Research Report
KTC-07-04/SPR246-02-3F

KENTUCKY TRANSPORTATION CENTER

PRELIMINARY SEISMIC EVALUATION AND RANKING OF BRIDGES ON AND OVER THE PARKWAYS IN WESTERN KENTUCKY

UNIVERSITY OF KENTUCKY
College of Engineering

OUR MISSION

We provide services to the transportation community
through research, technology transfer and education.
We create and participate in partnerships
to promote safe and effective
transportation systems.

OUR VALUES

Teamwork
Listening and communicating along with
courtesy and respect for others.

Honesty and Ethical Behavior
Delivering the highest quality
products and services.

Continuous Improvement
In all that we do.

Research Report
KTC-07-04/SPR246-02-3F

PRELIMINARY SEISMIC EVALUATION AND RANKING OF BRIDGES ON AND OVER THE PARKWAYS IN WESTERN KENTUCKY

by

Jian Xie
Research Professor, Kentucky Transportation Center

Issam E. Harik
Professor, Department of Civil Engineering and Program Manager, Structures and Coatings Section, Kentucky Transportation Center

Tong Zhao
Visiting Professor, Kentucky Transportation Center

and

Jindong Hu
Visiting Professor, Kentucky Transportation Center

Kentucky Transportation Center
College of Engineering, University of Kentucky

in cooperation with

Transportation Cabinet
Commonwealth of Kentucky

and

Federal Highway Administration
U.S. Department of Transportation

June 2008

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
KTC-07-04/SPR246-02-3F		

4. Title and Subtitle	5. Report Date
PRELIMINARY SEISMIC EVALUATION AND RANKING OF BRIDGES ON AND OVER THE PARKWAYS IN WESTERN KENTUCKY	June 2008
	6. Performing Organization Code
7. Author(s): Jian Xie, Issam E. Harik, Tong Zhao, and Jindong Hu	8. Performing Organization Report No. KTC-07-04/SPR246-02-3F
9. Performing Organization Name and Address Kentucky Transportation Center College of Engineering University of Kentucky Lexington, Kentucky 40506-0281	10. Work Unit No. (TRAIS) 11. Contract or Grant No. SPR246
12. Sponsoring Agency Name and Address Kentucky Transportation Cabinet State Office Building Frankfort, Kentucky 40622	13. Type of Report and Period Covered: Final 14. Sponsoring Agency Code

15. Supplementary Notes

Prepared in cooperation with the Kentucky Transportation Cabinet and the U.S. Department of Transportation, Federal Highway Administration.

16. Abstract

Five parkways in Western Kentucky are located in the region that is greatly influenced by the New Madrid and Wabash Valley Seismic Zones. This report executes a preliminary screening process, known also as the Seismic Rating System, for bridges on and over parkways in Western Kentucky to identify the seismic vulnerable bridges.

The ranking of bridges derived from this rating system is based on: structural vulnerability, seismic and geotechnical hazards, and bridge importance. There are 349 bridges were ranked with the Seismic Inventory of Bridges (SIB), a user-oriented database program developed according to the Seismic Retrofitting Manual. The bridge ranks (R) range from a low of 0 to a high of 75, based on a scale of 100.

According to the seismic rank and regularity of bridges on and over the parkways in Western Kentucky, there are a total of 17 bridges, including parallel bridges, were selected for detailed seismic analysis. The 17-bridges have an average ranking of 58, with a highest bridge rank of 75.

17. Key Words	18. Distribution Statement
Seismic Evaluation, Bridges, Parkways in Western Kentucky, Seismic Rating System, Structural Vulnerability, Seismic and Geotechnical Hazards	Unlimited with approval of Kentucky Transportation Cabinet

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	99	

Form DOT 1700.7(8-72) Reproduction of Completed Page Authorized

EXECUTIVE SUMMARY

Objective

In May 1995, the Federal Highway Administration (FHWA) published a revised Seismic Retrofitting Manual for Highway Bridges to serve as a guide for seismic evaluation and retrofit design of current bridges in order to reduce serious damage due to an anticipated earthquake. With the guidance provided in this manual, this report executes a screening process for bridges on and over the parkways in Western Kentucky to identify the seismic vulnerable bridges.

The primary objectives of the study that provides the basis of this report were to: (a) compile an inventory of bridges on and over the parkways in Western Kentucky, (b) conduct a field inspection of all applicable bridges, (c) rank these bridges in terms of their risk of structural vulnerability, and (d) determine the crucial or vulnerable bridges to be detailed seismic evaluation. Completion of objective (a) required the development of a database. This was done successfully by using Microsoft Access2000. Objective (b) was completed by performing in-depth site inspections for each bridge and the site inspection forms were included in Research Report (KTC-07-03/SPR246-01-2F). Objectives (c) and (d) were completed in accordance with the state of the art as described in Seismic Retrofitting Manual and Seismic Evaluation and Retrofit of Bridges (Harik, et. al).

Inventory of Bridges

The Seismic Vulnerability Identification is composed of two phases: the production of a seismic inventory and the establishment of a vulnerability rating. During the first phase, the structural information pertinent to 389 bridges were collected and implemented with the database mentioned above.

Site Inspection of Bridges

During June and July 2002, a field inspection of bridges on and over the parkways in Western Kentucky was conducted to verify the information obtained from a review of the bridge plans and to detect seismically vulnerable conditions of the applicable bridges.

Ranking and Evaluation of Bridges

This study ranked three hundred and forty-nine bridges on and over the parkways in Western Kentucky based on their structural vulnerability ratings except thirty-eight culverts and two underpasses. The bridge ranks (R) range from a low of 0 to a high of 75, based on a scale of 100.

Determination of Priority Bridges

According to the seismic rank and regularity of bridges on and over the parkways in Western Kentucky, there are a total of 17 bridges, including parallel bridges, were selected for detailed seismic analysis. The 17-bridges have an average ranking of 58, with a highest bridge rank of 75. All of the selected bridges were constructed in the 1960s, in which, seismic design was not taken into consideration. The selected bridges, which are of different construction types: reinforced and prestressed concrete, and steel composites bridges, for further evaluation are presented in Table E.1.

NOTE: This report is the third (3rd) in a series of six (6) reports for Project SRP 246: "Seismic Evaluation of Bridges along Western Kentucky Parkways". The six (6) reports are:

Report Number:	Report Title:
(1) KTC-07-02/SPR246-02-1F	Seismic Evaluation of Bridges on and over the Parkways in Western Kentucky – Summary Report
(2) KTC-07-03/SPR246-02-2F	Site Investigation of Bridges on and over the Parkways in Western Kentucky
(3) KTC-07-04/SPR246-02-3F*	Preliminary Seismic Evaluation and Ranking of Bridges on and over the Parkways in Western Kentucky
(4) KTC-07-05/SPR246-02-4F	Detailed Seismic Evaluation of Bridges on and over the Parkways in Western Kentucky
(5) KTC-07-06/SPR246-02-5F	Seismic Evaluation and Ranking of Embankments for Bridges on and over the Parkways in Western Kentucky
(6) KTC-07-07/SPR246-02-6F	Seismic-Hazard Maps and Time Histories for the Commonwealth of Kentucky

* Denote current report

Table E.1: Bridges that are deemed critical based on the preliminary analysis and ranking.

No.	Parkway	County	BIN Number	SPC	Drawing Number	R
1	Purchase	Fulton	38-0051-B00012	D	16696	75.0
2			38-0307-B00015	D	16649	75.0
3			38-9003-B00053	D	16694	75.0
4			38-9003-B00053P	D		75.0
5			38-9003-B00054	D	16695	75.0
6			38-9003-B00054P	D		75.0
7			38-9003-B00055	D	16561	75.0
8			38-9003-B00055P	D		75.0
9	Purchase	Hickman	53-0094-B00050	D	16566	75.0
10			53-1529-B00056	D	16567	75.0
11			53-9003-B00068	D	16565	75.0
12	Audubon	Daviess	30-9005-B00060	C	17494	38.0
13			30-9005-B00061	C	17464	38.0
14	Purchase	Graves	42-9003-B00157	C	16527	35.1
15			42-9003-B00157P	C		35.1
16	Pennyrile	Webster	117-9004-B00071[a]	B	16858	8.4
17			117-9004-B00071P	B		8.4

Note: [a] 48.6-53.3-53.3-53.3-53.3-53.3-48.53 (Seven Spans, RC)

ACKNOWLEDGEMENTS

The Federal Highway Administration and the Kentucky Transportation Cabinet provided the financial support for this project. Many thanks are extended to the following undergraduate and graduate students in the Department of Civil Engineering who worked many hours in the completion of this project: Robert Goodpaster, Michael Davidson, and Scott Pabian.

Table of Content

LIST OF TABLES

LIST OF FIGURES

1. INTRODUCTION

It is well known that the New Madrid and Wabash Valley Seismic Zones (see Figure 1) could cause considerable vibrations in Western Kentucky if a sizable earthquake occurred in that region. The New Madrid seismic zone is potentially one of the most destructive fault zones in the United States. In 1811-1812, four of the most severe earthquakes in American history occurred in the New Madrid Seismic Zone. The instrumental observations indicate that the New Madrid Seismic Zone is still the most hazardous zone in the east of the Rocky Mountains (Johnston 1985).

The New Madrid Seismic Zone extends through the Mississippi River Valley and encompasses 26 Western Kentucky counties in its area of strongest influence. Most of the seismic activity in Kentucky has occurred in the western portion of the State, near the New Madrid seismic zone. Seismologists have calculated the probability of a magnitude 6.3 earthquake (Richter scale) hitting this area in the next 50 years at 86 to 97%. It is no doubt that Western Kentucky in general is in a high-risk earthquake zone.

Five parkways in Western Kentucky are located in the region that is greatly influenced by the New Madrid and Wabash Valley Seismic Zones. These five parkways are Audubon Parkway, Pennyrile Parkway, Purchase Parkway, Western Kentucky Parkway, and William Natcher Parkway. There are currently about 400 bridges on/over the parkways (See Figure 2 and Table 1 through Table 3), which were designed and constructed prior to the application of present-day seismic design codes. These existing older bridges were not designed to resist seismic loadings and have not yet been subjected to any moderate or strong earthquake. Therefore, seismic evaluation and retrofit of these bridges in Western Kentucky have to be carried out.

2. SEISMIC RATING SYSTEM

2.1 General

An efficient and comprehensive retrofitting program requires that structures be ranked according to their need for seismic retrofitting. It is recommended that a preliminary screening process be established for this purposed for all bridges on and over the parkways in Western Kentucky.

Preliminary screening process – known also as the Seismic Rating System of bridges is used to identify and prioritize bridges that are seismically deficient and those in the greatest need of a detailed seismic evaluation, which will be described in another report.

The information provided herein is obtained from the Seismic Retrofitting Manual for Highway Bridges (Buckle, I.G. and Friedland, I.M., 1995), published by the Federal Highway Administration (Report No. FHWA-RD-94-052).

The Retrofitting Manual describes a method for developing a Seismic Rating System which may be used to prioritize bridges according to their need for seismic hazard reduction. Factors considered in the seismic rating process include structural vulnerabilities, seismic and geotechnical hazards, and bridge importance. The Seismic Rating System will be explained with the aid of Figure 3.

2.2 Determine Acceleration (A) and Importance coefficients (I)

A small particle, such as a building structure attached to the earth during an earthquake, will be moved back and forth rather irregularly. Commonly, this movement can be described as: (a) change in position, (b) change in velocity, and (c) change in acceleration, as a function of time. Most building codes prescribe how much horizontal force a building due to a design earthquake should withstand, and since this force is generally related to the ground acceleration, the ground acceleration is chosen. The peak ground acceleration (PGA) is then the maximum acceleration experienced by the building structure during the course of the earthquake motion.

Peak ground acceleration contour maps (See Figure 4), defining seismic zones and response spectra, are given for each Kentucky county basis for the seismic design of new bridges and seismic evaluation of existing bridges. Peak ground accelerations (PGA), as a function of the acceleration (A) coefficient and gravitational acceleration constant ($g = 9.81 m/sec^2$ or $386 in/sec^2$), of different counties in Western Kentucky are listed in Table 4.

The acceleration coefficients (A) adopted in this report are different from the American Association of State Highway and Transportation Officials (AASHTO) specifications because local peak-particle accelerations, time histories and response spectra for Kentucky have already been procured by the Kentucky Transportation Center (KTC). This information is obtained from a time history response spectra identification map for 50-year event and 250-year event derived by Street et al (1996).

Two categories used to describe the Importance (I) coefficient, as documented in the Seismic Retrofitting Manual (Buckle, I.G. and Friedland, I.M., 1995) are: essential and standard. Bridges classified as "Essential" are bridges that must remain functional and operational after an earthquake event. All other bridges are categorized as standard. The importance of all the bridges on and over the Parkways in Western Kentucky can be classified as "Essential" bridges.

2.3 Determine Seismic Performance Category (SPC)

Before seismic retrofitting can be undertaken for a group of bridges, they may first be classified according to their Seismic Performance Category (SPC). Based upon the considerations for seismic hazard and importance, four SPC categories (A, B, C, and D) are defined by the Retrofitting Manual, as shown in Table 5. This classification system is different from the classification system used in the AASHTO Specifications for new design. Since all the bridges on and over the Parkways in Western Kentucky are classified as "Essential" bridges, the SPC of these bridges can be exclusively determined by the seismic hazard (acceleration coefficient).

From referring to Figure 5 and Table 5, the Seismic Performance Category (SPC) of all the bridges on and over parkways in Western Kentucky are listed in Table 4. The requirements of seismic evaluation procedures with regard to SPC vary from one category to the other. For example, bridges in SPC B only need to be screened, evaluated and strengthened based on the vulnerability of their bearings, expansion joints and support widths. In SPC C and D, however, items including screening, evaluation and retrofitting will include all major components subjected to failure during a strong earthquake. The effects of soil failure, such as liquefaction, are also considered for bridges in SPC C and D.

2.4 Compile Structural Inventory Data

In order to obtain critical information regarding each bridge, a comprehensive inventory of bridges was compiled by review of the "as-built" plans, construction and maintenance records, and site inspections. The form shown in Figure 5 is used for data collection. In this inventory all the necessary data was organized and processed by a database entitled Seismic Inventory of Bridges (SIB), which was programmed using Microsoft Access 2000 (see Section 4). Data pertinent to 389 bridges was collected and implemented as a seismic evaluation information system. This inventory provides an essential base to improve our understanding of bridge damage due to future earthquakes.

The inventory of bridges was reviewed to: (a) select bridges to be used in detailed studies, (b) select structural characteristics (attributes) that best describe the seismic response of bridges, and (c) verify the correctness of the attribute values included in the bridge inventory database.

2.5 Determine Soil Profile Type and Soil Coefficient (S)

Table 6 shows how the different soil profile type and site coefficient (S) are determined. In locations where the soils properties are not known in sufficient detail to determine the soil profile type with confidence, or where the profile does not fit any of the above four types, the site coefficient shall be based on engineering judgment.

2.6 Determine Structural Vulnerability Rating (V)

Although the performance of a bridge is based on the interaction of all of its components, it has been observed in past earthquakes that certain bridge components of four general types are more vulnerable to damage than others. These are (a) the connections, bearings, and seats; (b) columns and foundations; (c) abutments; and (d) foundations. Of these, bearings are generally the least expensive to retrofit. For that reason, the Seismic Retrofitting Manual proposes a separate vulnerability-rating factor (V_1) for the connections, bearings, and seat details. The other three components are combined under another rating factor (V_2). The overall rating for the bridge is then given by the larger of these two factors. A flow chart summarizing the process to calculate Vulnerability Rating (V) is shown in Figure 6.

2.6.1 Vulnerability Rating for Connections, Bearings, and Seat Widths (V_1)

According to the Seismic Retrofitting Manual, a suggested step-by-step method for determining the vulnerability rating for connections, bearings, and seat widths is detailed in the flow chart of Figure 7.

