of County Federal Aid  
Indiana State Highway Commission  
State Office Building  
100 North Senate Avenue  
Indianapolis 4, Indiana  

Bureau of Public Roads  
Federal statutes designate the state highway departments of each state to administer all federal aid highway programs within the state. The U. S. Bureau of Public Roads therefore has no direct authority or jurisdiction over county roads or county bridges. Any direct cooperation between the Bureau of Public Roads and the boards of county commissioners is normally accomplished through the Indiana State Highway Commission. However, it should be noted that in cases of necessity, correspondence may be addressed to:  

District Engineer  
Bureau of Public Roads  
U. S. Dept. of Commerce  
ISTA Building  
150 West Market Street  
Indianapolis, Indiana
General

Indiana statutes from early times to present have generally recognized a distinction between county bridge construction and county road construction. Not only do we have separate statutes for roads and for bridges, but the statutes have generally provided the counties with broader fiscal powers for the construction and repair of bridges.

The existing state and federal statutes provide Indiana county highway departments with three primary sources of revenue for the construction and repair of county bridges as follows:

Motor Vehicle Highway Account—statutory state aid to counties for both roads and bridges

Federal-Aid Secondary Funds—optional federal aid to counties for both roads and bridges

County Taxation Funds—optional county taxation for bridges only; may be in the form of (a) cumulative bridge funds, (b) county general funds, (c) bond issues.

Fig. 4. These are sources of funds available to Indiana county highway departments for bridge construction, repair, or maintenance.

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Additional information on these three sources of revenue for county bridges is outlined in the following paragraphs.

**Special Note:** The reader and particularly the Indiana county road official should consult the latest edition of the “Handbook of Facts and Figures on Indiana County Roads,” HERPIC, Civil Engineering Building, Purdue University, for the specific amounts of money currently available to the individual counties from these sources of revenue.

**Motor Vehicle Highway Account**

This is the principal source of revenue for the overall operation of the county highway departments, including contractual services, purchases of materials, labor and/or equipment required in the construction and maintenance of county roads and bridges. The MVHA is an account of the general fund of the state which by statute (Acts 1941, Chap. 16, p. 517, as amended; Burns' 36-2815 through 2824) is credited with the collections of state motor fuel taxes, motor vehicle registration fees, and other fees relating to the operation of motor vehicles. These highway-user taxes established by statute are levied and collected by the state and after certain deductions are made for administrative and other expenses, as provided by statute, the funds are distributed quarterly on the following basis:

53 per cent to State Highway Commission for construction and maintenance of state highways

32 per cent to county highway departments and allocated among the 92 counties as follows:

(a) 5 per cent divided equally

(b) 65 per cent on ratio of county road mileage in each county to the total county road mileage in the state

(c) 30 per cent on ratio of motor vehicle registration in county to total motor vehicle registration in state

15 per cent to cities and towns, allocated on the basis of the ratio of the population of each to the total city and town population of the state.
Thus, in terms of county highway finance, the MVHA is actually a statutory state aid to the counties for local roads and bridges. Since this source of revenue is developed entirely from highway-user taxes, the continuing increases in motor vehicle registration and highway travel have produced corresponding increases in the amounts of revenue available to the counties from this source. In 1961 slightly more than $42,000,000 was distributed to Indiana’s 92 counties, ranging from almost $2,500,000 for Marion County to slightly less than $100,000 for Ohio County; annual distributions to individual counties of $300,000 to $500,000 are common.

**County Federal Aid**

This is an important supplementary source of revenue for county highway departments but may only be applied to new construction or reconstruction of road or bridge projects located on county federal aid routes. In addition the design features of the projects must meet the minimum standards approved for the class of project in question. (See Appendix A.) The federal statutes covering the Federal Aid Secondary highway program require that at least 50 per cent of the FAS funds apportioned to the states be made available for construction on county federal aid projects.

Thus, in terms of county highway finance, Federal Aid Secondary (FAS) funds are optional federal aid grants available to

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Fig. 5. County federal aid is an important source of funds for the construction of major bridges.
counties on a 50-50 matching basis for local roads and bridges. All county road officials are urged to make maximum use of this source of revenue. Overall, FAS funds will increase the average Indiana county’s highway income by approximately 8 per cent. For Indiana counties in particular, FAS funds provide an excellent method of supplementing a long-range bridge improvement program.

Over the past several years there has been a slow but steady increase in the amount of federal aid available to the counties. In 1962, $3,400,000 in FAS funds was apportioned and available to Indiana counties on the basis of county area, population, and road mileage. The funds are administered through the Indiana State Highway Commission and requests for information on county federal aid should be addressed to: Engineer of County Federal Aid, ISHC.

County Taxation Funds

Revenue from county taxation is available for bridge construction and repair on an optional basis and in three possible forms: cumulative bridge fund, county general fund, or bond issue. Specific information on these three funds is as follows:

Cumulative Bridge Fund

This is perhaps the most important supplementary source of revenue for the construction and repair of county bridges and grade separations. Indiana statutes (Acts 1951, Chap. 299, p. 989 as amended; Burns’ 36-1910 through 1912) authorize the county commissioners of the individual county units to establish a county-wide tax levy on all taxable personal and real property for the purpose of accumulating funds for the construction and repair (but not maintenance) of county highway bridges. The tax levy for this purpose may be established for a period of five years and may be renewed for like periods of time; however, the amount of the tax levy may not exceed 20 cents per $100 of taxable property and must be advertised annually along with other county tax levies. The complete detailed procedure for establishing a cumulative bridge fund is outlined in Appendix B.

While this source of revenue is optional with the individual county units, county road officials, and county commissioners in particular, are urged to make the maximum possible use of this source of revenue for bridge programs. The yearly income from a cumulative bridge fund depends on the amount of the
tax and the assessed valuation for the county. Generally, a cumulative bridge fund can increase the annual income from 15 to 30 per cent. Since this source of revenue is dedicated exclusively to the construction and repair (but not maintenance) of bridges, all counties should take advantage of this method of increasing the available income for bridge improvement programs.

County General Fund

Revenue for bridge programs from the county general fund is handled in the same manner as any other county tax fund. Therefore, no special procedure is required to develop this source of funds. It should be noted that the county general fund is seldom used as a primary source of revenue, but it often serves as a secondary source of revenue.

Bond Issue

This is another important supplementary source of revenue for financing the new construction of county bridges. A bond issue is normally used only for major bridge structures but is also sometimes used for emergency construction of smaller bridge structures. Present Indiana statutes (Burns’ 26-532) give the county council “the exclusive power to authorize the borrowing of money for the county, but the total amount of indebtedness shall not exceed an amount equaling 2 per cent of the taxable property in the county . . . .” In addition the present statutes on the limitation of tax levies (Burns’ 64-313) provide that a petition by fifty or more owners of taxable real estate is a preliminary requirement for initiating the bond issue procedure.

With these limitations, bond issues are used to finance bridge construction only in those cases where the structure serves the needs and interests of the entire community or where an emergency is created by flood or other disaster. As of December 1960, there were 19 Indiana counties that had outstanding bridge bond issues; the original amounts of these bond issues vary from as little as $11,000 to as much as $3,500,000.

It should be noted, however, that a separate bond issue is normally made for each individual bridge project. The revenue from the bond issue may be combined with funds from other sources, such as county federal aid funds or Motor Vehicle Highway Account funds, to cover the total estimated cost of the proposed bridge project. (See Section V.)
General

A first step in developing a sound county bridge program is to take inventory of all bridges and culverts; this is important for planning and for financing. Considerable time and effort will be required to make a field examination of each structure. Basic information on the structure's service and use as well as its dimensions and materials must be gathered. In addition, information on the physical condition, rating, and recommended improvements must also be obtained in the field in order to develop a realistic estimate of needs and costs.

The basic purpose of inventory data is to develop a measure of bridge and culvert status and needs for replacement and repair. This is of primary use to county road officials in the orderly management of county roads and bridges. A secondary, but equally important, use of the inventory data is in the support of requests for finances to the county council. Structure inventory data also can be used to develop impartial decisions in dealing with special-interest pressure groups.