2.6.2 Vulnerability Rating for Columns, Abutments, and Liquefaction Potential (V_2)

The vulnerability rating for the other components in the bridges that are susceptible to failure, V_2, is calculated from the individual component ratings as follows:

$$V_2 = CVR + AVR + LVR \leq 10$$

Where, CVR = column vulnerability rating
AVR = abutment vulnerability rating
LVR = liquefaction vulnerability rating

Suggested methods for calculating of each of these component ratings are given in Figure 8 through Figure 10.

2.7 Calculate Seismic Hazard Rating (E) and Bridge Rank (R)

As a measure of seismic hazard, the peak ground acceleration in rock or competent soil is used. The hazard is modified by the soil profile coefficient S, varying from 1.0 for rock to 2.0 for soft clays and sands, to allow for soil amplification effects. The seismic hazard rating (E) is calculated using the following equation.

$$E = 12.5 \cdot A \cdot S \leq 10 \quad \text{(Seismic Retrofitting Manual, Eq. 2-4)}$$

The bridge rank (R) is calculated based on a structural vulnerability rating (V) and a seismic hazard rating (E). Each rating (V and/or E) lies in the range of 0 to 10 and the rank (R) is found by multiplying these two ratings together:

$$R = V \cdot E \quad \text{(Seismic Retrofitting Manual, Eq. 2-2)}$$

Since V and E, each, range from 0 to 10, the minimum and maximum values for R will then be 0 and 100, respectively. In general, the higher the R value, the greater the need for detailed seismic evaluation and potential for retrofitting needs.

3. PRELIMINARY SEISMIC EVALUATION EXAMPLE OF ONE BRIDGE ON PURCHASE PARKWAY

3.1 Bridge Description

Bridge Number: 53-1529-B00056
Location: Hickman, Purchase Parkway
Year Designed: 1966
Superstructure: 2-80' continuous RC box girders with a skew of $8^o58'$
Substructure: one 3-column bent supported on pile foundation
Bridge Bearing Type: The abutments are not cast monolithic with superstructure and the type of the bridge bearings is sliding bearing.
Acceleration Coefficient: 0.4
Soil Type: III

3.2 Regularity of Bridge

Number of Span: 2
Maximum span length ratio from span to span: 80/80=1.0<3.0
According to the Seismic Retrofitting Manual, section 3.3.2.1, it is a regular bridge.

3.3 Bridge Rank (R)

3.3.1 Seismic Performance Category (SPC)

From referring to Table 5, the Seismic Performance Category of this bridge is D. And then, all components will be considered.

3.3.2 Vulnerability Rating (V)

3.3.2.1 Bearings

Step 1: The bridge has more than three girders with a skew less than 20^o and Sliding bearing is used. So, V_T=5.

Step 2: In the longitudinal direction, calculate the minimum required support length at the hinge seat.

$L = 80 + 80 = 160$ (ft)
$H = 15.5$ (ft)

Therefore:

$$N_d = 12+0.03L+0.12H$$
$$= 12+0.03\,(160)+0.12\,(15.5)$$
$$= 18.66 \text{ (in)}$$

N_c=24 (in) (See "as-built" plans)
$N_c > N_d$

Therefore, V_L=0 and the overall rating for connections, bearings, and seatwidths is:

V_1 = maximum of V_L and V_T

$= \quad 5$

3.3.2.2 Columns, Piers, and Footing

Step 1: Does not apply
Step 2: Does not apply
Step 3: Does not apply
Step 4: Calculate the value for Q for the shortest and most heavily reinforced columns, which are the column in bent 2.

$$Q = 13 - 6 \cdot \frac{L_c}{P_s \cdot F \cdot b_{\max}}$$

$$= 13 - 6 \cdot \frac{0.5 \cdot 11.5}{1.239 \cdot 2 \cdot 3.25}$$

$$= 8.717$$

Because the support skew is less than 20^o and the reinforcement grade is 40, then the maximum reduction of 3 can be made, i.e.,

CVR = Q – 3 =8.717 – 3 =5.717

Step 5: Does not apply
Step 6: Does not apply
Therefore, the column vulnerability rating CVR=5.717

3.3.2.3 Abutment

Step 1: Does not apply
Step 2: A roadway passes under the bridge.
The fill settlement may be estimated as follows:

S = 3% of the fill height (A=0.40>0.39)
= 3% (16) (12)
= 5.76 (in) < 6 in

Then, assign a vulnerability rating for the abutment

AVR = 0

Step 3: Does not apply
Therefore, the abutment vulnerability rating AVR=0

3.3.2.4 Liquefaction

Step 1: The site has a moderate susceptibility to liquefaction.
Step 2: Severe liquefaction-related damage is likely.
Step 3: LVR = 10
Step 4: Does not apply
Step 5: Does not apply
Step 6: Does not apply
Therefore, the liquefaction vulnerability rating LVR=10

3.3.2.5 Vulnerability Rating for Components Other Than Bearings (V_2)

V_2 = CVR+AVR+LVR
= 5.717+0+10
= 15.717 > 10

So, $V_2 = 10$

3.3.2.6 Overall Bridge Vulnerability (V)

$$V = \text{Maximum of } V_1 \text{ and } V_2$$
$$= 10$$

3.3.3 Seismic Hazard Rating (E)

The Seismic hazard rating is a function of both the Acceleration Coefficient (A) and the Site Coefficient (S). For this Bridge, A=0.4 and a default Site Coefficient of 1.5 is assumed based on a Type III soil profile. It therefore follows that:

$$E = 12.5 \cdot A \cdot S$$
$$= 12.5\,(0.4)\,(1.5)$$
$$= 7.5$$

3.3.4 Bridge Rank (R)

Bridge Rank is then given by:

$$R = V \cdot E$$
$$= 10\,(7.5)$$
$$= 75$$

4. SEISMIC INVENTORY OF BRIDGES

In order to work efficiently, Seismic Inventory of Bridges (SIB), a user-oriented database program (see Figure 11) according to the Seismic Retrofitting Manual mentioned above, is developed with Microsoft Access. It will assist the user by providing a lot of help information for preliminary seismic screening. Seismic ranking computation of the bridge can be easily performed after inputting all the necessary information such as general information of the bridge, site and superstructure, columns and piers, abutments and bearings.

The preliminary seismic evaluation of the example bridge, described in Section 3, is also processed with SIB (See Figure 12). The Bridge Rank (R) provided by the SIB program is the same as calculating result list in Section 3.

5. RESULTS

5.1 Bridge Ranking

The seismic ranking of bridges on and over the five parkways, i.e., Purchase Parkway, Western Kentucky Parkway, Pennyrile Parkway, Audubon Parkway, and William Natcher Parkway, are calculated and listed in Table 7 through Table 11, respectively. All of the bridge ranks are given based on the Seismic Ranking System, described in Section 2 of this report, and with the program of the Seismic Inventory of Bridges, provided in Section 4. These tables use the Bridge Identification Numbers (BIN) assigned by the KTC, and mark the bridges that were evaluated in detail.

Bridge seismic rank, which is based on structural vulnerability and the seismic hazard, ranges from 0 to 100, and the higher the score, the greater the need for the bridge to be retrofitted. The rank table corresponding to this damage status has been established for each bridge. The rankings (R) of these bridges fall between 0 and 75. The statistics of bridge ranks at the 50-Year Event and at the 250-Year Event are listed in Table 12 and Table 13. The distribution of bridge ranks, which are greater than 0, are shown in Figure 13 and Figure 14.

The values in Table 12 through Table 13 and the distributions in Figure 13 through Figure 14 indicate that:

(1) For the bridges classified as SPC B, most (82.0% for 50-Year Event and 81.8% for 250-Year Event) rank 0, and the maximum bridge rank is 11.3;

(2) For the bridges classified as SPC C, most (55.3% for 50-Year Event and 46.7% for 250-Year Event) rank between 11 and 20, and the maximum bridge rank is 38.0;

(3) For the bridges classified as SPC D, all of the seismic rank is 75.

5.2 Priority Bridges to Be Evaluated

Based on the ranking system, the bridges, which rank 35 or higher, are selected for detailed seismic evaluation as indicated in Table 14.

Moreover, according to the Seismic Retrofitting Manual, some irregular bridges should be processed with detailed seismic evaluation. The requirements for regular bridge are shown in Table 15. Any bridge not satisfying the requirements is considered to be “irregular”. Among the 389 bridges on and over the parkways in Western Kentucky, only two bridges, 117-9004-B00071 and 117-9004-B00071P, can be considered as irregular bridges.

Table 1: Number of Bridges on and over the Parkways in Western Kentucky

Parkway	County	Number of Bridges by County	Number of Bridges by Parkway
Purchase	Fulton	9	87
	Hickman	3	
	Graves	49	
	Marshall	26	
Western Kentucky	Lyon	9	121
	Caldwell	13	
	Hopkins	22	
	Muhlenberg	25	
	Ohio	13	
	Butler	1	
	Grayson	21	
	Hardin	17	
Pennyrile	Christian	23	85
	Hopkins	36	
	Webster	11	
	Henderson	15	
Audubon	Henderson	13	21
	Daviess	8	
William Natcher	Warren	17	75
	Butler	14	
	Ohio	23	
	Daviess	21	
Total number of bridges on and over the parkways in Western Kentucky			389

Table 2: Number of Culverts along the Parkways in Western Kentucky

Parkway	County	Number of Culverts by County	Number of Culverts by Parkway
Purchase	Fulton	1	7
	Hickman	0	
	Graves	1	
	Marshall	5	
Western Kentucky	Lyon	1	14
	Caldwell	4	
	Hopkins	1	
	Muhlenberg	1	
	Ohio	1	
	Butler	0	
	Grayson	5	
	Hardin	1	
Pennyrile	Christian	3	8
	Hopkins	4	
	Webster	0	
	Henderson	1	
Audubon	Henderson	2	3
	Daviess	1	
William Natcher	Warren	0	8
	Butler	3	
	Ohio	4	
	Daviess	1	
Total number of culverts along the parkways in Western Kentucky			40

Table 3: Number of Parallel Bridges on and over the Parkways in Western Kentucky

Parkway	County	Number of Parallel Bridges by County	Number of Parallel Bridges by Parkway
Purchase	Fulton	3	25
	Hickman	0	
	Graves	16	
	Marshall	6	
Western Kentucky	Lyon	3	33
	Caldwell	2	
	Hopkins	9	
	Muhlenberg	9	
	Ohio	4	
	Butler	0	
	Grayson	2	
	Hardin	4	
Pennyrile	Christian	5	24
	Hopkins	12	
	Webster	4	
	Henderson	3	
Audubon	Henderson	2	4
	Daviess	2	
William Natcher	Warren	5	21
	Butler	3	
	Ohio	6	
	Daviess	7	
Total number of parallel bridges on and over the parkways in Western Kentucky			107

Table 4: Peak Ground Acceleration and Seismic Performance Category

Parkway	County	*Seismic Events*			
		50-Year Event[1]		250-Year Event[4]	
		PGA[2]	SPC[3]	PGA[2]	SPC[3]
Purchase	Fulton	0.30g	D	0.40g	D
	Hickman	0.30g	D	0.40g	D
	Graves	0.15g	C	0.19g	C
	Marshall	0.15g	C	0.15g	C
Western Kentucky	Lyon	0.09g	B	0.15g	C
	Caldwell	0.09g	B	0.09g	B
	Hopkins	0.09g	B	0.09g	B
	Muhlenberg	0.09g	B	0.09g	B
	Ohio	0.09g	B	0.09g	B
	Butler	0.09g	B	0.09g	B
	Grayson	0.09g	B	0.09g	B
	Hardin	0.09g	B	0.09g	B
Pennyrile	Christian	0.09g	B	0.09g	B
	Hopkins	0.09g	B	0.09g	B
	Webster	0.09g	B	0.09g	B
	Henderson	0.15g	C	0.15g	C
Audubon	Henderson	0.15g	C	0.15g	C
	Daviess	0.15g	C	0.15g	C
William Natcher	Warren	0.09g	B	0.09g	B
	Butler	0.09g	B	0.09g	B
	Ohio	0.09g	B	0.09g	B
	Daviess	0.15g	C	0.15g	C

Note: 1) Event with 90% Probability of Not Being Exceeded in 50 Years
2) Peak Ground Acceleration
3) Seismic Performance Category
4) Event with 90% Probability of Not Being Exceeded in 250 Years

Table 5: Classification of Seismic Performance Category (SPC)
(Seismic Retrofitting Manual, Table 1)

Acceleration Coefficient	Importance Classification	
	Essential	Standard
$A \leq 0.09$	B	A
$0.09 < A \leq 0.19$	C	B
$0.19 < A \leq 0.29$	C	C
$0.29 < A$	D	C

Table 6: Soil Profile Type and Site Coefficient (S)
(Seismic Retrofitting Manual, Table 3)

Soil Type	Soil Profile	Site Coefficient
I	Rock or stiff soils Soil depth less than 60 m (200 ft)	1.0
II	Stiff cohesive or deep cohesionless soil Soil depth exceeds 60 m (200 ft)	1.2
III	Soft to medium stiff clays and sands Soil depth exceeds 9 m (30 ft)	1.5
IV	Soft clays or silts Soil depth exceeds 12 m (40 ft)	2.0

Table 7: Seismic Ranking of Bridges on and over the Purchase Parkway

No.	County	BIN Number[a]	P[b]	Main Span[c]	Drawing Number	50-Year Event[d]			250-Year Event[h]		
						A[e]	SPC[f]	R[g]	A[e]	SPC[f]	R[g]
1	Fulton	38-0051-B00012		2	16696	0.30g	D	56.0	0.40g	D	75.0
2		38-0307-B00015		2	16649	0.30g	D	56.0	0.40g	D	75.0
3		38-9003-B00053		3	16694	0.30g	D	56.0	0.40g	D	75.0
4		38-9003-B00053	P	3	16694	0.30g	D	56.0	0.40g	D	75.0
5		38-9003-B00054		3	16695	0.30g	D	56.0	0.40g	D	75.0
6		38-9003-B00054	P	3	16695	0.30g	D	56.0	0.40g	D	75.0
7		38-9003-B00055		7	16561	0.30g	D	56.0	0.40g	D	75.0
8		38-9003-B00055	P	7	16561	0.30g	D	56.0	0.40g	D	75.0
9		38-9003-B00056		1	Culvert 16563	0.30g	D	—	0.40g	D	—
10	Graves	42-0058-B00096		2	16558	0.15g	C	12.9	0.19g	C	16.4
11		42-0080-B00106		4	13105	0.15g	C	14.1	0.19g	C	17.8
12		42-0121-B00111		4	15519	0.15g	C	14.1	0.19g	C	17.8
13		42-0131-B00009		2	16531	0.15g	C	15.3	0.19g	C	19.4
14		42-0301-B00028		2	16534	0.15g	C	0.0	0.19g	C	0.0
15		42-0339-B00143		4	16555	0.15g	C	3.6	0.19g	C	4.6
16		42-0944-B00180		2	16654	0.15g	C	14.3	0.19g	C	18.1
17		42-1748-B00128		4	16581	0.15g	C	13.3	0.19g	C	16.8
18		42-9003-B00153		4	16583	0.15g	C	14.1	0.19g	C	17.8
19		42-9003-B00154		4	16584	0.15g	C	22.5	0.19g	C	28.5
20		42-9003-B00154	P	4		0.15g	C	22.5	0.19g	C	28.5

Table 7 continued: Seismic Ranking of Bridges on and over the Purchase Parkway

No.	County	BIN Number[a]	P[b]	Main Span[c]	Drawing Number	50-Year Event[d]			250-Year Event[h]		
						A[e]	SPC[f]	R[g]	A[e]	SPC[f]	R[g]
21		24-9004-B00117		2	16755	0.09g	B	5.6	0.09g	B	5.6
22		24-9004-B00118		1	16756	0.09g	B	0.0	0.09g	B	0.0
23		24-9004-B00118	P	1		0.09g	B	0.0	0.09g	B	0.0
24	Henderson	51-0425-B00137		2	19547	0.15g	C	32.0	0.15g	C	32.0
25		51-0425-B00137	P	2		0.15g	C	32.0	0.15g	C	32.0
26		51-9004-B00061		2	Culvert 16932	0.15g	C	—	0.15g	C	—
27		51-9004-B00062		3	17200	0.15g	C	25.0	0.15g	C	25.0
28		51-9004-B00062	P	3		0.15g	C	25.0	0.15g	C	25.0
29		51-9004-B00063		2	16799	0.15g	C	13.0	0.15g	C	13.0
30		51-9004-B00064		2	16800	0.15g	C	28.0	0.15g	C	28.0
31		51-9004-B00065		2	16801	0.15g	C	28.0	0.15g	C	28.0
32		51-9004-B00066		2	16950	0.15g	C	27.0	0.15g	C	27.0
33		51-9004-B00067		2	16952	0.15g	C	28.0	0.15g	C	28.0
34		51-9004-B00068		3	16948	0.15g	C	28.0	0.15g	C	28.0
35		51-9004-B00068	P	3		0.15g	C	28.0	0.15g	C	28.0
36		51-9004-B00069		2	16933	0.15g	C	11.0	0.15g	C	11.0
37		51-9004-B00111		2	16934	0.15g	C	19.0	0.15g	C	19.0
38		51-9004-B00112		2	16936	0.15g	C	0.0	0.15g	C	0.0
39		51-9005-B00073		2	17502	0.15g	C	28.0	0.15g	C	28.0
40		51-9005-B00073	P	2		0.15g	C	28.0	0.15g	C	28.0

Table 7 continued: Seismic Ranking of Bridges on and over the Purchase Parkway

No.	County	BIN Number[a]	P[b]	Main Span[c]	Drawing Number	50-Year Event[d]			250-Year Event[h]		
						A[e]	SPC[f]	R[g]	A[e]	SPC[f]	R[g]
41	Hopkins	54-0062-B00048		4	14008	0.09g	B	0.0	0.09g	B	0.0
42		54-9004-B00010		2	Culvert 16870	0.09g	B	—	0.09g	B	—
43		54-9004-B00011		2	16871	0.09g	B	0.0	0.09g	B	0.0
44		54-9004-B00012		3	16834	0.09g	B	0.0	0.09g	B	0.0
45		54-9004-B00012	P	3		0.09g	B	0.0	0.09g	B	0.0
46		54-9004-B00013		2	16733	0.09g	B	0.0	0.09g	B	0.0
47		54-9004-B00014		3	16734	0.09g	B	0.0	0.09g	B	0.0
48		54-9004-B00014	P	3		0.09g	B	0.0	0.09g	B	0.0
49		54-9004-B00015		2	16735	0.09g	B	0.0	0.09g	B	0.0
50		54-9004-B00016		2	16862	0.09g	B	0.0	0.09g	B	0.0
51		54-9004-B00017		2	Culvert 16863	0.09g	B	—	0.09g	B	—
52		54-9004-B00018		2	16864	0.09g	B	0.0	0.09g	B	0.0
53		54-9004-B00019		2	16865	0.09g	B	0.0	0.09g	B	0.0
54		54-9004-B00020		3	16866	0.09g	B	0.0	0.09g	B	0.0
55		54-9004-B00020	P	3		0.09g	B	0.0	0.09g	B	0.0
56		54-9004-B00021		3	16867	0.09g	B	0.0	0.09g	B	0.0
57		54-9004-B00021	P	3		0.09g	B	0.0	0.09g	B	0.0
58		54-9004-B00095		6	14076	0.09g	B	0.0	0.09g	B	0.0
59		54-9004-B00095	P	6		0.09g	B	0.0	0.09g	B	0.0
60		54-9004-B00096		5	14159	0.09g	B	0.0	0.09g	B	0.0

Table 7 continued: Seismic Ranking of Bridges on and over the Purchase Parkway

No.	County	BIN Number[a]	P[b]	Main Span[c]	Drawing Number	50-Year Event[d]			250-Year Event[h]		
						A[e]	SPC[f]	R[g]	A[e]	SPC[f]	R[g]
61		54-9004-B00096	P	5	14159	0.09g	B	0.0	0.09g	B	0.0
62		54-9004-B00097		4	14006	0.09g	B	0.0	0.09g	B	0.0
63		54-9004-B00097	P	4		0.09g	B	0.0	0.09g	B	0.0
64		54-9004-B00098		3	14005	0.09g	B	0.0	0.09g	B	0.0
65		54-9004-B00098	P	3		0.09g	B	0.0	0.09g	B	0.0
66		54-9004-B00099		5	14007	0.09g	B	0.0	0.09g	B	0.0
67		54-9004-B00099	P	5		0.09g	B	0.0	0.09g	B	0.0
68		54-9004-B00100		4	14167	0.09g	B	0.0	0.09g	B	0.0
69		54-9004-B00100	P	4		0.09g	B	0.0	0.09g	B	0.0
70		54-9004-B00101		3	14168	0.09g	B	0.0	0.09g	B	0.0
71		54-9004-B00101	P	3		0.09g	B	0.0	0.09g	B	0.0
72		54-9004-B00104		2	Culvert 14158	0.09g	B	—	0.09g	B	—
73		54-9004-B00105		1	Culvert 14163	0.09g	B	—	0.09g	B	—
74		54-9004-B00106		5	14003	0.09g	B	0.0	0.09g	B	0.0
75		54-9004-B00106	P	5		0.09g	B	0.0	0.09g	B	0.0
76		54-9004-B00211		3	22426	0.09g	B	0.0	0.09g	B	0.0
77	Webster	117-9004-B00068		2	16835	0.09g	B	0.0	0.09g	B	0.0
78		117-9004-B00069		3	16837	0.09g	B	0.0	0.09g	B	0.0
79		117-9004-B00069	P	3		0.09g	B	0.0	0.09g	B	0.0
80		117-9004-B00070		2	16839	0.09g	B	0.0	0.09g	B	0.0

Table 7 continued: Seismic Ranking of Bridges on and over the Purchase Parkway

No.	County	BIN Number[a]	P[b]	Main Span[c]	Drawing Number	50-Year Event[d]			250-Year Event[h]		
						A[e]	SPC[f]	R[g]	A[e]	SPC[f]	R[g]
81		117-9004-B00071		7	16858	0.09g	B	8.4	0.09g	B	8.4
82		117-9004-B00071	P	7		0.09g	B	8.4	0.09g	B	8.4
83		117-9004-B00072		4	16859	0.09g	B	0.0	0.09g	B	0.0
84		117-9004-B00072	P	4		0.09g	B	0.0	0.09g	B	0.0
85		117-9004-B00073		2	16852	0.09g	B	0.0	0.09g	B	0.0
86		117-9004-B00074		5	16855	0.09g	B	0.0	0.09g	B	0.0
87		117-9004-B00074	P	5		0.09g	B	0.0	0.09g	B	0.0

Note: a) BIN Number = Bridge Identification Number

b) P = Parallel Bridge

c) Main Span = Number of Spans

d) 50-Year Event = Event with 90% Probability of Not Being Exceeded in 50 Years

e) A = Acceleration in Rock

f) SPC = Seismic Performance Category

g) R = Bridge Rank Based on Structural Vulnerability and Seismic Hazard Rating

h) 250-Year Event = Event with 90% Probability of Not Being Exceeded in 250 Years

Table 8: Seismic Ranking of Bridges on and over the Western Kentucky Parkway

No.	County	BIN Number[a]	P[b]	Main Span[c]	Drawing Number	50-Year Event[d]			250-Year Event[h]		
						A[e]	SPC[f]	R[g]	A[e]	SPC[f]	R[g]
1	Lyon	72-0093-B00050		4	16910	0.09g	B	0.0	0.15g	C	9.4
2		72-9001-B00029		4	17012	0.09g	B	0.0	0.15g	C	11.0
3		72-9001-B00030		4	16878	0.09g	B	0.0	0.15g	C	9.4
4		72-9001-B00030	P	4		0.09g	B	0.0	0.15g	C	9.4
5		72-9001-B00049		4	17150	0.09g	B	0.0	0.15g	C	14.0
6		72-9001-B00049	P	4		0.09g	B	0.0	0.15g	C	14.0
7		72-9001-B00051		1	16911	0.09g	B	—	0.15g	C	—
8		72-9001-B00052		4	16912	0.09g	B	0.0	0.15g	C	23.0
9		72-9001-B00052	P	4		0.09g	B	0.0	0.15g	C	23.0
10	Caldwell	17-0091-B00037		4	14885	0.09g	B	5.6	0.09g	B	5.6
11		17-0293-B00007		4	14887	0.09g	B	0.0	0.09g	B	0.0
12		17-2613-B00061		4	14855	0.09g	B	0.0	0.09g	B	0.0
13		17-2619-B00048		4	14857	0.09g	B	0.0	0.09g	B	0.0
14		17-9001-B00028		1	Culvert 16880	0.09g	B	—	0.09g	B	—
15		17-9001-B00029		4	14883	0.09g	B	0.0	0.09g	B	0.0
16		17-9001-B00029	P	4		0.09g	B	0.0	0.09g	B	0.0
17		17-9001-B00030		2	Culvert 14888	0.09g	B	—	0.09g	B	—
18		17-9001-B00031		2	Culvert 14852	0.09g	B	—	0.09g	B	—
19		17-9001-B00032		2	Culvert 14856	0.09g	B	—	0.09g	B	—
20		17-9001-B00033		4	14929	0.09g	B	0.0	0.09g	B	0.0

Table 8 continued: Seismic Ranking of Bridges on and over the Western Kentucky Parkway

No.	County	BIN Number[a]	P[b]	Main Span[c]	Drawing Number	50-Year Event[d]			250-Year Event[h]		
						A[e]	SPC[f]	R[g]	A[e]	SPC[f]	R[g]
21		17-9001-B00033	P	4	14929	0.09g	B	0.0	0.09g	B	0.0
22		17-9001-B00060		4	14854	0.09g	B	0.0	0.09g	B	0.0
23	Hopkins	54-0109-B00070		4	14931	0.09g	B	0.0	0.09g	B	0.0
24		54-0454-B00117		4	14982	0.09g	B	0.0	0.09g	B	0.0
25		54-0813-B00131		4	15082	0.09g	B	0.0	0.09g	B	0.0
26		54-9001-B00136		5	14837	0.09g	B	0.0	0.09g	B	0.0
27		54-9001-B00136	P	5		0.09g	B	0.0	0.09g	B	0.0
28		54-9001-B00137		5	14838	0.09g	B	0.0	0.09g	B	0.0
29		54-9001-B00137	P	5		0.09g	B	0.0	0.09g	B	0.0
30		54-9001-B00138		5	14930	0.09g	B	0.0	0.09g	B	0.0
31		54-9001-B00138	P	5		0.09g	B	0.0	0.09g	B	0.0
32		54-9001-B00139		3	14932	0.09g	B	0.0	0.09g	B	0.0
33		54-9001-B00139	P	3		0.09g	B	0.0	0.09g	B	0.0
34		54-9001-B00140		3	14978	0.09g	B	0.0	0.09g	B	0.0
35		54-9001-B00140	P	3		0.09g	B	0.0	0.09g	B	0.0
36		54-9001-B00141		2	Culvert 14981	0.09g	B	—	0.09g	B	—
37		54-9001-B00143		4	15132	0.09g	B	0.0	0.09g	B	0.0
38		54-9001-B00143	P	4		0.09g	B	0.0	0.09g	B	0.0
39		54-9001-B00144		6	15137	0.09g	B	0.0	0.09g	B	0.0
40		54-9001-B00144	P	6		0.09g	B	0.0	0.09g	B	0.0

Table 8 continued: Seismic Ranking of Bridges on and over the Western Kentucky Parkway

No.	County	BIN Number[a]	P[b]	Main Span[c]	Drawing Number	50-Year Event[d]			250-Year Event[h]		
						A[e]	SPC[f]	R[g]	A[e]	SPC[f]	R[g]
41		54-9001-B00145		4	29225	0.09g	B	0.0	0.09g	B	0.0
42		54-9001-B00145	P	4	15078	0.09g	B	0.0	0.09g	B	0.0
43		54-9001-B00146		11	15083	0.09g	B	0.0	0.09g	B	0.0
44		54-9001-B00146	P	11		0.09g	B	0.0	0.09g	B	0.0
45	Muhlenberg	89-0431-B00132		4	24645	0.09g	B	0.0	0.09g	B	0.0
46		89-0431-B00132	P	4		0.09g	B	0.0	0.09g	B	0.0
47		89-2692-B00085		4	14909	0.09g	B	0.0	0.09g	B	0.0
48		89-2694-B00059		4	15322	0.09g	B	0.0	0.09g	B	0.0
49		89-2695-B00058		4	15320	0.09g	B	0.0	0.09g	B	0.0
50		89-2697-B00131		4	24633	0.09g	B	0.0	0.09g	B	0.0
51		89-9001-B00089		5	14912	0.09g	B	0.0	0.09g	B	0.0
52		89-9001-B00089	P	5		0.09g	B	0.0	0.09g	B	0.0
53		89-9001-B00090		5	14839	0.09g	B	0.0	0.09g	B	0.0
54		89-9001-B00090	P	5		0.09g	B	0.0	0.09g	B	0.0
55		89-9001-B00091		4	15105	0.09g	B	0.0	0.09g	B	0.0
56		89-9001-B00091	P	4		0.09g	B	0.0	0.09g	B	0.0
57		89-9001-B00092		3	15318	0.09g	B	0.0	0.09g	B	0.0
58		89-9001-B00092	P	3		0.09g	B	0.0	0.09g	B	0.0
59		89-9001-B00093		9	15300	0.09g	B	11.3	0.09g	B	11.3
60		89-9001-B00093	P	9		0.09g	B	11.3	0.09g	B	11.3

Table 8 continued: Seismic Ranking of Bridges on and over the Western Kentucky Parkway

No.	County	BIN Number[a]	P[b]	Main Span[c]	Drawing Number	50-Year Event[d]			250-Year Event[h]		
						A[e]	SPC[f]	R[g]	A[e]	SPC[f]	R[g]
61		89-9001-B00094		5	15111	0.09g	B	0.0	0.09g	B	0.0
62		89-9001-B00094	P	5		0.09g	B	0.0	0.09g	B	0.0
63		89-9001-B00096		3	15262	0.09g	B	0.0	0.09g	B	0.0
64		89-9001-B00096	P	3		0.09g	B	0.0	0.09g	B	0.0
65		89-9001-B00109		3	20120	0.09g	B	0.0	0.09g	B	0.0
66		89-9001-B00109	P	3		0.09g	B	0.0	0.09g	B	0.0
67		89-9001-B00115		3	Culvert	0.09g	B	—	0.09g	B	—
68		89-9001-B00130		4	23916	0.09g	B	0.0	0.09g	B	0.0
69		89-9001-XX0905		4		0.09g	B		0.09g	B	
70	Ohio	92-0505-B00093		4	14814	0.09g	B	0.0	0.09g	B	0.0
71		92-1245-B00108		4	14882	0.09g	B	0.0	0.09g	B	0.0
72		92-1245-B00112		4	15274	0.09g	B	0.0	0.09g	B	0.0
73		92-2712-B00136		4	15032	0.09g	B	0.0	0.09g	B	0.0
74		92-9001-B00130		3	14759	0.09g	B	0.0	0.09g	B	0.0
75		92-9001-B00130	P	3		0.09g	B	0.0	0.09g	B	0.0
76		92-9001-B00131		2	Culvert 14758	0.09g	B	—	0.09g	B	—
77		92-9001-B00132		3	15027	0.09g	B	0.0	0.09g	B	0.0
78		92-9001-B00132	P	3		0.09g	B	0.0	0.09g	B	0.0
79		92-9001-B00133		4	15022	0.09g	B	0.0	0.09g	B	0.0
80		92-9001-B00133	P	4		0.09g	B	0.0	0.09g	B	0.0