Relationship of Structure Inventory to Road Inventory

Ideally, bridge and culvert inventories and road inventories should be performed concurrently. Both of these inventories are fundamental requirements for good county road management. However, the fact that the road inventory is not planned should not deter or delay the progress of the bridge and culvert inventory. The main advantage in making both inventories at the same time is that both have a common system of reference, such as structure number, road number, and log mile. In any event, the inventory of either roads or bridges must be approached with the view that both will ultimately be combined into an overall county highway inventory to serve the needs of good county road management. The inventory information provides basic file data for the start of a service record on each individual structure.
The reader and particularly county road officials should refer to the following publication for additional information on county road planning and programs:
“Manual on Advanced Road Programs” (October 1960), National Association of County Engineers, 1001 Connecticut Avenue, N. W., Washington 6, D. C.

Preliminary Data, Inventory Crews, and Equipment

Taking a county-wide inventory of bridges and culverts is basically an “organized gathering of information.” Therefore, one of the first steps in this process is to determine what information may already be available on county roads, bridges, and culverts. The Planning Division of the Indiana State Highway Commission collects certain information that can be of considerable assistance in getting started.

A sample inventory card in current use by the Planning Division, ISHC, is shown in Figures 6 and 7. It is important to note that this information will relate primarily to location and overall dimensions of bridges and culverts; it must be supplemented by other field information in order to determine the condition and rating of each structure.

The assignment of competent and qualified personnel to a bridge inventory crew is essential for the field work. Ideally, the bridge inventory crew should be under the supervision of an experienced county highway engineer and by all means the crew chief should have a basic understanding of bridges, their structural defects, and field repair methods.

Normally, one logging crew, consisting of a crew chief and one or two aides, is adequate to carry out a county-wide inventory within a reasonable period of time. This assignment should not be merely a “rainy-day” duty; if so, the inventory process drags on indefinitely and suffers for lack of uniformity. The following is a recommended list of equipment for the logging crew:

(a) Automobile—preferably a 4-door sedan, equipped with a precise odometer (1-ft survey meter) for the accurate logging of distance.

(b) County road maps—several copies of the latest available edition, accurate as to both county roads and drainage.
Fig. 6. This is the front side of an "Indiana Road Inventory" card-form used by the Planning Division of the ISHC. Besides road data, the location of a county bridge and its assigned number are provided.

Fig. 7. This is the back side of the form shown in Figure 6. Some detailed bridge information is given. Appendix C of this bulletin explains the abbreviations used for bridge types.
(c) Bridge and culvert inventory card forms—an ample supply of $8\frac{1}{2}$ by 11 in. tagboard cards as illustrated in Figure 9.

(d) Tape—metallic or steel, 50 or 100 ft

(e) Tape—flexible, steel, 6 ft

(f) Hand level and level rod

(g) Plumb bob and line

(h) Compass (pocket)

(i) Camera and supply of film

(j) Hip boots—one or more pairs

(k) Life jacket

Fig. 8. The well-equipped crew shown here is obtaining bridge dimensions for a county bridge inventory program. A third man in the crew is at the other end of the tape.

**Definition and Types of Bridges and Culverts**

A bridge is a structure providing passage over a stream, river, canal, valley, road, or other obstruction, and leaving a clear way beneath. The American Association of State Highway Officials (AASHO) applies a size limitation to bridges: "Structures over 20 ft long measured along the centerline of the roadway between inside faces of end supports, including both stream crossing and grade separations." This is a commonly accepted definition for bridges and is used in this bulletin.

Culverts are defined as structures that carry water beneath a road and are less than 20 ft long measured parallel to the centerline of the roadway. An installation with multiple openings
may be classified as a bridge, provided the effective drainage opening is 20 ft or more measured parallel to the centerline of the roadway and, further, that pipe conduit, if used, has an effective diameter of at least 54 in.

Common types of existing bridges, culverts, headwalls, and endwalls are illustrated in Appendices C, D, and E, respectively. These line drawings will be helpful to the logging crews for field identification.

Inventory Forms

The sample inventory form shown in Figure 9 is generally self-explanatory and has been designed to provide a method of assembling a maximum of information on the individual bridge or culvert structure while using a single form. It is recommended that the inventory form be printed on a medium-weight tagboard and on light-weight bond paper. The tagboard cards should be filled out and used as a “work copy” in the field. This same information should then be typed (in triplicate) on the light-weight bond forms as information and reference copies.

It should be noted that the information on the sample inventory form, Figure 9, has been organized into several categories or areas of information. The following is a listing of these categories along with their purpose:

SERVICE AND USE—how is the bridge or culvert used by the community and what service does it provide?

DRAINAGE AND FLOOD DATA—is the bridge or culvert subject to flood; if so, to what extent?

DIMENSIONS AND MATERIALS (BRIDGES)—what is the size and type of bridge and how made?

DIMENSIONS AND MATERIALS (CULVERTS)—what is the size and type of culvert and how made?

CONDITION AND PRIORITY—what is the physical state or condition of the structure and how does this compare with minimum tolerable standards and the priority rating of other bridges?

RECOMMENDED IMPROVEMENTS—what should be done to make the structure more serviceable or safer?

ESTIMATED COSTS—within limits, how much will the recommended improvements cost?
### COUNTY HIGHWAY
#### BRIDGE AND CULVERT INVENTORY

- **County, Indiana**

<table>
<thead>
<tr>
<th>Condition and Priority</th>
<th>Good</th>
<th>Fair</th>
<th>Poor</th>
<th>Very</th>
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<tbody>
<tr>
<td>Roadway Width</td>
<td>20</td>
<td>15</td>
<td>7</td>
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</tr>
<tr>
<td>Vertical Clearance</td>
<td>5</td>
<td>4</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Approach Alignment</td>
<td>15</td>
<td>12</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>Waterway Area</td>
<td>15</td>
<td>12</td>
<td>6</td>
<td>0</td>
</tr>
<tr>
<td>Structural Condition</td>
<td>20</td>
<td>15</td>
<td>7</td>
<td>0</td>
</tr>
<tr>
<td>Load Capacity</td>
<td>25</td>
<td>18</td>
<td>8</td>
<td>0</td>
</tr>
</tbody>
</table>

**Total Condition Rating Points** = (100 - Condition Rating)

### RECOMMENDED IMPROVEMENTS AND ESTIMATED COSTS

<table>
<thead>
<tr>
<th>Bridges</th>
<th>Cost</th>
<th>Bridge Materials Recommended</th>
</tr>
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<tbody>
<tr>
<td>New Structure-old site</td>
<td></td>
<td>Superstructure</td>
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<td>New Structure-new site</td>
<td></td>
<td>Substructure</td>
</tr>
<tr>
<td>Floor - new</td>
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<td>Floor</td>
</tr>
<tr>
<td>Floor - repair</td>
<td></td>
<td>Concrete</td>
</tr>
<tr>
<td>Widen Structure</td>
<td></td>
<td>Composite</td>
</tr>
<tr>
<td>Point Structure</td>
<td></td>
<td>Wood*</td>
</tr>
<tr>
<td>Substructure Rep.</td>
<td></td>
<td>* Treated ; Untreated</td>
</tr>
<tr>
<td>Channel Rep.</td>
<td></td>
<td>Culverts - Materials and Costs</td>
</tr>
<tr>
<td>Approach Rep.</td>
<td></td>
<td>Other (Remarks)</td>
</tr>
<tr>
<td>Other (Remarks)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Bridge Est. Total</th>
<th>$</th>
<th>Replace</th>
<th>Type and Material</th>
<th>Est. Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Remarks:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Culvert Est. Total</th>
<th>$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Remarks:</td>
<td></td>
</tr>
</tbody>
</table>

**Analysis by**

**Reviewed by**
It is important for county road officials, and particularly the bridge logging crew, to realize the need for developing information in each of these categories for each bridge structure as the inventory progresses. In other words, all of the information set forth on the sample form is needed in order to make sound decisions on planning and financing a county bridge program. Furthermore, additional field notes may be required to fully explain unusual needs or conditions.

In addition to the use of the inventory cards and forms in the initial inventory log of the county bridges and culverts, it is recommended that new inventory cards be filled out for each new bridge or culvert as it is constructed or installed. In this way, the county can have a current, up-to-date record of all bridge and culvert structures.

Field Logging of Bridges and Culverts

As noted previously, the bridge logging crew should be headed by a crew chief who has a basic understanding of highway structures, their structural defects, and field repair methods. After the available record information relating to the county bridges and culverts has been assembled, the field logging operation should be organized.