Table 8 continued: Seismic Ranking of Bridges on and over the Western Kentucky Parkway

No.	County	BIN Number[a]	P[b]	Main Span[c]	Drawing Number	50-Year Event[d]			250-Year Event[h]		
						A[e]	SPC[f]	R[g]	A[e]	SPC[f]	R[g]
81		92-9001-B00134		3	15279	0.09g	B	0.0	0.09g	B	0.0
82		92-9001-B00134	P	3		0.09g	B	0.0	0.09g	B	0.0
83	Butler	16-9001-B00034		4	14761	0.09g	B	0.0	0.09g	B	0.0
84	Grayson	43-0079-B00023		4	14947	0.09g	B	0.0	0.09g	B	0.0
85		43-0088-B00006		4	14990	0.09g	B	0.0	0.09g	B	0.0
86		43-0185-B00019		4	14949	0.09g	B	0.0	0.09g	B	0.0
87		43-0224-B00003		4	14991	0.09g	B	0.0	0.09g	B	0.0
88		43-0259-B00009		4	14984	0.09g	B	0.0	0.09g	B	0.0
89		43-9001-B00026		3	14899	0.09g	B	0.0	0.09g	B	0.0
90		43-9001-B00026	P	3		0.09g	B	0.0	0.09g	B	0.0
91		43-9001-B00027		3	14890	0.09g	B	0.0	0.09g	B	0.0
92		43-9001-B00027	P	3		0.09g	B	0.0	0.09g	B	0.0
93		43-9001-B00028		2	Culvert 14953	0.09g	B	—	0.09g	B	—
94		43-9001-B00029		3	Culvert 14950	0.09g	B	—	0.09g	B	—
95		43-9001-B00030		2	Culvert 14946	0.09g	B	—	0.09g	B	—
96		43-9001-B00031		2	Culvert 14943	0.09g	B	—	0.09g	B	—
97		43-9001-B00032		1	Culvert 15055	0.09g	B	—	0.09g	B	—
98		43-9001-B00060		4	14987	0.09g	B	0.0	0.09g	B	0.0
99		43-9001-B00069		4	15053	0.09g	B	0.0	0.09g	B	0.0
100		43-9001-B00070		4	14752	0.09g	B	0.0	0.09g	B	0.0

Table 8 continued: Seismic Ranking of Bridges on and over the Western Kentucky Parkway

No.	County	BIN Number[a]	P[b]	Main Span[c]	Drawing Number	50-Year Event[d]			250-Year Event[h]		
						A[e]	SPC[f]	R[g]	A[e]	SPC[f]	R[g]
101		43-9001-B00073		4	14903	0.09g	B	0.0	0.09g	B	0.0
102		43-9001-B00076		4	14952	0.09g	B	0.0	0.09g	B	0.0
103		43-9001-B00078		4	14751	0.09g	B	0.0	0.09g	B	0.0
104		43-9001-B00082		4	14942	0.09g	B	0.0	0.09g	B	0.0
105	Hardin	47-0084-B00043		4	14811	0.09g	B	0.0	0.09g	B	0.0
106		47-1136-B00053		4	14973	0.09g	B	0.0	0.09g	B	0.0
107		47-31W-B00108		4	18438	0.09g	B	0.0	0.09g	B	0.0
108		47-31W-B00153		4	23193	0.09g	B	0.0	0.09g	B	0.0
109		47-9001-B00045		4	14813	0.09g	B	0.0	0.09g	B	0.0
110		47-9001-B00056		4	14753	0.09g	B	0.0	0.09g	B	0.0
111		47-9001-B00085		4	14812	0.09g	B	0.0	0.09g	B	0.0
112		47-9001-B00090		4	14967	0.09g	B	0.0	0.09g	B	0.0
113		47-9001-B00092		4	14969	0.09g	B	0.0	0.09g	B	0.0
114		47-9001-B00092	P	4		0.09g	B	0.0	0.09g	B	0.0
115		47-9001-B00093		3	14968	0.09g	B	0.0	0.09g	B	0.0
116		47-9001-B00093	P	3		0.09g	B	0.0	0.09g	B	0.0
117		47-9001-B00094		3	14966	0.09g	B	0.0	0.09g	B	0.0
118		47-9001-B00094	P	3		0.09g	B	0.0	0.09g	B	0.0
119		47-9001-B00095		3	Culvert 14906	0.09g	B	—	0.09g	B	—
120		47-9001-B00127		4	20387	0.09g	B	0.0	0.09g	B	0.0

Table 8 continued: Seismic Ranking of Bridges on and over the Western Kentucky Parkway

No.	County	BIN Number[a]	P[b]	Main Span[c]	Drawing Number	50-Year Event[d]			250-Year Event[h]		
						A[e]	SPC[f]	R[g]	A[e]	SPC[f]	R[g]
121		47-9001-B00127	P	4	20387	0.09g	B	0.0	0.09g	B	0.0

Note: a) BIN Number = Bridge Identification Number

b) P = Parallel Bridge

c) Main Span = Number of Spans

d) 50-Year Event = Event with 90% Probability of Not Being Exceeded in 50 Years

e) A = Acceleration in Rock

f) SPC = Seismic Performance Category

g) R = Bridge Rank Based on Structural Vulnerability and Seismic Hazard Rating

h) 250-Year Event = Event with 90% Probability of Not Being Exceeded in 250 Years

Table 9: Seismic Ranking of Bridges on and over the Pennyrile Kentucky Parkway

No.	County	BIN Number[a]	P[b]	Main Span[c]	Drawing Number	50-Year Event[d]			250-Year Event[h]		
						A[e]	SPC[f]	R[g]	A[e]	SPC[f]	R[g]
1	Christian	24-9004-B00092		2	Culvert 16757	0.09g	B	—	0.09g	B	—
2		24-9004-B00093		2	16741	0.09g	B	0.0	0.09g	B	0.0
3		24-9004-B00093	P	2		0.09g	B	0.0	0.09g	B	0.0
4		24-9004-B00094		3	16737	0.09g	B	0.0	0.09g	B	0.0
5		24-9004-B00095		4	16738	0.09g	B	0.0	0.09g	B	0.0
6		24-9004-B00096		2	16680	0.09g	B	0.0	0.09g	B	0.0
7		24-9004-B00097		4	16683	0.09g	B	0.0	0.09g	B	0.0
8		24-9004-B00098		4	16686	0.09g	B	0.0	0.09g	B	0.0
9		24-9004-B00099		4	16687	0.09g	B	0.0	0.09g	B	0.0
10		24-9004-B00100		2	16731	0.09g	B	0.0	0.09g	B	0.0
11		24-9004-B00101		2	16941	0.09g	B	5.6	0.09g	B	5.6
12		24-9004-B00102		3	16938	0.09g	B	0.0	0.09g	B	0.0
13		24-9004-B00102	P	3		0.09g	B	0.0	0.09g	B	0.0
14		24-9004-B00103		1	Culvert 17030	0.09g	B	—	0.09g	B	—
15		24-9004-B00104		3	16939	0.09g	B	0.0	0.09g	B	0.0
16		24-9004-B00104	P	3		0.09g	B	0.0	0.09g	B	0.0
17		24-9004-B00105		3	16940	0.09g	B	0.0	0.09g	B	0.0
18		24-9004-B00105	P	3		0.09g	B	0.0	0.09g	B	0.0
19		24-9004-B00106		1	16753	0.09g	B	0.0	0.09g	B	0.0
20		24-9004-B00116		2	16754	0.09g	B	0.0	0.09g	B	0.0

Table 9 continued: Seismic Ranking of Bridges on and over the Pennyrile Kentucky Parkway

No.	County	BIN Number[a]	P[b]	Main Span[c]	Drawing Number	50-Year Event[d]			250-Year Event[h]		
						A[e]	SPC[f]	R[g]	A[e]	SPC[f]	R[g]
21		24-9004-B00117		2	16755	0.09g	B	5.6	0.09g	B	5.6
22		24-9004-B00118		1	16756	0.09g	B	0.0	0.09g	B	0.0
23		24-9004-B00118	P	1		0.09g	B	0.0	0.09g	B	0.0
24	Henderson	51-0425-B00137		2	19547	0.15g	C	32.0	0.15g	C	32.0
25		51-0425-B00137	P	2		0.15g	C	32.0	0.15g	C	32.0
26		51-9004-B00061		2	Culvert 16932	0.15g	C	—	0.15g	C	—
27		51-9004-B00062		3	17200	0.15g	C	25.0	0.15g	C	25.0
28		51-9004-B00062	P	3		0.15g	C	25.0	0.15g	C	25.0
29		51-9004-B00063		2	16799	0.15g	C	13.0	0.15g	C	13.0
30		51-9004-B00064		2	16800	0.15g	C	28.0	0.15g	C	28.0
31		51-9004-B00065		2	16801	0.15g	C	28.0	0.15g	C	28.0
32		51-9004-B00066		2	16950	0.15g	C	27.0	0.15g	C	27.0
33		51-9004-B00067		2	16952	0.15g	C	28.0	0.15g	C	28.0
34		51-9004-B00068		3	16948	0.15g	C	28.0	0.15g	C	28.0
35		51-9004-B00068	P	3		0.15g	C	28.0	0.15g	C	28.0
36		51-9004-B00069		2	16933	0.15g	C	11.0	0.15g	C	11.0
37		51-9004-B00111		2	16934	0.15g	C	19.0	0.15g	C	19.0
38		51-9004-B00112		2	16936	0.15g	C	0.0	0.15g	C	0.0
39	Hopkins	54-0062-B00048		4	14008	0.09g	B	0.0	0.09g	B	0.0
40		54-9004-B00010		2	Culvert 16870	0.09g	B	—	0.09g	B	—

Table 9 continued: Seismic Ranking of Bridges on and over the Pennyrile Kentucky Parkway

No.	County	BIN Number[a]	P[b]	Main Span[c]	Drawing Number	50-Year Event[d]			250-Year Event[h]		
						A[e]	SPC[f]	R[g]	A[e]	SPC[f]	R[g]
41		54-9004-B00011		2	16871	0.09g	B	0.0	0.09g	B	0.0
42		54-9004-B00012		3	16834	0.09g	B	0.0	0.09g	B	0.0
43		54-9004-B00012	P	3		0.09g	B	0.0	0.09g	B	0.0
44		54-9004-B00013		2	16733	0.09g	B	0.0	0.09g	B	0.0
45		54-9004-B00014		3	16734	0.09g	B	0.0	0.09g	B	0.0
46		54-9004-B00014	P	3		0.09g	B	0.0	0.09g	B	0.0
47		54-9004-B00015		2	16735	0.09g	B	0.0	0.09g	B	0.0
48		54-9004-B00016		2	16862	0.09g	B	0.0	0.09g	B	0.0
49		54-9004-B00017		2	Culvert 16863	0.09g	B	—	0.09g	B	—
50		54-9004-B00018		2	16864	0.09g	B	0.0	0.09g	B	0.0
51		54-9004-B00019		2	16865	0.09g	B	0.0	0.09g	B	0.0
52		54-9004-B00020		3	16866	0.09g	B	0.0	0.09g	B	0.0
53		54-9004-B00020	P	3		0.09g	B	0.0	0.09g	B	0.0
54		54-9004-B00021		3	16867	0.09g	B	0.0	0.09g	B	0.0
55		54-9004-B00021	P	3		0.09g	B	0.0	0.09g	B	0.0
56		54-9004-B00095		6	14076	0.09g	B	0.0	0.09g	B	0.0
57		54-9004-B00095	P	6		0.09g	B	0.0	0.09g	B	0.0
58		54-9004-B00096		5	14159	0.09g	B	0.0	0.09g	B	0.0
59		54-9004-B00096	P	5	14159	0.09g	B	0.0	0.09g	B	0.0
60		54-9004-B00097		4	14006	0.09g	B	0.0	0.09g	B	0.0

Table 9 continued: Seismic Ranking of Bridges on and over the Pennyrile Kentucky Parkway

No.	County	BIN Number[a]	P[b]	Main Span[c]	Drawing Number	50-Year Event[d]			250-Year Event[h]		
						A[e]	SPC[f]	R[g]	A[e]	SPC[f]	R[g]
61		54-9004-B00097	P	4	14006	0.09g	B	0.0	0.09g	B	0.0
62		54-9004-B00098		3	14005	0.09g	B	0.0	0.09g	B	0.0
63		54-9004-B00098	P	3		0.09g	B	0.0	0.09g	B	0.0
64		54-9004-B00099		5	14007	0.09g	B	0.0	0.09g	B	0.0
65		54-9004-B00099	P	5		0.09g	B	0.0	0.09g	B	0.0
66		54-9004-B00100		4	14167	0.09g	B	0.0	0.09g	B	0.0
67		54-9004-B00100	P	4		0.09g	B	0.0	0.09g	B	0.0
68		54-9004-B00101		3	14168	0.09g	B	0.0	0.09g	B	0.0
69		54-9004-B00101	P	3		0.09g	B	0.0	0.09g	B	0.0
70		54-9004-B00104		2	Culvert 14158	0.09g	B	—	0.09g	B	—
71		54-9004-B00105		1	Culvert 14163	0.09g	B	—	0.09g	B	—
72		54-9004-B00106		5	14003	0.09g	B	0.0	0.09g	B	0.0
73		54-9004-B00106	P	5		0.09g	B	0.0	0.09g	B	0.0
74		54-9004-B00211		3	22426	0.09g	B	0.0	0.09g	B	0.0
75	Webster	117-9004-B00068		2	16835	0.09g	B	0.0	0.09g	B	0.0
76		117-9004-B00069		3	16837	0.09g	B	0.0	0.09g	B	0.0
77		117-9004-B00069	P	3		0.09g	B	0.0	0.09g	B	0.0
78		117-9004-B00070		2	16839	0.09g	B	0.0	0.09g	B	0.0
79		117-9004-B00071		7	16858	0.09g	B	8.4	0.09g	B	8.4
80		117-9004-B00071	P	7		0.09g	B	8.4	0.09g	B	8.4

Table 9 continued: Seismic Ranking of Bridges on and over the Pennyrile Kentucky Parkway

No.	County	BIN Number[a]	P[b]	Main Span[c]	Drawing Number	50-Year Event[d]			250-Year Event[h]		
						A[e]	SPC[f]	R[g]	A[e]	SPC[f]	R[g]
81		117-9004-B00072		4	16859	0.09g	B	0.0	0.09g	B	0.0
82		117-9004-B00072	P	4		0.09g	B	0.0	0.09g	B	0.0
83		117-9004-B00073		2	16852	0.09g	B	0.0	0.09g	B	0.0
84		117-9004-B00074		5	16855	0.09g	B	0.0	0.09g	B	0.0
85		117-9004-B00074	P	5		0.09g	B	0.0	0.09g	B	0.0

Note: a) BIN Number = Bridge Identification Number

b) P = Parallel Bridge

c) Main Span = Number of Spans

d) 50-Year Event = Event with 90% Probability of Not Being Exceeded in 50 Years

e) A = Acceleration in Rock

f) SPC = Seismic Performance Category

g) R = Bridge Rank Based on Structural Vulnerability and Seismic Hazard Rating

h) 250-Year Event = Event with 90% Probability of Not Being Exceeded in 250 Years

Table 10: Seismic Ranking of Bridges on and over the Audubon Parkway

No.	County	BIN Number[a]	P[b]	Main Span[c]	Drawing Number	50-Year Event[d]			250-Year Event[h]		
						A[e]	SPC[f]	R[g]	A[e]	SPC[f]	R[g]
1	Henderson	51-9005-B00070		1	Culvert 17572	0.15g	C	—	0.15g	C	—
2		51-9005-B00071		1	Culvert 17573	0.15g	C	—	0.15g	C	—
3		51-9005-B00072		3	17569	0.15g	C	8.3	0.15g	C	8.3
4		51-9005-B00073		2	17502	0.15g	C	28.0	0.15g	C	28.0
5		51-9005-B00073	P	2		0.15g	C	28.0	0.15g	C	28.0
6		51-9005-B00074		2	17503	0.15g	C	16.0	0.15g	C	16.0
7		51-9005-B00075		2	17473	0.15g	C	12.0	0.15g	C	12.0
8		51-9005-B00076		2	17475	0.15g	C	16.0	0.15g	C	16.0
9		51-9005-B00077		1	17476	0.15g	C	0.0	0.15g	C	0.0
10		51-9005-B00077	P	1		0.15g	C	0.0	0.15g	C	0.0
11		51-9005-B00078		2	17477	0.15g	C	12.0	0.15g	C	12.0
12		51-9005-B00079		2	17509	0.15g	C	16.0	0.15g	C	16.0
13		51-9005-B00080		2	17510	0.15g	C	7.6	0.15g	C	7.6
14	Daviess	30-9005-B00058		2	17497	0.15g	C	20.0	0.15g	C	20.0
15		30-9005-B00058	P	2		0.15g	C	20.0	0.15g	C	20.0
16		30-9005-B00059		3	17496	0.15g	C	14.0	0.15g	C	14.0
17		30-9005-B00059	P	3		0.15g	C	14.0	0.15g	C	14.0
18		30-9005-B00060		2	17494	0.15g	C	38.0	0.15g	C	38.0
19		30-9005-B00061		2	17464	0.15g	C	38.0	0.15g	C	38.0
20		30-9005-B00062		1	Culvert 17463	0.15g	C	—	0.15g	C	—

Table 10 continued: Seismic Ranking of Bridges on and over the Audubon Parkway

No.	County	BIN Number[a]	P[b]	Main Span[c]	Drawing Number	50-Year Event[d]			250-Year Event[h]		
						A[e]	SPC[f]	R[g]	A[e]	SPC[f]	R[g]
21		30-9005-B00063		2	17462	0.15g	C	12.0	0.15g	C	12.0

Note: a) BIN Number = Bridge Identification Number

b) P = Parallel Bridge

c) Main Span = Number of Spans

d) 50-Year Event = Event with 90% Probability of Not Being Exceeded in 50 Years

e) A = Acceleration in Rock

f) SPC = Seismic Performance Category

g) R = Bridge Rank Based on Structural Vulnerability and Seismic Hazard Rating

h) 250-Year Event = Event with 90% Probability of Not Being Exceeded in 250 Years

Table 11: Seismic Ranking of Bridges on and over the William Natcher Parkway

No.	County	BIN Number[a]	P[b]	Main Span[c]	Drawing Number	50-Year Event[d]			250-Year Event[h]		
						A[e]	SPC[f]	R[g]	A[e]	SPC[f]	R[g]
1	Daviess	30-9007-B00081		3	17963	0.15g	C	17.0	0.15g	C	17.0
2		30-9007-B00081	P	3	17963	0.15g	C	17.0	0.15g	C	17.0
3		30-9007-B00082		3	17964	0.15g	C	14.0	0.15g	C	14.0
4		30-9007-B00082	P	3	17964	0.15g	C	14.0	0.15g	C	14.0
5		30-9007-B00083		4	17966	0.15g	C	24.0	0.15g	C	24.0
6		30-9007-B00084		4	17969	0.15g	C	1.2	0.15g	C	1.2
7		30-9007-B00085		2	17914	0.15g	C	28.0	0.15g	C	28.0
8		30-9007-B00085	P	2	17914	0.15g	C	28.0	0.15g	C	28.0
9		30-9007-B00086		4	17939	0.15g	C	5.8	0.15g	C	5.8
10		30-9007-B00087		1	Culvert 17940	0.15g	C	—	0.15g	C	—
11		30-9007-B00088		3	17941	0.15g	C	15.0	0.15g	C	15.0
12		30-9007-B00088	P	3	17941	0.15g	C	15.0	0.15g	C	15.0
13		30-9007-B00089		3	17950	0.15g	C	14.0	0.15g	C	14.0
14		30-9007-B00089	P	3	17950	0.15g	C	14.0	0.15g	C	14.0
15		30-9007-B00090		3	17951	0.15g	C	14.0	0.15g	C	14.0
16		30-9007-B00090	P	3	17951	0.15g	C	14.0	0.15g	C	14.0
17		30-9007-B00091		4	17954	0.15g	C	1.1	0.15g	C	1.1
18		30-9007-B00092		4	17956	0.15g	C	10.0	0.15g	C	10.0
19		30-9007-B00093		4	17960	0.15g	C	2.9	0.15g	C	2.9
20		30-9007-B00094		3	17962	0.15g	C	14.0	0.15g	C	14.0

Table 11 continued: Seismic Ranking of Bridges on and over the William Natcher Parkway

No.	County	BIN Number[a]	P[b]	Main Span[c]	Drawing Number	50-Year Event[d]			250-Year Event[h]		
						A[e]	SPC[f]	R[g]	A[e]	SPC[f]	R[g]
21		30-9007-B00094	P	3	17962	0.15g	C	14.0	0.15g	C	14.0
22	Ohio	92-9007-B00060		3	18099	0.09g	B	0.0	0.09g	B	0.0
23		92-9007-B00060	P	3		0.09g	B	0.0	0.09g	B	0.0
24		92-9007-B00061		4	18106	0.09g	B	0.0	0.09g	B	0.0
25		92-9007-B00062		4	18109	0.09g	B	0.0	0.09g	B	0.0
26		92-9007-B00063		3	18005	0.09g	B	0.0	0.09g	B	0.0
27		92-9007-B00063	P	3		0.09g	B	0.0	0.09g	B	0.0
28		92-9007-B00064		4	18006	0.09g	B	0.0	0.09g	B	0.0
29		92-9007-B00065		4	17878	0.09g	B	0.0	0.09g	B	0.0
30		92-9007-B00066		—	Culvert 17880	0.09g	B	—	0.09g	B	—
31		92-9007-B00067		3	17936	0.09g	B	0.0	0.09g	B	0.0
32		92-9007-B00067	P	3		0.09g	B	0.0	0.09g	B	0.0
33		92-9007-B00068		—	Culvert 18016	0.09g	B	—	0.09g	B	—
34		92-9007-B00069		4	18017	0.09g	B	0.0	0.09g	B	0.0
35		92-9007-B00070		4	18020	0.09g	B	0.0	0.09g	B	0.0
36		92-9007-B00071		—	Culvert 18021	0.09g	B	—	0.09g	B	—
37		92-9007-B00072		4	18094	0.09g	B	0.0	0.09g	B	0.0
38		92-9007-B00072	P	4		0.09g	B	0.0	0.09g	B	0.0
39		92-9007-B00073		—	Culvert 18095	0.09g	B	—	0.09g	B	—
40		92-9007-B00074		4	18096	0.09g	B	0.0	0.09g	B	0.0

Table 11 continued: Seismic Ranking of Bridges on and over the William Natcher Parkway

No.	County	BIN Number[a]	P[b]	Main Span[c]	Drawing Number	50-Year Event[d]			250-Year Event[h]		
						A[e]	SPC[f]	R[g]	A[e]	SPC[f]	R[g]
41		92-9007-B00075		4	18097	0.09g	B	0.0	0.09g	B	0.0
42		92-9007-B00075	P	4		0.09g	B	0.0	0.09g	B	0.0
43		92-9007-B00076		3	18103	0.09g	B	0.0	0.09g	B	0.0
44		92-9007-B00076	P	3		0.09g	B	0.0	0.09g	B	0.0
45	Butler	16-0231-B00054		2	18003	0.09g	B	0.0	0.09g	B	0.0
46		16-0403-B00053		4	17976	0.09g	B	0.0	0.09g	B	0.0
47		16-9007-B00055		1	Culvert 18025	0.09g	B	—	0.09g	B	—
48		16-9007-B00056		1	Culvert 18026	0.09g	B	—	0.09g	B	—
49		16-9007-B00057		3	18029	0.09g	B	0.0	0.09g	B	0.0
50		16-9007-B00057	P	3		0.09g	B	0.0	0.09g	B	0.0
51		16-9007-B00058		2	Culvert 18090	0.09g	B	—	0.09g	B	—
52		16-9007-B00059		3	18091	0.09g	B	0.0	0.09g	B	0.0
53		16-9007-B00059	P	3		0.09g	B	0.0	0.09g	B	0.0
54		16-9007-B00060		3	17974	0.09g	B	0.0	0.09g	B	0.0
55		16-9007-B00060	P	3		0.09g	B	0.0	0.09g	B	0.0
56		16-9007-B00061		3	17774	0.09g	B	11.3	0.09g	B	11.3
57		16-9007-B00062		2	18088	0.09g	B	0.0	0.09g	B	0.0
58		16-9007-B00063		4	18089	0.09g	B	0.0	0.09g	B	0.0
59	Warren	114-0231-B00055		4	18119	0.09g	B	8.4	0.09g	B	8.4
60		114-0626-B00056		4	18152	0.09g	B	0.0	0.09g	B	0.0

Table 11 continued: Seismic Ranking of Bridges on and over the William Natcher Parkway

No.	County	BIN Number[a]	P[b]	Main Span[c]	Drawing Number	50-Year Event[d]			250-Year Event[h]		
						A[e]	SPC[f]	R[g]	A[e]	SPC[f]	R[g]
61		114-0884-B00050		4	18261	0.09g	B	0.0	0.09g	B	0.0
62		114-9007-B00049		2	18259	0.09g	B	0.0	0.09g	B	0.0
63		114-9007-B00049	P	2		0.09g	B	0.0	0.09g	B	0.0
64		114-9007-B00051		3	18268	0.09g	B	0.0	0.09g	B	0.0
65		114-9007-B00051	P	3		0.09g	B	0.0	0.09g	B	0.0
66		114-9007-B00052		3	18269	0.09g	B	0.0	0.09g	B	0.0
67		114-9007-B00052	P	3		0.09g	B	0.0	0.09g	B	0.0
68		114-9007-B00053		4	18270	0.09g	B	0.0	0.09g	B	0.0
69		114-9007-B00053	P	4		0.09g	B	0.0	0.09g	B	0.0
70		114-9007-B00054		4	18151	0.09g	B	0.0	0.09g	B	0.0
71		114-9007-B00054	P	4		0.09g	B	0.0	0.09g	B	0.0
72		114-9007-B00057		4	18262	0.09g	B	0.0	0.09g	B	0.0
73		114-9007-B00058		4	18121	0.09g	B	0.0	0.09g	B	0.0
74		114-9007-B00059		3	18123	0.09g	B	6.8	0.09g	B	6.8
75		114-9007-B00060		4	18125	0.09g	B	0.0	0.09g	B	0.0

Note: a) BIN Number = Bridge Identification Number

b) P = Parallel Bridge

c) Main Span = Number of Spans

d) 50-Year Event = Event with 90% Probability of Not Being Exceeded in 50 Years

e) A = Acceleration in Rock
f) SPC = Seismic Performance Category
g) R = Bridge Rank Based on Structural Vulnerability and Seismic Hazard Rating
h) 250-Year Event = Event with 90% Probability of Not Being Exceeded in 250 Years

Table 12: Statistic of Bridge Rank at the 50-Year Event

50-Year Event						
SPC		—	0	>0		
B	1	28	206	10	Max	11.3
					Min	5.6
					Avg	8.3
C		11	9	112	Max	38.0
					Min	0.7
					Avg	17.7
D		1		11	Max	75.0
					Min	75.0
					Avg	75.0
SUM	1	40	215	133		

Table 13: Statistic of Bridge Rank at the 250-Year Event

250-Year Event						
SPC		—	0	>0		
B	1	27	198	10	Max	11.3
					Min	5.6
					Avg	8.3
C		12	9	120	Max	38.0
					Min	0.7
					Avg	19.2
D		1		11	Max	75.0
					Min	75.0
					Avg	75.0
SUM	1	40	207	141		

Table 14: Priority Bridges to Be Evaluated

No.	Parkway	County	BIN Number	SPC	Drawing Number	R
1	Purchase	Fulton	38-0051-B00012	D	16696	75.0
2			38-0307-B00015	D	16649	75.0
3			38-9003-B00053	D	16694	75.0
4			38-9003-B00053P	D		75.0
5			38-9003-B00054	D	16695	75.0
6			38-9003-B00054P	D		75.0
7			38-9003-B00055	D	16561	75.0
8			38-9003-B00055P	D		75.0
9	Purchase	Hickman	53-0094-B00050	D	16566	75.0
10			53-1529-B00056	D	16567	75.0
11			53-9003-B00068	D	16565	75.0
12	Audubon	Daviess	30-9005-B00060	C	17494	38.0
13			30-9005-B00061	C	17464	38.0
14	Purchase	Graves	42-9003-B00157	C	16527	35.1
15			42-9003-B00157P	C		35.1
16	Pennyrile	Webster	117-9004-B00071[a]	B	16858	8.4
17			117-9004-B00071P	B		8.4
Note: a) 48.6-53.3-53.3-53.3-53.3-53.3-48.53 (Seven Spans, RC)						

Table 15: Regular Bridge Requirements

(Seismic Retrofitting Manual, Table 4(b))

Parameter	Value				
Number of Spans	2	3	4	5	6
Maximum subtended angle (curved bridge)	90^o	90^o	90^o	90^o	90^o
Maximum span length ratio from span-to-span	3	2	2	1.5	1.5
Maximum bent/pier stiffness ratio from span-to-span (excluding abutments)	-	4	4	3	2