In starting the field logging a definite schedule and routing of the field crew should be prepared so that the field work can proceed in an orderly manner. Ideally, the complete county road numbering and naming system should be worked out in advance of the field logging.

The field work should start in some definite part or area of the county and continue until substantially all of the field work is complete in that area. One convenient method is to divide the county into approximate quarters similar to that used in the road numbering procedure, then to systematically log the location and structure information on a “road-by-road” and “structure-by-structure” basis. After one quarter is complete, the field logging should proceed to another. It should be understood that the field logging can proceed in an orderly and efficient way only if the crew is fully manned and equipped as previously outlined.

Every effort should be made to complete the field logging, making all measurements, inspections, sketches, and photographs, in one, and only one, trip to the structure site. How-
ever, there will be occasions when two or more trips to the site will be required. It may be necessary to go back at a later date when the water level is lower for a better inspection of piers, abutments, and foundations. Some larger structures may warrant a design re-analysis which undoubtedly would require several inspection trips. This type of work would also have to be done by an experienced bridge engineer.

The inventory log form, Figure 9, should be completed in detail for bridges of all sizes and for culverts down to a size of 54 in. Culverts less than 54 in. are ordinarily inventoried during a roadway inventory; however, if no roadway inventory is planned in the near future, it would be desirable to at least list the location, diameter, and general condition of culverts smaller than 54 in.

It is also recommended that the inventory log of each individual bridge structure be supplemented with appropriate photographs that will at least show an approach view and a drainage-way view of the bridge. While the photographs may often be of limited value to the county highway engineer who is familiar with the bridges, the main value of the photographs is in presenting an overall review of county bridge problems. Good, well-planned photographs will prove particularly effective in supporting budget requests for additional financing.
IV—CONDITION AND PRIORITY RATING FOR BRIDGES AND CULVERTS

General

The physical condition, adequacy, and safety of a structure can be determined by an analysis of its six most important features: (1) load capacity—depends much on original design, (2) structural condition—depends much on the present condition of materials, (3) horizontal clearance, (4) waterway area, (5) approach alignment, and (6) vertical clearance. A portion of the inventory form entitled “Condition and Priority” is provided for rating each of these six features and obtaining a numerical condition rating for the structure.

With a condition rating for each structure in the county highway system a priority rating can easily be developed to indicate which structure or group of structures should be repaired or improved first. The condition rating and the priority rating given in this manual are highly simplified versions of those recommended by the National Association of County Engineers. An experienced county highway supervisor or professional engineer might prefer to use the NACE recommended system.

This section also presents recommended design and tolerable standards for structures on arterial, feeder, and local roads. The design standards provide for good and adequate structures which can handle present and near-future traffic. The tolerable standards describe the minimum structure conditions county road officials should tolerate on their roads.

Roadway Width and Height Clearance

Measure the minimum horizontal and vertical roadway clearance through the structure. Compare the measurements to the standards provided in Tables 1 and 2. Note that the standards are for arterial, feeder, and local roads. From the tables determine (a) whether the existing condition is good, fair, poor, or very poor; and (b) the number of points to be assigned in the “Condition and Priority” portion of the inventory log.
### TABLE 1
RECOMMENDED STANDARDS AND RATINGS FOR ROADWAY WIDTH CLEARANCE

<table>
<thead>
<tr>
<th>Width Standards</th>
<th>Arterial Width (ft.)</th>
<th>Feeder Width (ft.)</th>
<th>Local Width (ft.)</th>
<th>Rating</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design</td>
<td>28</td>
<td>24</td>
<td>22</td>
<td>Good</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>27</td>
<td>23</td>
<td>21</td>
<td>Fair</td>
<td>15</td>
</tr>
<tr>
<td>Tolerable</td>
<td>25</td>
<td>22</td>
<td>20</td>
<td>Poor</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>-24</td>
<td>-22</td>
<td>-20</td>
<td>Very Poor</td>
<td>0</td>
</tr>
</tbody>
</table>

### TABLE 2
RECOMMENDED STANDARDS AND RATINGS FOR VERTICAL HEIGHT CLEARANCE

<table>
<thead>
<tr>
<th>Height Standards</th>
<th>Arterial Height (ft)</th>
<th>Feeder Height (ft)</th>
<th>Local Height (ft)</th>
<th>Rating</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design</td>
<td>14</td>
<td>14</td>
<td>14</td>
<td>Good</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>13</td>
<td>13</td>
<td>12</td>
<td>Fair</td>
<td>4</td>
</tr>
<tr>
<td>Tolerable</td>
<td>12</td>
<td>12</td>
<td>11</td>
<td>Poor</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>-12</td>
<td>-12</td>
<td>-10</td>
<td>Very Poor</td>
<td>0</td>
</tr>
</tbody>
</table>
Fig. 10. When making vertical and horizontal roadway clearance measurements for a bridge inventory, measure minimum openings as indicated by the dashed lines.

Fig. 11. In rating the approaches of bridges during the inventory, horizontal and vertical alignment are considered.
Approach Alignment

The approach alignment should be rated on the basis of difference between the safe road speed and the safe speed on the approach. Safe speed depends on curvature and stopping sight-distance on either approach. Good, fair, poor, and very poor approaches are described below. The rating points assigned to each condition are shown.

Fig. 12. The steep approach shown here greatly reduces sight distance, therefore the approach is given a low rating.
### TABLE 3
RECOMMENDED STANDARDS AND RATINGS FOR BRIDGE AND CULVERT APPROACH ALIGNMENT ON ARTERIAL, FEEDER, AND LOCAL ROADS

<table>
<thead>
<tr>
<th>Approach Alignment Standards</th>
<th>Approach Alignment</th>
<th>Rating</th>
<th>Condition Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design</td>
<td>The road approaching the structure, on either end, offers no restrictive condition of horizontal or vertical curvature or stopping sight-distance for the maximum safe road speed.</td>
<td>Good</td>
<td>15</td>
</tr>
<tr>
<td>Tolerable</td>
<td>The approaches have enough curvature or impaired stopping sight-distance to cause motorists to slightly reduce safe road speed. There have been no accidents attributable to the approach conditions.</td>
<td>Fair</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>The approach curvature or stopping sight-distance causes a definite reduction in speed. There have been no accidents of any consequence.</td>
<td>Poor</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>The approaches to the structure present a serious safety hazard due to very sharp vertical or horizontal curves or inadequate stopping sight-distance. There are indications that the bridge has been repeatedly bumped or scraped. Bridge accidents have been reported.</td>
<td>Very Poor</td>
<td>0</td>
</tr>
</tbody>
</table>

**Waterway Area**

The waterway area of a bridge or culvert is inadequate when it restricts the flow of water so as to cause upstream flooding. Information on flooding which is due to a restriction usually tells more about the adequacy of the size of the waterway opening than the actual size measurements. Therefore, the area of the waterway opening is rated on the basis of reported or recorded upstream flooding. The waterway area conditions are described and assigned rating points in Table 4.
Fig. 13. The waterway area of this bridge consists of all the area enclosed by the dashed lines.

### TABLE 4

RECOMMENDED STANDARDS AND RATINGS FOR THE ADEQUACY OF WATERWAY AREA OF BRIDGES AND CULVERTS ON ARTERIAL, FEEDER, AND LOCAL ROADS

<table>
<thead>
<tr>
<th>Waterway Area Standards</th>
<th>Amount of Upstream Flooding and Damage</th>
<th>Rating</th>
<th>Condition Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design</td>
<td>No upstream flooding.</td>
<td>Good</td>
<td>15</td>
</tr>
<tr>
<td>Tolerable</td>
<td>Occasional upstream flooding but no damage of importance.</td>
<td>Fair</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Occasional upstream flooding (less than once in five years) causing brief closure of road but causing no serious damage to the structure or its approaches.</td>
<td>Poor</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Frequent upstream flooding (more often than once in five years) causing closure of road and danger to the integrity of the structure and its approaches.</td>
<td>Very Poor</td>
<td>0</td>
</tr>
</tbody>
</table>

**Structural Condition**

Structural condition as used here refers primarily to the soundness and the functional capability of materials—steel, concrete, and wood. The structural condition is rated on the condition of materials and the amount of maintenance being per-
formed on the structure. In steel construction look for condition of paint, degree of rusting, looseness of rivets and joints, and alignment problems. Concrete structures and concrete floors on steel structures should be checked for cracking, spalling, scaling, or general disintegration. In timber spans and floors check the condition of paint, wood rot, wear (floors), cracking, splitting, warping, splices, camber, and crushing at the joints.

Check the superstructure and substructure for the above material conditions, alignment, and for damage by vehicles, fire, ice, debris, and vandals. The substructure includes abutments, bents, piers, piles, etc.; also check these for settlement, tilting, and undermining.

Rate the overall structural condition and assign the rating points according to the system shown in Table 5.
### TABLE 5

RECOMMENDED STANDARDS AND RATINGS OF GENERAL STRUCTURAL CONDITION OF BRIDGES AND CULVERTS ON ARTERIAL, FEEDER, AND LOCAL ROADS

<table>
<thead>
<tr>
<th>Structural Standards</th>
<th>Condition of Structural Members and Amount of Maintenance Required</th>
<th>Rating</th>
<th>Condition Points</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Design</strong></td>
<td>All structural members as sound as those of a new or nearly new structure. Only routine maintenance required.</td>
<td>Good</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>Main structural components essentially sound but structure requires fairly frequent maintenance.</td>
<td>Fair</td>
<td>15</td>
</tr>
<tr>
<td><strong>Tolerable</strong></td>
<td>Main structural components have been weakened to some extent by rust, scaling, spalling, rot, etc. Possible to maintain but requires frequent inspection and considerable expense. Condition warrants extensive rebuilding or replacement.</td>
<td>Poor</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>Structurally deteriorated to the point where much of original strength has been impaired, constant surveillance is required and maintenance effort required is excessive. Condition urgently warrants rebuilding or replacement.</td>
<td>Very Poor</td>
<td>0</td>
</tr>
</tbody>
</table>

**Load Capacity**

The load capacity of an existing structure will depend much on the original design, i.e., the size and strength of the structural members. Reevaluating the load capacity of many of the smaller and older structures does not present much of a problem. According to Table 6, structures that can not carry 10 or 15 tons are given a load capacity rating of zero. Undoubtedly a great many structures in most counties would receive a rating of zero, and it would not require an expert to do the analysis.

The rating of the larger and heavier structures in a county may have to be done by an experienced bridge engineer. When the load capacity is determined by a competent party, the information may be used for posting load limits as well as for inventory information.
Fig 15. Load capacity, which is also considered in a bridge inventory, depends mainly on the original design, but also on the structural condition of the members. This light truss failed because of inadequate load capacity.

Table 6 shows recommended load capacity standards and the load capacity ratings for county bridges on arterial, feeder and local roads.

| TABLE 6 |
| RECOMMENDED RATINGS AND STANDARDS FOR LOAD CAPACITY |

<table>
<thead>
<tr>
<th>Load Capacity Standards</th>
<th>Arterial Capacity (Tons)</th>
<th>Feeder and Local Capacity (Tons)</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Condition</td>
</tr>
<tr>
<td>Design</td>
<td>20</td>
<td>15</td>
<td>Good</td>
</tr>
<tr>
<td></td>
<td>19</td>
<td>14</td>
<td>Fair</td>
</tr>
<tr>
<td></td>
<td>18</td>
<td>13</td>
<td>Fair</td>
</tr>
<tr>
<td>Tolerable</td>
<td>17</td>
<td>12</td>
<td>Poor</td>
</tr>
<tr>
<td></td>
<td>16</td>
<td>11</td>
<td>Poor</td>
</tr>
<tr>
<td></td>
<td>15</td>
<td>10</td>
<td>Poor</td>
</tr>
<tr>
<td></td>
<td>-15</td>
<td>-10</td>
<td>Very Poor</td>
</tr>
</tbody>
</table>
Making and Using Priority Ratings

The **Condition Rating** of the structure is the sum of the points assigned to each of the six significant structure characteristics. A structure in good condition and meeting all recommended design standards would have a top **Condition Rating** of 100 points. A sample computation is shown on the right side of Table 7, which is a reproduction of a portion of the "Bridge and Culvert Inventory Log" form:

### TABLE 7

**A SAMPLE CALCULATION OF CONDITION RATING AND PRIORITY RATING**

<table>
<thead>
<tr>
<th>CONDITION AND PRIORITY</th>
<th>Good</th>
<th>Fair</th>
<th>Poor</th>
<th>Very Poor</th>
<th>Rating Assigned</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roadway Width</td>
<td>20</td>
<td>15</td>
<td>7</td>
<td>0</td>
<td>7</td>
</tr>
<tr>
<td>Vertical Clearance</td>
<td>5</td>
<td>4</td>
<td>2</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>Approach Alignment</td>
<td>15</td>
<td>12</td>
<td>6</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Waterway Area</td>
<td>15</td>
<td>12</td>
<td>6</td>
<td>0</td>
<td>12</td>
</tr>
<tr>
<td>Structural Condition</td>
<td>20</td>
<td>15</td>
<td>7</td>
<td>0</td>
<td>7</td>
</tr>
<tr>
<td>Load Capacity</td>
<td>25</td>
<td>18</td>
<td>8</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

**Total Condition Rating Points** = 30

**Priority Rating** = (100 — Condition Rating) = 70

The **Priority Rating** is found by simply subtracting the value of the **Condition Rating** from 100 (PR = 100—CR). Observe in the example that the structure in question has a low **Condition Rating** of 30 points. The **Priority Rating** is therefore 70. In other words, structures in poor condition should have a high priority number in order to get priority attention or early repair. A new, high-type bridge would have a **Priority Rating** of zero.

The priority rating system described here should only be used to compare similar structure types on similar road types. In other words, separate priority listings should be developed for each of the following six categories of structures: (1) bridges located on arterial roads, (2) bridges located on feeder roads, (3) bridges located on local roads, (4) culverts located on arterial roads, (5) culverts located on feeder roads, (6) culverts located on local roads. It is the responsibility of the county road officials
to select from these several sets of priority listings the structure, or small group of structures, to be repaired first.

To help select the structures for immediate repair or improvement and those for later repair or improvement, consider structure importance. A bridge on a primary road is considerably more important than a similar bridge, in a similar condition, on a feeder road.

Other factors to be considered in programing the work are (1) geographic distribution of work within the county, (2) continuity of route improvement, (3) replacement versus major repair, (4) coordination with related projects of the State Highway Commission, and (5) availability of matching funds for FAS projects. These factors, which influence programing, are discussed in more detail in the following section.
V—COUNTY-WIDE PROGRAM FOR BRIDGE IMPROVEMENT

General

A program for bridge improvement is a plan of action that brings together information described in previous sections of the manual. It is not practical to set forth definite procedures for developing a specific county-wide program of bridge improvement; however, general guides and principles are recommended which, if followed, should give county road officials an insight for a progressive bridge program.

Needs Report on County Bridges and Culverts

The needs report may be a formal report which closely ties together all the information, or it may be an assembly of separate items. In any event, a needs report is a definite requirement and should include the items listed below. Most of these items are described more fully in earlier pages.

Fig. 16. The formal needs report contains the items listed in this illustration.

Inventory Cards and Forms

After the completion of the field logging and county-wide inventory of bridges and culverts, the inventory cards along with any photographs should be made a part of the official county highway file records, and the two or more copies of the light-bond, typed, inventory forms should be bound and indexed as an "Inventory Book of Bridges and Culverts." One such bound inventory book should be filed with the county auditor as a part of the official county records.
Bridge and Culvert Map

From the inventory records an official "County Map of Bridges and Culverts" should be prepared to a scale of an inch to the mile, or greater, if desired. This map should also show the entire county highway system along with the major drainage lines and the functional classification of the roads as arterial, feeder, and local. The location of each structure should be indicated with symbols that distinguish bridges from culverts. The map symbols should also be accompanied by the structure number so that the inventory information can be related to the map location. At least three copies of such a map should be prepared and be available in the offices of the board of county commissioners, the county highway supervisor, and the county auditor.

Priority Lists

Priority listings may be developed in a number of ways. Perhaps the easiest and quickest way is to arrange the inventory form for each structure in numerical sequence by its priority rating. This procedure will produce six priority listings: bridges on arterial, feeder, and local roads; and culverts on arterial, feeder, and local roads. Each priority listing should start with the lowest numerical priority rating in that group.