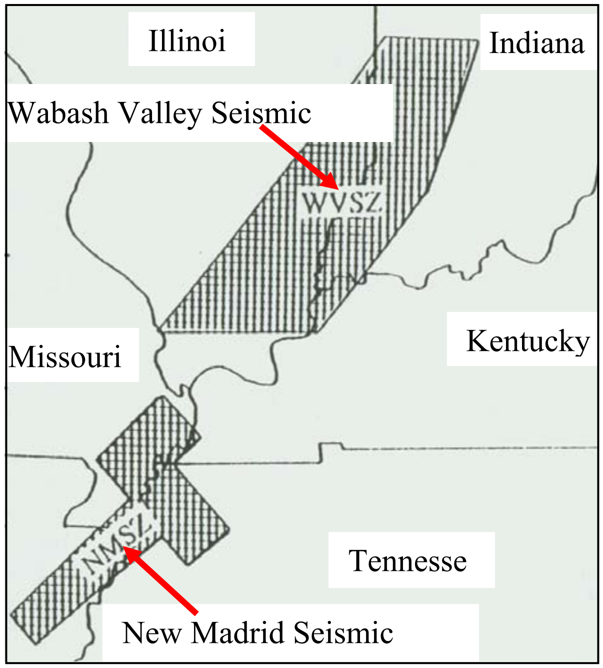


Figure 1: Seismic Source Zones Affecting Western Kentucky

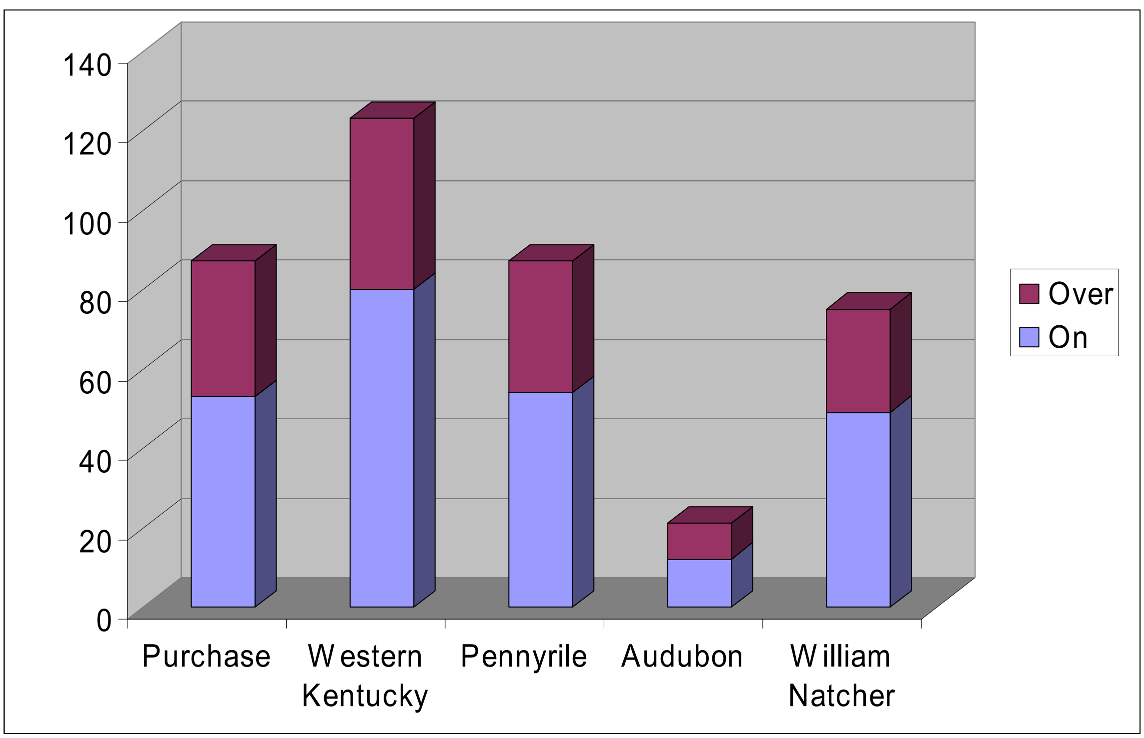


Figure 2: Number of Bridges on and Over the Parkways in Western Kentucky

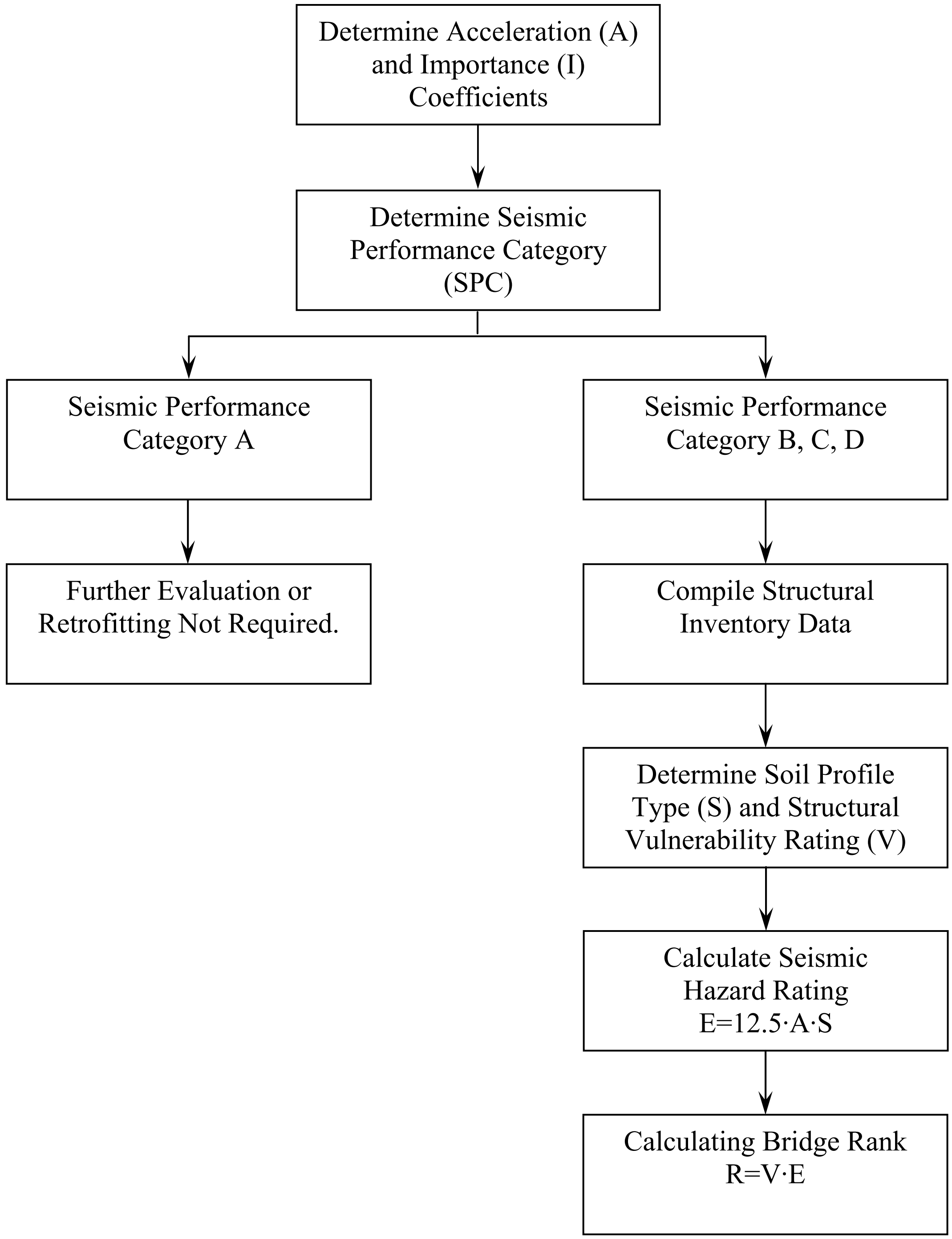
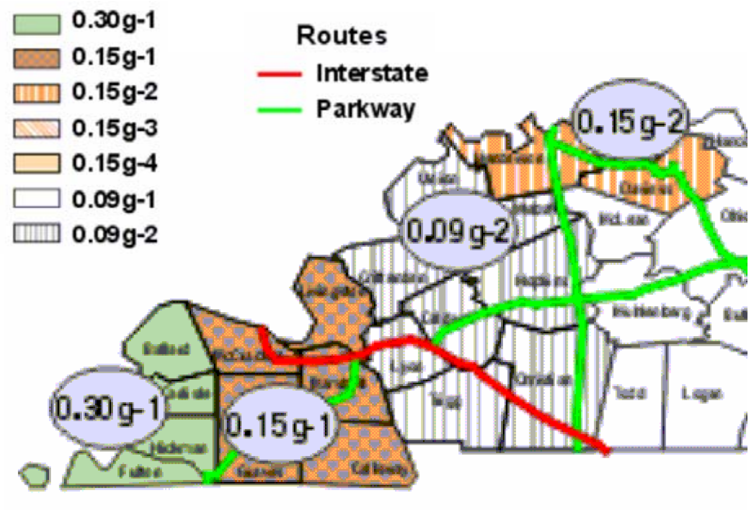
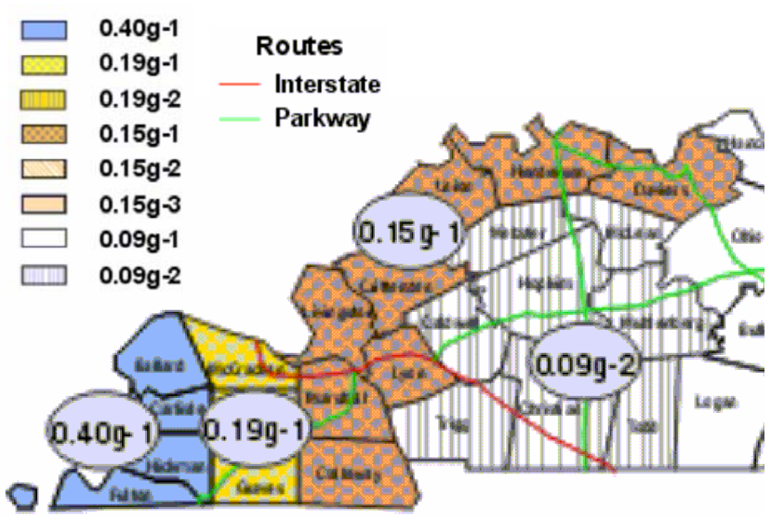


Figure 3: Seismic Ranking System

(Seismic Retrofitting manual, Figure 6)



(a) 50-year earthquake event



(b) 250-year earthquake event

Figure 4: Seismic Acceleration Maps

GENERAL	GPS Location	Longitude	Latitude	Bridge Number
	Year Built	*19*	County	Crossing
	Have modifications been made since the bridge was constructed? *No*.			If *yes*. Please list them (Structure or load).
	Does the bridge cross a body of water?	*Yes* *No*		
	Has the bridge been seismically retrofitted?	*Yes* *No*		
	Is it a rigid box culvert?	*Yes* *No*		
SUPERSTRUCTURE	Is the superstructure integral with the abutments?	*Yes* *No*		**Comments:**
	Does the superstructure contain box girders?	*Yes* *No*		
	Is there lateral movement under traffic loading?	0 2 4 6 8		
	Is the bridge likely to collapse in an earthquake after toppling failure of the bearings?	0 2 4 6 8		
	Would gross movement of superstructure cause instability?	0 2 4 6 8		
	Is the bridge skewed?	0° 10° 20° 30° 40° 50° 60°		
	Is there any unusual gap or offset at an expansion joint?	in		
BEARINGS	Type	*Rocker* *Elastomeric* *Sliding* *Muti-ratation*	Condition?	Bad Fair Good
	If there are pedestals, are the bearings likely to overturn in an earthquake?	0 2 4 6 8		
	Does the bridge with less than 3 girders have exterior girder supported on the seat edge?	*Yes* *No*		
	Are the bearing seats under the abutment end-diaphragm continuous?	*Yes* *No*		
	Are there any girders supported on individual pedestals or columns?	*Yes* *No*		
	The longitudinal support length measured in a direction perpendicular to the support at abutments.	in		
SUBSTRUCTURE	Is the abutment a cantilever earth-retaining abutment?	*Yes* *No*		
	Are the reinforced concrete columns monolithic with the superstructure?	*Yes* *No*		
	Is there horizontal or vertical movement or tilting of the abutments, columns or piers?	0 2 4 6 8		
	Is there unusual or extensive erosion of soil at or near any of the substructure units?	0 2 4 6 8		
	Are abutment-slop failures possible in an earthquake?	0 2 4 6 8		
OTHER				

Figure 5: Site Inspection Form for Parkways

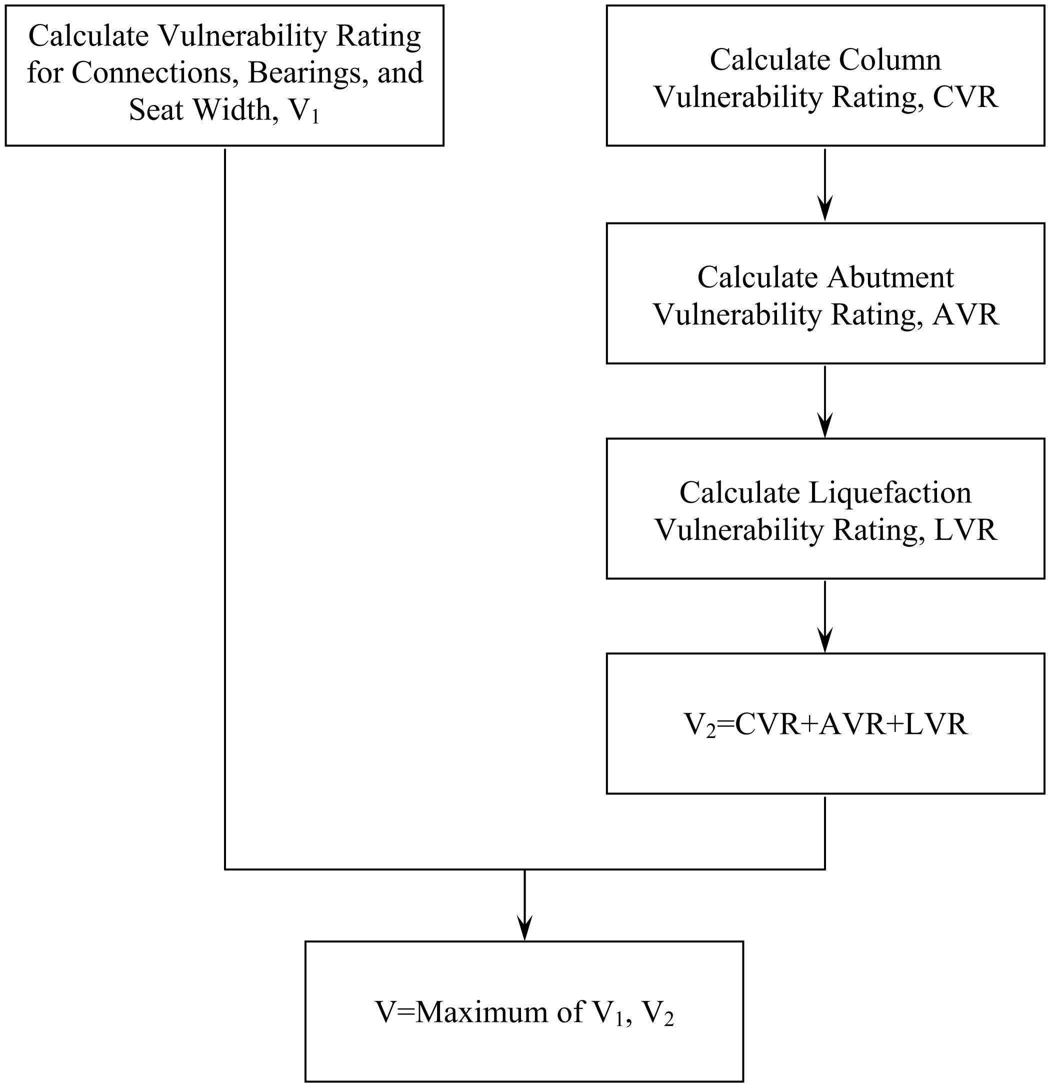


Figure 6: Flow Chart for Calculation of Bridge Vulnerability Rating (V)