Recommended Improvements and Estimated Costs

This information must be completed for each bridge and culvert before an improvement program can be fully developed. Ideally, this should be worked out, particularly the recommended improvements, concurrently with the field logging and inspection. Each part of the "Needs Report" is important, but unless the recommended improvements and estimated costs are completed and summarized for all the bridges and culverts in the county, county road officials will often be unable to justify the improvement program. This particular point is often very critical with respect to getting public support and approval of the financing for the improvement program.

Summary of Needs

In addition to developing all of the basic items of information that relate to the planning decisions of county road officials, a summary capsule of overall county needs for bridge and culvert improvement must be prepared. Such a summary must be
expressed in terms that the local public can understand, and must be given sufficient publicity to insure that the county’s needs for bridge and culvert replacement are understood.

Here again there is no set rule for the content of a needs summary, but the following data are recommended:

- The number of bridges on arterial, feeder, and local roads, and their estimated replacement cost at current prices.
- The number of culverts (all sizes) crossing arterial, feeder, and local roads, and their estimated replacement cost at current prices.
- The number of bridges having a “poor” or “very poor” rating for each of the six structure characteristics rated (roadway width, vertical clearance, approach alignment, waterway area, structural condition, and load capacity) along with their estimated replacement costs at current prices.

**Financial Plan**

After the needs report has been completed, a financial plan to sustain the improvement program is required. The kind of financial plan usually will govern the rate at which construction and replacement can proceed.

Indiana county road officials have three major sources of revenue, outlined in Section II; these are:

- Motor Vehicle Highway Account
- Federal Aid Secondary (FAS)
- County Taxation
  - Cumulative Bridge Fund
  - General Fund
  - Bond Issues

In working out a financial plan for a county bridge improvement program, county road officials should review the availability of funds from all possible sources. It is only logical that cumulative bridge funds and FAS funds will form the principal financial resources for a county bridge improvement program; however, serious consideration should be given to MVHA funds for short-term needs and to bond issues for long-term needs.

**Short-Range and Long-Range Programs**

A long-range program may be thought to cover a period of about ten years and to embody long-term objectives for upgrad-
ing the entire county highway system from the standpoint of both traffic safety and capacity. The number of bridge projects proposed in a long-range program must, of course, be within the capabilities of the financial plan, and the projects should be presented in a tentative schedule that will indicate the approximate order and year in which the improvements are to be made.

A short-range program is that portion of the long-range program that is to be executed in the immediate and near future, within approximately two to three years. It will include those projects for which plans and specifications are already available and which will be built under next year's budget. These projects will generally have high priority ratings. To insure the orderly progress of bridge improvement, the short-range program must also include a fairly firm list of projects for at least three years ahead. This will assure ample time for preparation of surveys, plans, and specifications in advance and will permit a steady flow of work, even in the face of unexpected problems and delays.

Other Factors in Programming

In addition to the numerical priority rating for the selection of projects to be included in a bridge improvement program, there are often a number of other factors which should be considered but which cannot be reduced to a priority formula. Some of the more common factors that arise are listed below; the order of listing does not necessarily indicate an order of importance.

Geographic Distribution of Work within County

Unless there are compelling and justifiable reasons, the program should not be concentrated in one particular section of the county—this only raises questions in the mind of the public.

Continuity of Route Improvement

It is always good planning to keep the level of improvement along a particular route as uniform as possible; for example, a narrow, one-lane bridge on a newly-improved arterial road might be given added consideration over and above its numerical priority rating.
Replacement versus Major Repairs

This is often a difficult decision in which one must rely on personal judgment. Major repairs to a one-lane bridge on an arterial road can seldom be justified; on the other hand, major repairs may be justified to a one-lane bridge on a local road, particularly where a sizable structure is involved.

Coordination with Related Projects by State Highway

New facilities on a state highway often change the classification of routes, and hence the need and priority of bridge improvements.

Availability of Matching Funds for FAS Projects

It may prove desirable at times to advance the priority of a project in order to obligate available FAS matching funds that would otherwise lapse.

Program Continuity and Personnel

County bridge improvement programs that are progressive and actually carry forward must be a continuing process; they represent a process that is never really finished; they must be managed and guided; and they must be considerably more than a "budget-time problem" even though the annual budget is a vital consideration.

Each year as annual budgets and appropriations are approved, the short-range program should be reviewed and new projects advanced in position so that there is always a reasonably firm list of projects to be improved for the next two or three years ahead. And, there should always be a backlog of plans and specifications on at least two or three projects so that changes of schedule or substitution of projects can be effected without completely dislocating the program.

The periodic completion of projects and up-dating of the short-range program will eventually reduce the size of the long-range program. Therefore, the overall needs for bridge improvement should be reviewed approximately every five years so that decisions can be based on up-to-date information. Correspondingly, the long-range program should be extended about every six to eight years.
If a county bridge improvement program is to achieve these objectives and be carried forward as outlined above, there must be competent, experienced personnel in the county highway department. This need for capable personnel exists with all county road programs but is especially applicable to bridge programs. No matter how well-planned a program may be, it simply cannot execute itself; it must be managed and guided day by day.

Ideally, all county highway departments should be equipped and staffed to perform the following:

(a) to develop a long-range bridge improvement program for their county,
(b) to perform preliminary investigations and field surveys for all routine projects,
(c) to prepare engineering plans and specifications for all routine county bridge projects,
(d) to handle engineering testing and inspection of routine bridge construction projects,
(e) to make routine bridge repairs and improvements with their own county forces.
VI—APPROPRIATIONS AND EXPENDITURES
FOR CONSTRUCTION AND REPAIR
OF BRIDGES AND CULVERTS

General

An important and concluding step in the planning and financing of county bridge programs is the fiscal process of budgeting, appropriating, encumbering, and expending the funds. The steps in this fiscal process must conform to the requirements of Indiana statutes as well as the administrative regulations set forth by the State Board of Accounts and the State Board of Tax Commissioners. Thus, it is important that county commissioners, county highway supervisors, and county engineers have an understanding of the salient features of each step involved, since the applicable requirements and regulations have a direct bearing on the overall program planning.

The purpose of this section is to set forth, as simply as possible, the intent of these statutory requirements and administrative regulations that are currently applicable to county bridge programs. For specific details and questions, not covered herein and not available from the statutory references nor from the county auditor’s office, county road officials should seek the counsel of:

State Board of Tax Commissioners
State Office Building—Room 201
Indianapolis, Indiana

or

State Board of Accounts
State Office Building—Room 912
Indianapolis, Indiana

Calendar of Actions

The following is a listing of important calendar dates that county road officials should keep in mind in planning their annual county highway budgets and appropriations. This schedule of dates is particularly important to the planning and financing of bridge programs since this is the only major highway activity that currently can be financed from funds derived from county taxation.
Calendar of Actions

June — Suggested month for county commissioners

Aug. 1 — To start proceedings to establish a cumulative bridge fund
— Last date on which taxpayers may file a petition with county auditor for revision of cumulative bridge fund

Aug. — Last date for filing county budget estimate with the county auditor (on or before the Wednesday following the first Monday in August)

Aug. — Last date for first publication of county budget (not less than 18 days prior to annual meeting of council)

Aug. — Last date for second publication of county budget (seven days after first publication)

Sept. — Meeting of county council (first Tuesday after first Monday in September)

Sept. — Meeting of County Board of Tax Adjustment (second Monday in September)

Sept. — Last date on which ten or more taxpayers may appeal to State Board of Tax Commissioners on action of county council (not later than the fourth Monday of September)