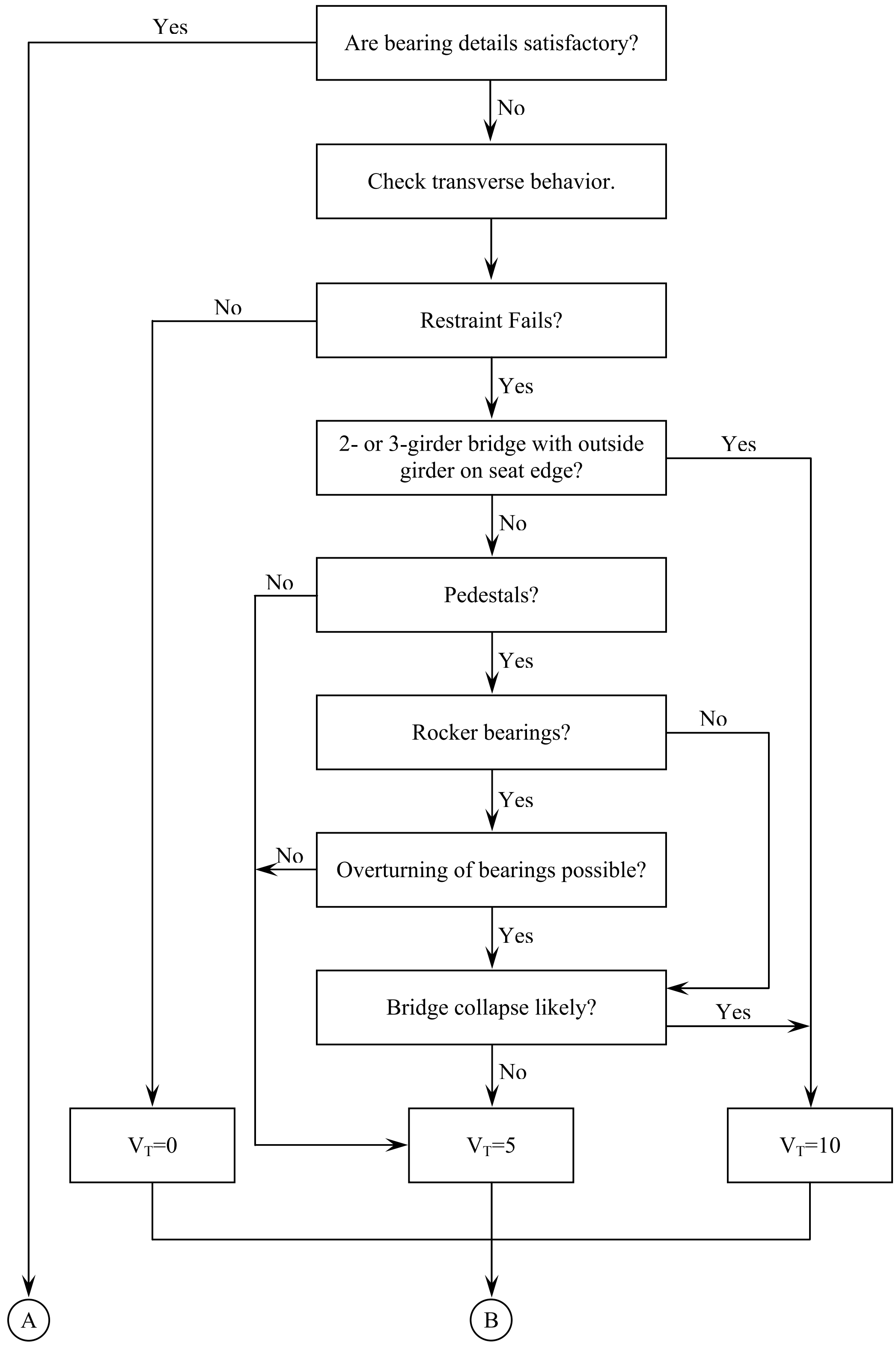


Figure 7: Flow Chart for Calculation of Vulnerability Rating for Connections, Bearings, and Seat Widths (V_1)
(Seismic Retrofitting Manual, Figure 9b)

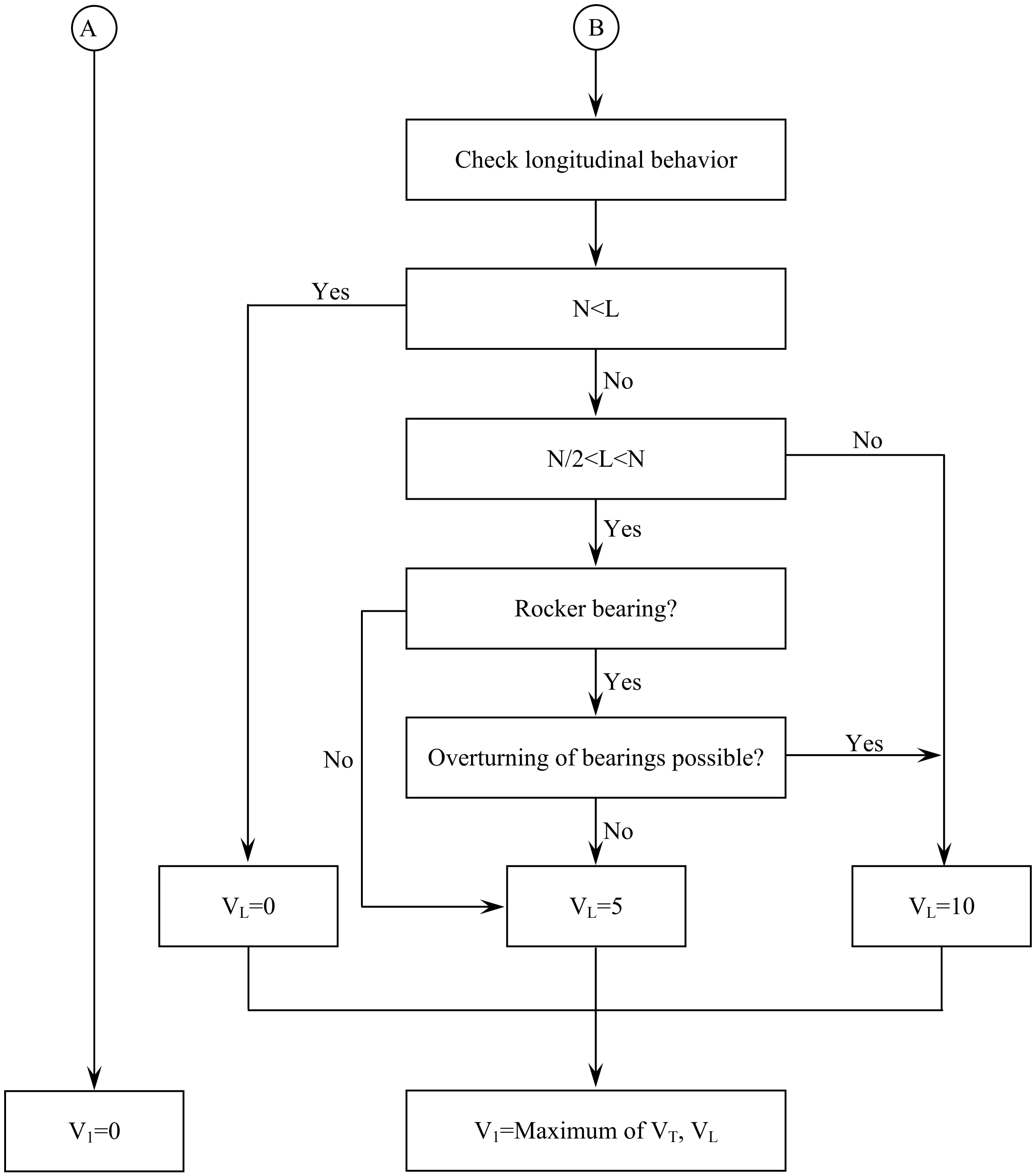


Figure 7 continued: Flow Chart for Calculation of Vulnerability Rating for Connections, Bearings, and Seat Widths (V_1)
(Seismic Retrofitting Manual, Figure 9b)

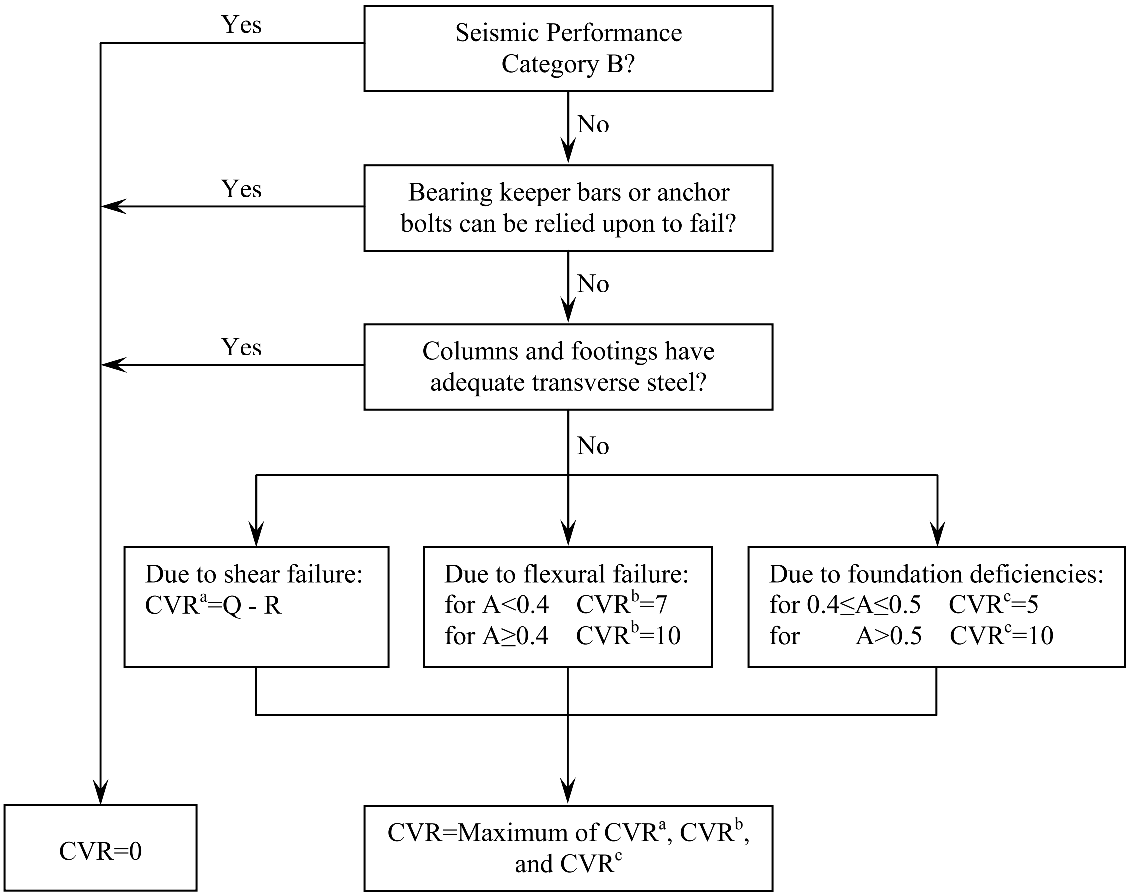


Figure 8: Flow Chart for Calculation of Column Vulnerability Rating (CVR)

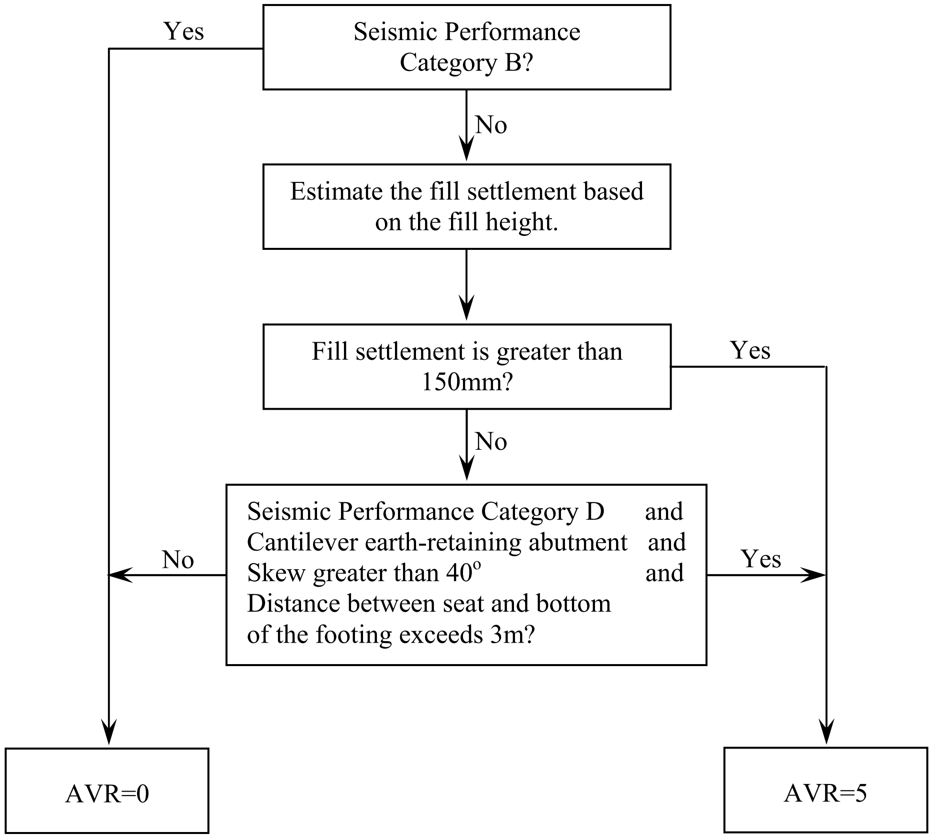
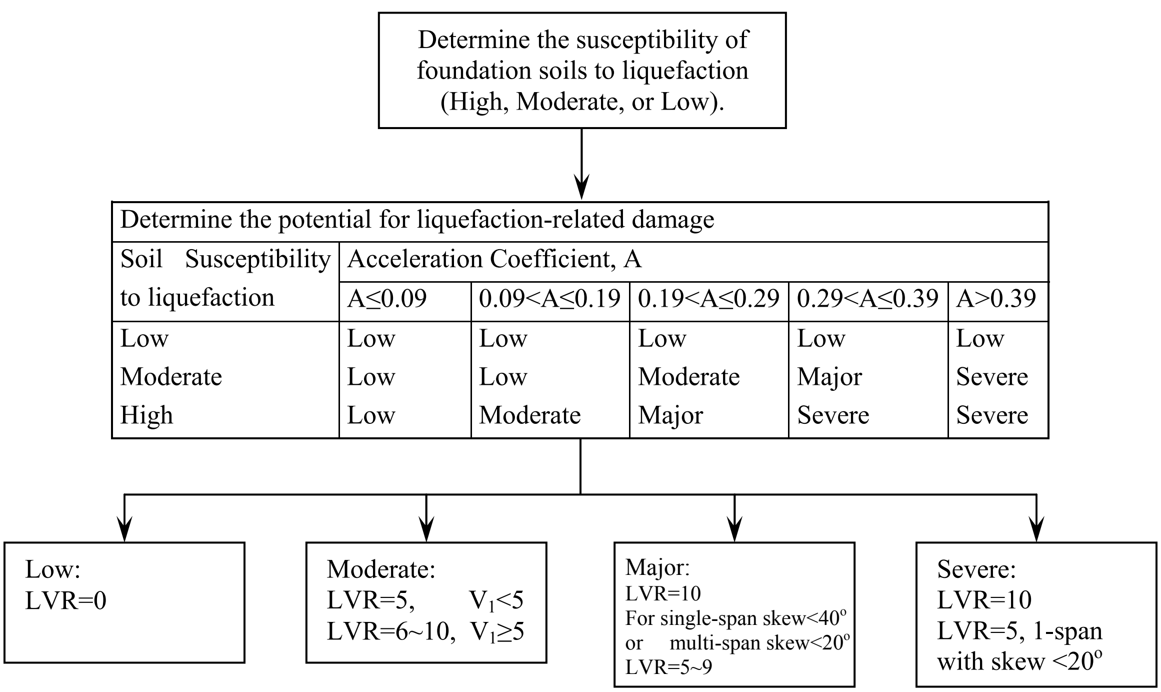
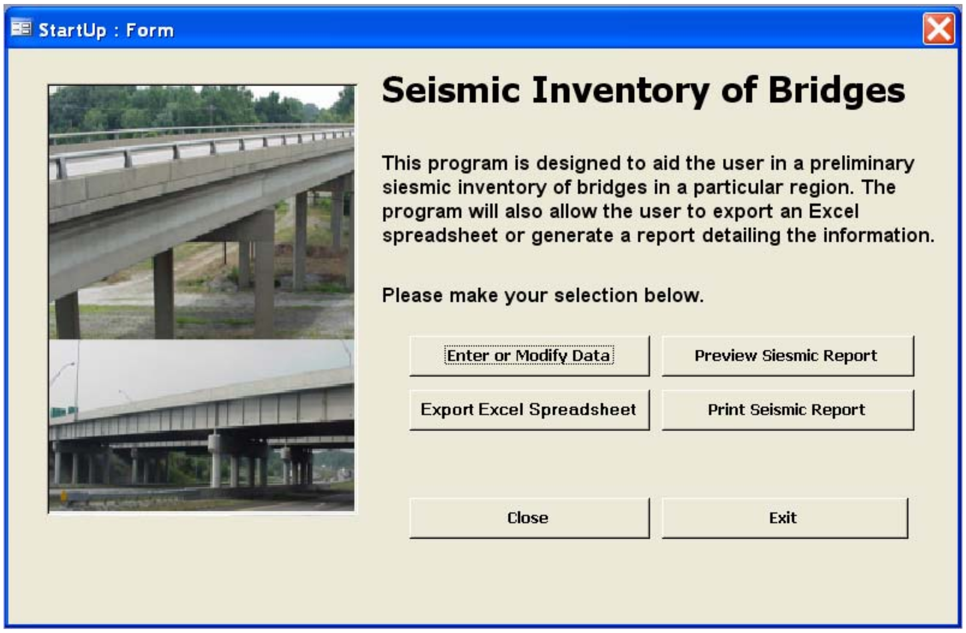