Oct. 1 — Last date for County Board of Tax Adjustment to complete its duties

Nov. — Last date for starting proceedings to request a reappropriation of funds by the county council. There is no statutory deadline for this action but it is suggested that these proceedings be started at least by the third week in November in order to have sufficient time to call the meeting of the county council and follow all of the statutory procedures required to have the claims advertised and allowed by the board of county commissioners before the end of the year.
<table>
<thead>
<tr>
<th>SEQUENCE</th>
<th>ACTION DETAILS</th>
<th>FORMS USED</th>
</tr>
</thead>
<tbody>
<tr>
<td>BUDGET ESTIMATE</td>
<td>prepared by County Highway Supervisor, approved by County Commissioners and submitted to the County Council for review, revision, and approval.</td>
<td>COUNTY HIGHWAY SUPERVISORS ESTIMATE (County Budget Form No. 26)</td>
</tr>
<tr>
<td>APPROPRIATION</td>
<td>made by Ordinance adopted by County Council after two readings; additional appropriations, if needed, require a special meeting of the County Council for this purpose.</td>
<td>ORDINANCE FOR APPROPRIATIONS (County Budget Form No. 30) County Auditor handles this form</td>
</tr>
<tr>
<td>REQUISITION</td>
<td>prepared by County Highway Supervisor to show quantity and specifications of materials, supplies, or equipment required; filed with County Auditor who advertises for Bids. County Commissioners receive and accept or reject Bid Proposals.</td>
<td>HIGHWAY SUPERVISOR'S REQUISITION (County Form No. 116) BID PROPOSAL—(by Vendor) (Form No. 95.)</td>
</tr>
<tr>
<td>ENCUMBRANCE</td>
<td>made by Purchase Order or Awarded Contract. The amount of encumbrance, whether Purchase Order or Contract, must not exceed the amount available from the Appropriation.</td>
<td>PURCHASE ORDER (General Form No. 98) BID PROPOSAL—(by Contractor) (Form No. 96)</td>
</tr>
<tr>
<td>DISBURSEMENTS Only After Delivery of Goods or Completion of Contract</td>
<td>made by itemized and certified claim by Claimant, approved by County Highway Supervisor, filed with County Auditor allowed by the Board of County Commissioners and a Warrant issued by the County Auditor.</td>
<td>CLAIM (County Form No. 17) SCHEDULE OF CLAIMS (County Form No. 3)</td>
</tr>
</tbody>
</table>
Construction and Repair of Bridges by County Forces

Under the present Indiana statutes covering public purchasing (Burns' 53-108)—

"... county commissioners, acting in behalf of any county, may purchase materials in the manner provided by law (Burns' 53-501) and perform any work by means of its own workmen and owned or leased equipment, in the construction, maintenance, and repair of any highway, bridge, or culvert, without awarding a contract therefor, whenever the cost of such work shall be estimated to be less than eight thousand dollars ($8,000.00)." This amount increased from $8,000 to $20,000 by Chap. 350, Acts 1967.

In the application of this permissive statute, the estimated cost of the bridge project should include all labor, material, equipment rental, engineering, and all other related expenses. It is also important to note that, even though bids would not be received on such a project, it would be necessary to take bids on any item of material required for the bridge project costing $2,000* or more (Burns' 53-501).

Bridge construction or repair projects that cost in excess of $8,000 must therefore be let to contract. With this limitation, it naturally follows that county bridge crews, even when experienced and qualified, can only undertake the construction of the small bridges or culvert structures and the normal repair of the existing bridge structures.

Construction and Repair of Bridges by Contract

Expenditures for the construction and repair of bridges having an estimated cost of $8,000 or more (Burns' 53-108) may only be made by letting the work to contract. It should be noted, however, that contracts may be let for less than $8,000 if desired. This means, therefore, that practically all county bridge structures of about 25 ft or more in length will be let to contract; likewise, all bridge repair work of any major consequence.

Under the present Indiana statutes, in the letting of contracts for bridge construction (Burns' 26-2001 through 2009) it is required that the board of county commissioners adopt plans and specifications for the bridge construction, which are deposited with the county auditor for public inspection from first advertisement for letting of contract. The statutory procedure further pro-

* This amount increased from $1,000 to $2,000 by Chap. 328, Acts 1963.
vides for an advertised notice of letting on two consecutive weeks in a newspaper having general circulation in the county, with last publication ten days before letting. Other provisions include a noncollusion affidavit and surety bond from the bidder, construction inspection, award of contract to lowest responsible bidder, power of board of county commissioners to reject any and all bids and to re-advertise for bids, and penalty fines for failure to comply with required procedure.

**Appropriations from County Taxation**

Funds derived from county taxation for the construction and repair of county bridges are normally obtained through a cumulative bridge fund (Appendix B) or in special or emergency situations through bond issues or directly from county general funds. Irrespective of the method of funding, all appropriations derived from county taxation are handled in a like manner.

**Bridge Construction**

Separate appropriations must be made for *bridge construction* projects with each appropriation itemized to show the location of each bridge and the amount appropriated (Burns’ 26-519).

Subsidiary cost items directly related to the bridge construction project may be included in the budget estimate and appropriation for the individual bridge project. These subsidiary cost items include preliminary engineering (plans and specifications), construction engineering (inspection and testing), additional right-of-way, if required, and road approaches at the ends of the bridge. However, all of the subsidiary items of cost and expense must be itemized in the original budget estimate in order to be fully covered by the appropriation; otherwise, the legality of these subsidiary expenditures is open to question.

Another equally important point is to make the budget estimate and appropriation adequate. The anticipated bridge construction costs must be completely covered by the available appropriation, otherwise, any proposed contract or agreement is “declared to be absolutely void” (Burns’ 26-525). This is a critical point in the case of construction contracts. In those cases where all bids received are in excess of the available appropriation, the board of county commissioners must reject all bids.
and either re-advertise in anticipation of lower bid prices or request an additional appropriation through the county council and then re-advertise for bids.

Funds derived from county taxation (cumulative bridge funds, bond issue, or county general funds) may be and often are used as matching funds for county federal aid bridge projects; this procedure is highly desirable, providing all the federal aid requirements can be met. The use of federal aid funds, however, does not change the requirement for having each bridge construction project itemized to show the location of each bridge and the amount appropriated for it in all those cases where the matching funds are derived from county taxation. (Burns' 26-519).

Aside from the use of federal aid funds, a single source of funds is normally used in making an appropriation for the construction of a bridge project. However, on major structures or in hardship cases, funds may be combined or comingled from two or more sources, providing that at the original inception of the bridge construction project the bridge is itemized as to location and as to the amounts appropriated from the separate available sources to yield the total estimated cost of the completed bridge construction project. It is recommended and is generally preferable to make all the minor, subsidiary expenditures from the same source of funds.

Bridge Repair

A separate budget item and appropriation must be made for bridge repair to be paid for out of funds derived from county taxation. An itemization of this appropriation is also required, but not in the same amount of detail as for bridge construction.

If the county highway department proposes to accomplish the bridge repair work with its own labor and equipment, then the itemization need only cover the “material” items, by type, that will be required for the year’s work program of bridge repair. If, on the other hand, a part or all of the bridge repair program is to be accomplished on a purchase order agreement using equipment and labor from outside the county highway department, the itemization of the appropriation should include “Labor,” “Equipment Rental,” and “Materials.” In either case, the item of “Materials” should ordinarily be broken down into
bridge steel, bridge timbers, bridge piling, or concrete where these are major items to be purchased for repair work. In addition, it is necessary to take bids on any material item purchase costing $2,000* or more (Burns' 53-501).

In working up budget estimates and appropriations for bridge repair to be paid for out of county taxation, county road officials should make a careful distinction between repair and maintenance. Routine cleaning of bridge shoes, bridge painting, weed-mowing at ends of bridges, minor washouts, road-grading or patching of approaches, and the clearing of trash and debris from the bridge opening is ordinarily classified as "maintenance" and as such may not be paid for out of funds derived out of county taxation. Repair, on the other hand, includes the replacement or strengthening of any part of the structure, floor, foundation, piers, abutments, or guard rail, as well as major washouts on or through approaches.

Another important regulation regarding the use of county tax funds for bridge repair is that "Material" items cannot be purchased to build up a stockpile inventory. Therefore, the purchasing of materials should be scheduled so that the bridge repair materials are used during the same calendar year that the purchase is made. In those cases where it is desirable to carry a stockpile inventory of a particular material item, purchases should be made from gas tax funds.

**Appropriations from Motor Vehicle Highway Account**

Funds from this source may be appropriated with greater latitude than in the case of county tax funds. However, in all cases and irrespective of the source of funds, expenditures can only be made from appropriations previously authorized by an ordinance of the county council.

**Bridge Construction**

Under present Indiana statutes it is not necessary to make a separate appropriation for each bridge construction project when the cost is to be paid out of MVHA funds. Therefore, a single appropriation for bridge construction may cover one or more structures without any detailed itemization, except in the case

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* This amount increased from $1,000 to $2,000 by Chap. 328, Acts 1963.
where MVHA funds are to be combined or comingle with funds derived from county taxation: cumulative bridge funds, county general funds, or bond issues. (See page 47.)

**Bridge Repair**

An appropriation for the item of bridge repair is not required when the cost of bridge repair is to be paid out of MVHA funds. However, all items of “Materials” such as bridge piling, bridge timber, and bridge steel as well as “Equipment Rental” must have separate appropriations. “Material” items may be purchased from MVHA funds for stockpile inventory. It should be noted, however, that it is necessary to take bids on any material item purchase costing $2,000* or more (Burns’ 53-501).

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* This amount increased from $1,000 to $2,000 by Chap. 328, Acts 1963.
APPENDIX A

BRIDGE DESIGN STANDARDS

Bridges on Secondary Roads

(a) Since bridges and structures will represent a significant portion of the cost of secondary and feeder roads, the economic justification of expenditures requires careful coordination of bridge capacity and cost. The following guide should be adhered to in applying AASHO standards for secondary roads:

<table>
<thead>
<tr>
<th>Item</th>
<th>Class I over 1,000</th>
<th>Class II 400 to 1,000</th>
<th>Class III 200 to 400</th>
<th>Class IV less than 200</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design loading</td>
<td>H-15</td>
<td>H-15</td>
<td>H-10 for treated</td>
<td>H-10</td>
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<td></td>
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<td>timber. Single H-15</td>
<td></td>
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<td></td>
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<td>for steel and concrete</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>permanent construction</td>
<td></td>
</tr>
<tr>
<td>Clear roadway width, feet*</td>
<td>4 feet wider than</td>
<td>22-24</td>
<td>20-22</td>
<td>14-20†</td>
</tr>
<tr>
<td></td>
<td>approach pavement</td>
<td></td>
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</tr>
</tbody>
</table>

Bridges to remain:

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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Clear roadway width, feet</td>
<td>22</td>
<td>18</td>
<td>14</td>
<td>10</td>
</tr>
</tbody>
</table>

* In no case less than the traveled roadway width on approaches.
† On long bridges, turnouts may be considered.
(b) Design standards for Class I bridges should conform with current practice applicable to roads with similar traffic conditions on the federal-aid primary highway system.

(c) Class II and III bridges, expected to carry heavy trucks on more than an intermittent basis, shall be designed for a minimum capacity of H-15.

(d) On Class III bridges it is intended that the H-10 minimum design loading generally shall apply only to treated timber trestle construction with main carrying members of timber. For steel or concrete stringer and concrete deck construction, H-15 single lane loading placed in any position on the roadway should be the minimum used.

(e) Single-lane bridges and those of less than traveled-approach roadway width shall be considered for new construction only in exceptional cases. Their use shall be authorized only with the provision of standard advance warning signs and guardrail roadway transitions.

(f) Culverts shall, in all cases, be of full shoulder to shoulder graded width, load carrying capacity to be as given for bridges.

(g) Minimum overhead clearance for new through structures shall be 14 feet. Deficient clearance for spans to remain in place shall, if feasible, be increased to 14 feet and in all cases to at least 12 feet 6 inches. Clearance less than 14 feet should be indicated by high-visibility overhead signs. All clearances preferably shall apply for full width between curbs.

(h) The vertical clearances given in preceding paragraph and widths shown in the guide shall apply to under-passes, both new and those to remain in place.

(i) Federal-aid funds may be used for reconstruction required to bring substandard bridges up to the minimum capacities and widths specified in the guide, under “bridges to remain.” Such work shall be limited to bridges where the required expenditures can be economically justified as a temporary expedient. Approval will be conditioned on the understanding that the bridges will be put on the program for replacement in the future when conditions warrant.
(j) Existing bridges of width less than that specified for new bridges, having remaining useful life and adequate capacity, may be retained in place contingent on:

(1) Provision of good alignment and visibility in approach roads to insure safe passage at traffic speeds commensurate with the improved road

(2) Posting for load and speed limits

(3) Installation of standard advance reflectorized signs on approach roads and reflectorized buttons at bridge ends

(4) Provision of guardrail roadway transitions at bridge ends where traffic volumes are in excess of 100 vehicles per day.
APPENDIX B

OUTLINE OF PROCEDURE TO ESTABLISH A CUMULATIVE BRIDGE FUND FOR CONSTRUCTION AND REPAIR OF COUNTY BRIDGES

Acts of Indiana 1951—Chap. 299 as amended
Burns' Indiana Statutes 36-1910 et seq.

[Outline below applies specifically to County Units; a similar procedure is available to City Councils and Town Boards.]

Item 1. Board of County Commissioners adopts a resolution to provide a cumulative bridge fund in accordance with Chap. 299, Acts 1951, as amended; such resolution must specify the proposed tax rate and the years in which it is to be levied; a tax levy up to 20¢ per $100 for a period not exceeding 5 years is permitted under present law. See Exhibit A.

Item 2. Board of County Commissioners gives a 10-day notice to the taxpayers of the county (See Exhibit B) on the proposed action and of a public hearing on same:

by posting such notice in three (3) public places in the county and

by publication in two (2) newspapers of opposite political parties published in the county or by publication in one (1) newspaper if only one (1) is published in the county.

Item 3. Board of County Commissioners determines, after holding public hearing, whether to proceed with the proposed plan to provide a cumulative bridge fund; if the Board proceeds with plan then the ...

Item 4. Board of County Commissioners submits the adopted plan, (stating the proposed tax rate and years in which it will be applied) along with proofs of posting and publication, to the State Board of Tax Commissioners for review and approval.

Item 5. Board of County Commissioners notifies the affected taxpayers by posting and one (1) publication as provided (in Item 2) above that the proposed plan to provide a cumulative
bridge fund has been submitted to the State Board of Tax Commissioners for review and approval. See Exhibit C. Special Note: The form notice in Exhibit C is prepared by State Board of Tax Commissioners and mailed to County Auditor for publication.

**Item 6.** Not later than ten (10) days following the above publication, ten (10) or more personal and property taxpayers in the taxing district (county) may file a petition with the County Auditor, setting forth their objections to the proposed levy.

**Item 7.** The County Auditor certifies such petition (if filed) immediately to the State Board of Tax Commissioners.

**Item 8.** The State Board of Tax Commissioners sets a date for a local hearing on such petition of objections and notifies the Board of County Commissioners, the County Auditor, and the first ten (10) signers of the petition of the time and place of the hearing.

**Item 9.** The State Board of Tax Commissioners, after hearing, approve or disapprove the proposed plan for providing a cumulative bridge fund and certifies its action to the County Auditor. (The State Board of Tax Commissioners has no power to modify the proposed plan but can only approve or disapprove the plan as presented.)

**Item 10.** If the State Board of Tax Commissioners does not approve the plan as presented, the Board to County Commissioners may initiate proceedings for a new and different plan for providing a cumulative bridge fund.

**Item 11.** If the State Board of Tax Commissioners approves the plan, the established tax rate shall be published annually along with other tax levies for the county.

**Item 12.** Ten (10) or more property taxpayers may file a petition with the County Auditor, not later than August 1 of any year, for the reduction or revision of said levy, setting forth their objections to such a levy.

**Item 13.** The County Auditor shall certify the petition to the State Board of Tax Commissioners and the same procedure of notice and hearing as outlined in Items 8 or 9 shall be followed.
**Item 14.** Taxes collected by the cumulative bridge levy are held in a special fund and can be expended only for the purpose for which they were levied (building and repair of bridges).

**Item 15.** No expenditures can be made from the cumulative fund except those appropriated (either annual appropriations or additional emergency appropriations) in the manner provided by law—i.e., appropriated by the County Council, and approved by the State Board of Tax Commissioners.
EXHIBIT A

RESOLUTION TO ESTABLISH
A CUMULATIVE BRIDGE FUND FOR
THE BUILDING AND REPAIR OF BRIDGES

Be it resolved by the Board of County Commissioners, __________ County, Indiana, that it is desired and deemed necessary to proceed with a proposed plan to establish a cumulative bridge fund for building and repair of bridges and grade separation in __________ County, and the levying of an additional tax at the rate of ___¢ on each $100.00 of taxable property in __________ County, Indiana, to provide funds for said fund; said tax to be first levied in ________, payable in ________, and annually thereafter for a total period of ___ years, not to exceed five years, all as provided by Chapter 299 of the Acts of the General Assembly of the State of Indiana for 1951, as amended.

Be it further resolved that proof of publication and proof of notices of such public hearing had on this ___ day of __________, 19___, and a certified copy of this resolution and such proposed plan be submitted to the State Board of Tax Commissioners of the State of Indiana, as provided by law.

Adopted this ___ day of __________, 19__.

Attest – Seal

________________________

________________________

County Auditor  County Commissioners

EXHIBIT B

FORM OF FIRST NOTICE RELATIVE
THE ESTABLISHMENT OF A CUMULATIVE BRIDGE FUND

NOTICE TO TAXPAYERS OF __________ COUNTY

Notice is hereby given to the taxpayers of __________ County, Indiana, that the Board of County Commissioners will meet at (place) __________ on (date) __________ at ___ o'clock ___ , Central Standard Time, for the purpose of considering a proposal to establish a cumulative bridge fund for the building and repair of bridges and grade separation and the levying of an additional tax at the rate of ___¢ on each $100.00 of taxable property in __________ County, Indiana, to provide funds for said fund; said tax to be first levied in ________, payable in ________, and each year thereafter for ___ years, all as provided by Chapter 299 of the Acts of the General Assembly of the State of Indiana for 1951, as amended.

Taxpayers are invited to be present and will have a right to be heard thereon before said proposal is finally approved and submitted to the State Board of Tax Commissioners for approval.

Attest – Seal

________________________

________________________

County Auditor  County Commissioners
EXHIBIT C

This notice prepared by State Board of Tax Commissioners and mailed to County Auditor for publication.

FORM OF SECOND NOTICE RELATIVE TO THE ESTABLISHMENT OF A CUMULATIVE BRIDGE FUND

NOTICE TO TAXPAYERS OF ____________ COUNTY

You are hereby notified that upon the ______ day of _______ 19___, that the Board of County Commissioners of ____________ County, Indiana, by resolution duly adopted and pursuant to Notice thertofofore, given and under and by virtue of Chapter 299 of the Acts of the 87th General Assembly of the State of Indiana, approved March 7th, 1951 as amended, duly adopted a plan whereby a cumulative bridge fund be provided for the building and repair of bridges in said County, and that such a fund be provided for by a tax levy of _____ of each $100.00 of assessed valuation on all property in that taxing district taxable for such purposes. Such tax to be assessed beginning with the levy for ______ payble in ______, and annually thereafter for a total period of ____ years, as provided by said Act.

That pursuant to said Act any ten (10) or more taxpayers in the taxing district of ____________ County, Indiana, other than those who pay Poll Tax only, may file a petition with the County Auditor of ____________ County, Indiana, not later than ten (10) days after this publication setting forth their objections to such proposed levy. Upon filing of such petition said Auditor will immediately certify same to the State Board of Tax Commissioners.

Attest - Seal

__________________________

County Auditor  County Commissioners

SPECIAL NOTE TO COUNTY ROAD OFFICIALS:

Current and approved forms shown in Exhibit A, Exhibit B, and Exhibit C are available on request from the State Board of Tax Commissioners.

Specific questions on the establishment of cumulative bridge funds and the approval of annual budgets and appropriations therefor should be referred to:

State Board of Tax Commissioners
State Office Bldg. - Room 201
Indianapolis, Indiana
## BRIDGE TYPES

### with

Name Abbreviations

<table>
<thead>
<tr>
<th>Name</th>
<th>Abbreviations</th>
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<tbody>
<tr>
<td>I-1/cO/nS</td>
<td>I Columns Substructure</td>
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<td>I</td>
<td>Columns</td>
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<td>BL</td>
<td>Beam Leg</td>
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<td>L.</td>
<td>Floor Beam</td>
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<td>Beam Stringers</td>
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### Diagrams

- **Beam Leg-BL**
- **Truss Leg-T.L**
- **Low Warren Truss-L.W.T.**
- **Low Warren Truss with Verticals-L.W.T.V**
- **Low Pratt Truss 1/2 Hip-L.P.T.H.**
- **Low Pratt Truss, Full Slope-L.P.T.FS.**

59
Thru Howe Truss - T.H.T.  
Thru Burr Covered Truss - T.B.C.T.
Thru Lattice or Town Truss - T.L.T.  
Note: When Covered - T.L.C.T.
Thru Warren Truss - T.W.T.
Thru How Covered Truss - T.H.C.T.
Thru Whipple Truss - T.Wh.T.
Thru Prott Truss - T.Pr.T.
Thru Baltimore Truss - T.B.T.
Camel Back Truss - C.B.T.
Thru Petit Truss - T.Pe.T.
Thru Quadrangular Warren Truss - T.Q.W.T.
Thru K Truss - K1
Thru Fink Truss - T.F.T.
Thru K Truss - K2
Thru Ballman Truss - T.Bo.T.
Bowstring Steel Arch - Bow Arch
CONCRETE SLAB (PLAIN)

RIGID FRAME - CONCRETE

Open Spandrel Arch - O.S.A.

Spandrel Fill Arch - S.F.A.

Rein. Conc. Girder - R.C.G.


TIMBER TRESTLE
OTHER TYPES

Frame Bent

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<thead>
<tr>
<th>TYPE</th>
<th>SUBSTRUCTURE</th>
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</thead>
<tbody>
<tr>
<td>Flat Slab</td>
<td>R.F.S</td>
</tr>
<tr>
<td>Integral Slab and Beam</td>
<td>I.S.B.</td>
</tr>
<tr>
<td>Thru Conc Arch</td>
<td>J.C.A.</td>
</tr>
<tr>
<td>1/2 Thru Conc Arch</td>
<td>1/2T.C.A.</td>
</tr>
<tr>
<td>Thru Steel Arch</td>
<td>T.S.A.</td>
</tr>
<tr>
<td>Stone Block Arch</td>
<td>S.B.A.</td>
</tr>
<tr>
<td>1/2 Thru Steel Arch</td>
<td>1/2T.S.A.</td>
</tr>
<tr>
<td>Thru Plate Girder</td>
<td>T.P.G.</td>
</tr>
<tr>
<td>1/2 Thru Plate Girder</td>
<td>1/2T.P.G.</td>
</tr>
<tr>
<td>Deck Plate Girder</td>
<td>D.P.G.</td>
</tr>
<tr>
<td>Spandrel Fill Arch</td>
<td>S.F.A-MP.</td>
</tr>
<tr>
<td>Lift and Bascule</td>
<td>L.B.</td>
</tr>
</tbody>
</table>

PILE BENT

FRAME BENT

TYPE OF SUBSTRUCTURE

Ashlar Masonry...A.M.
Stone Block......S.B.
Concrete........C.
Steel Tube and Plates...S.T.&P.
Steel Shapes.....I,H,&
Wood...............Wd.
## Appendix D
### COMMON CULVERT TYPES AND MATERIALS

<table>
<thead>
<tr>
<th>Culvert Type</th>
<th>Typical Cross Section</th>
<th>Common Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pipe, single or multiple</td>
<td></td>
<td>Corrugated metal, plain or reinforced concrete, vitrified clay, cast iron</td>
</tr>
<tr>
<td>Pipe arch, single or multiple</td>
<td></td>
<td>Corrugated metal</td>
</tr>
<tr>
<td>Box culvert, single or multiple span</td>
<td></td>
<td>Reinforced concrete</td>
</tr>
<tr>
<td>Bridge culvert, single or multiple span</td>
<td></td>
<td>Reinforced concrete</td>
</tr>
<tr>
<td>Arch</td>
<td></td>
<td>Reinforced concrete, corrugated metal, or stone masonry arch on reinforced-concrete foundation</td>
</tr>
</tbody>
</table>

From "Highway Engineering"
By R. I. Hewes and C. H. Oglesby;
John Wiley and Sons Inc., 1956

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Appendix E
COMMON CULVERT HEADWALLS AND ENDWALLS

(a) Straight type  (b) L type

(c) Wing type  (d) Flared type  (e) U type

(f) Stepped-U type  (g) Warped type

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