Figure 9: Flow Chart for Calculation of Abutment Vulnerability Rating (AVR)

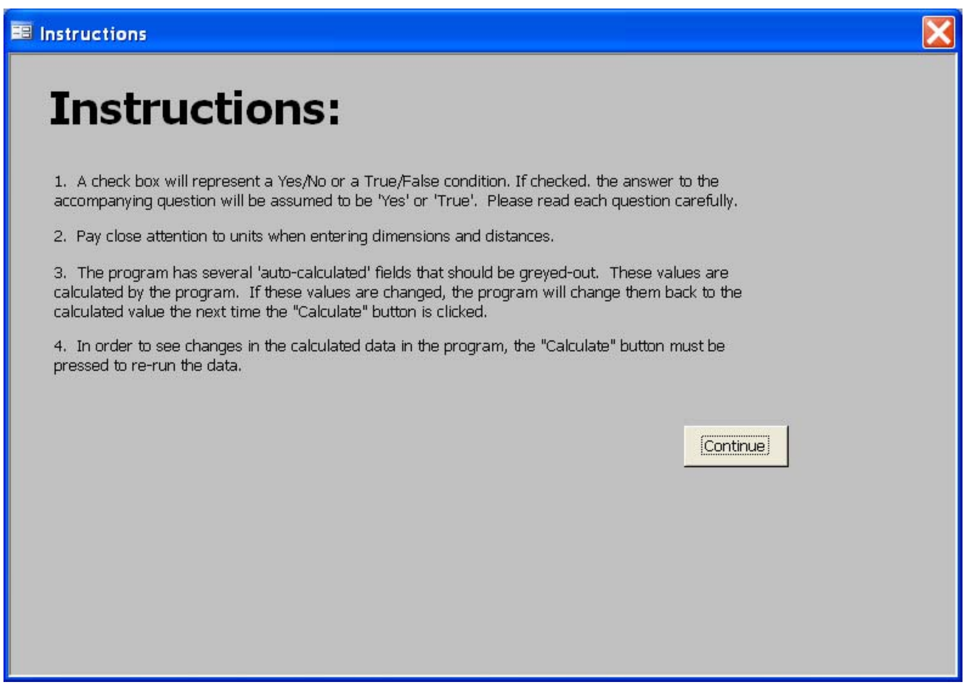


Soil Susceptibility to liquefaction	Acceleration Coefficient, A				
	A≤0.09	0.09<A≤0.19	0.19<A≤0.29	0.29<A≤0.39	A>0.39
Low	Low	Low	Low	Low	Low
Moderate	Low	Low	Moderate	Major	Severe
High	Low	Moderate	Major	Severe	Severe

Figure 10: Flow Chart for Calculation of Liquefaction Vulnerability Rating (LVR)

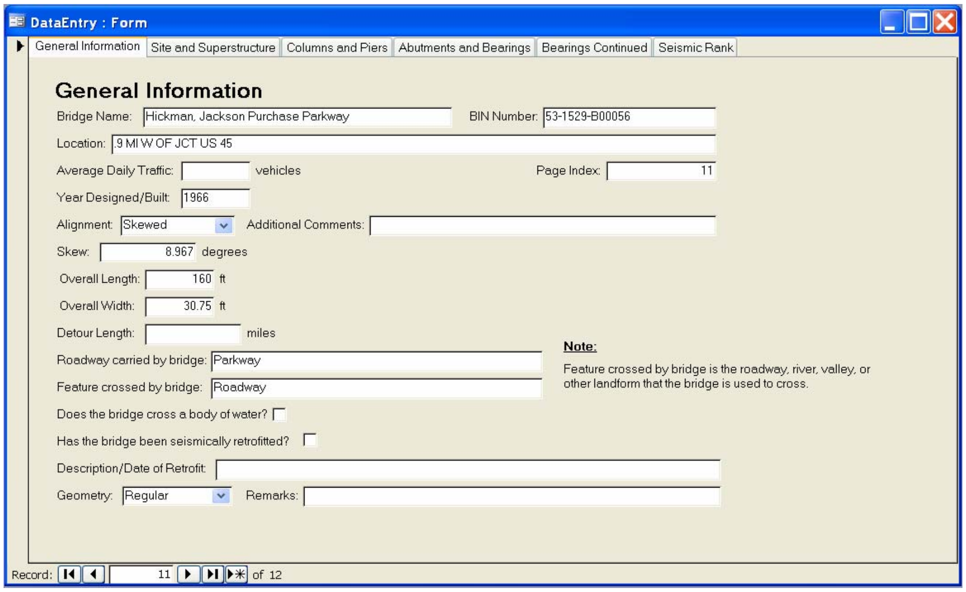


(a) StartUp

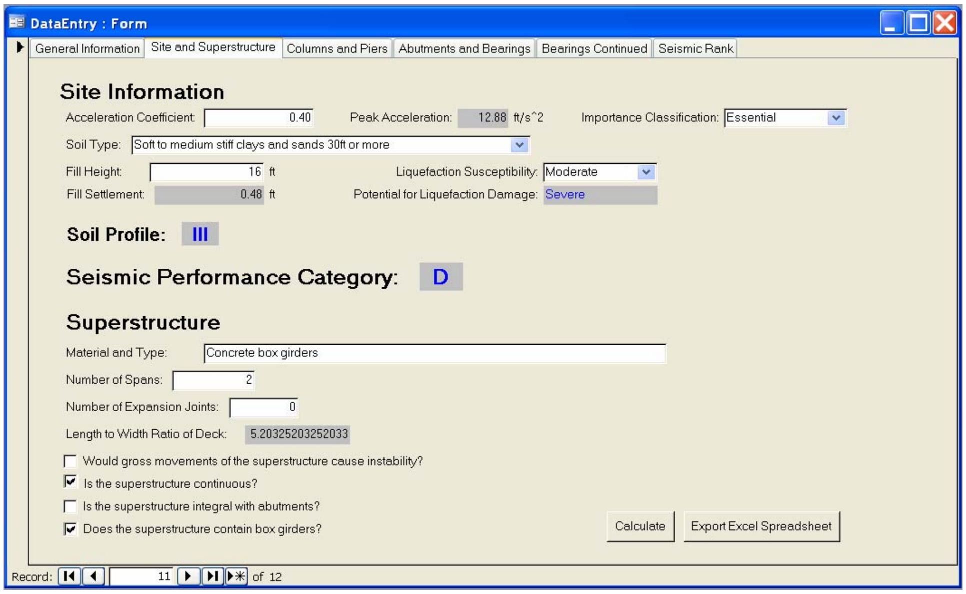


(b) Instruction

Figure 11: Preliminary Seismic Screening Program



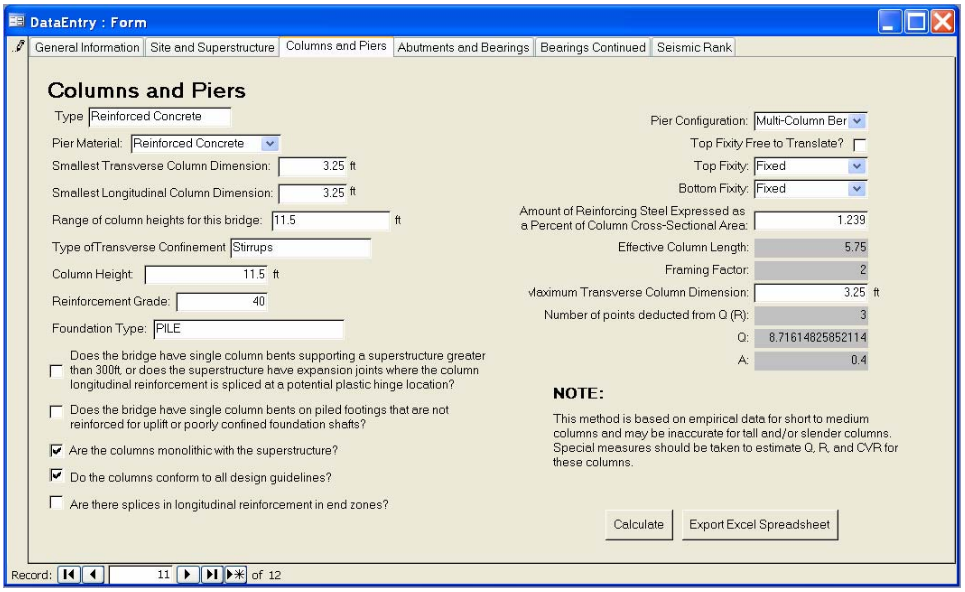
(a) General Information



(b) Site and Superstructure Information

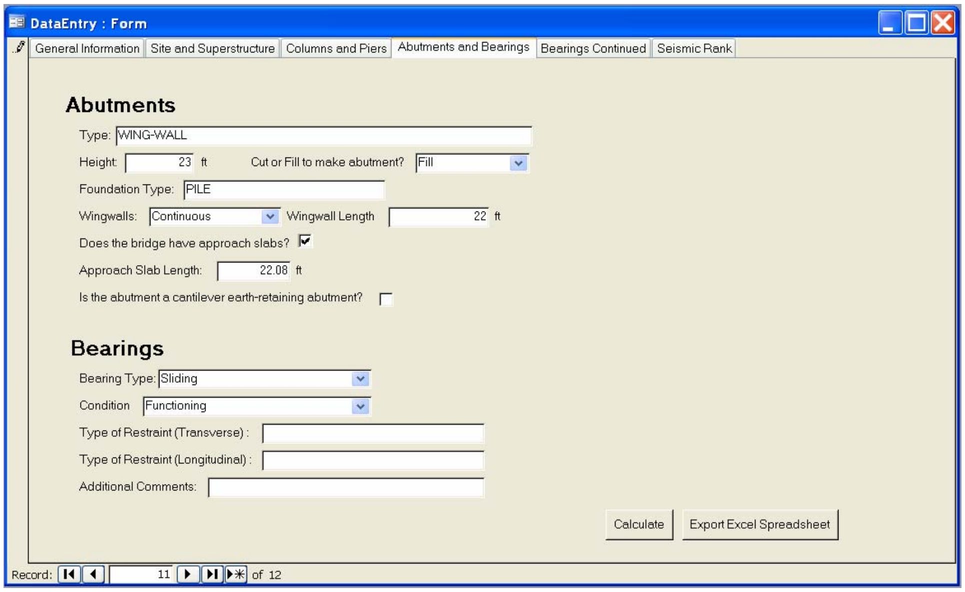
(The values with gray highlight are auto-calculated when the “Calculate” button is pressed.)

Figure 12: Example of Preliminary Seismic Evaluation with SIB Program



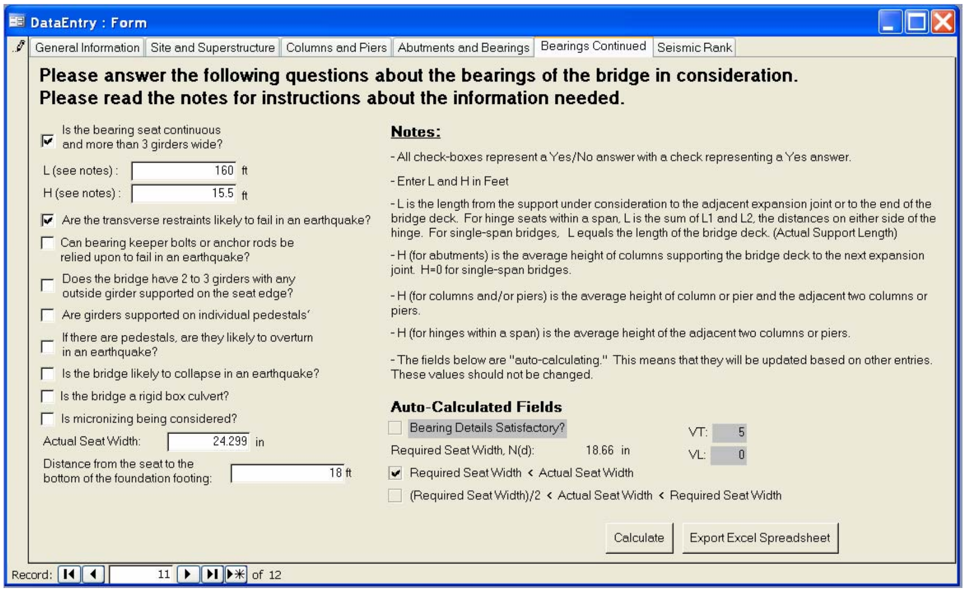
(c) Columns and Piers Information

(The values with gray highlight are auto-calculated when the “Calculate” button is pressed.)



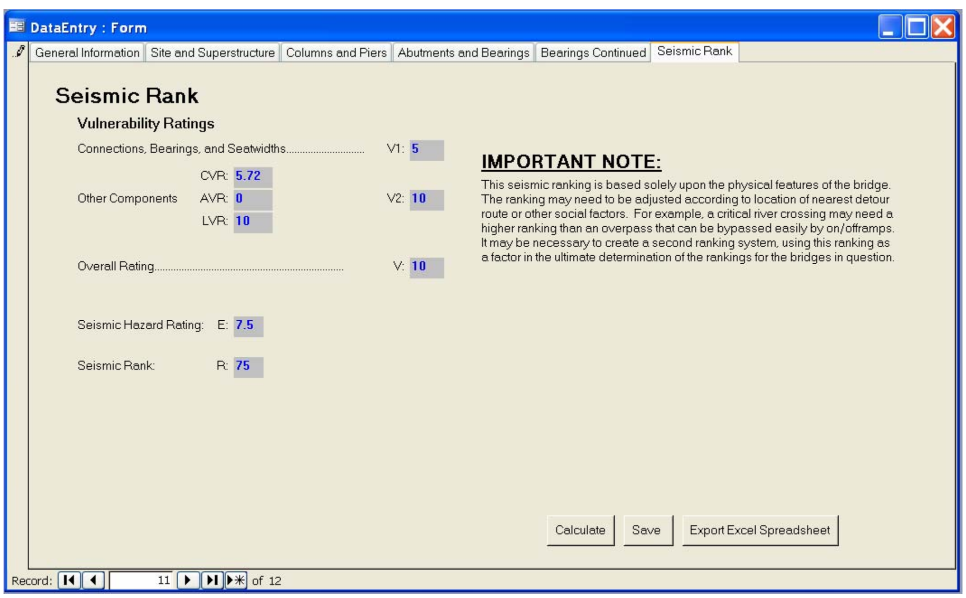
(d) Abutments and Bearings Information

Figure 12 continued: Example of Preliminary Seismic Evaluation with SIB Program



(e) Bearings Information Continued

(The values with gray highlight are auto-calculated when the “Calculate” button is pressed.)



(f) Seismic Rank Results

(The values with gray highlight are auto-calculated when the “Calculate” button is pressed.)

Figure 12 continued: Example of Preliminary Seismic Evaluation with SIB Program

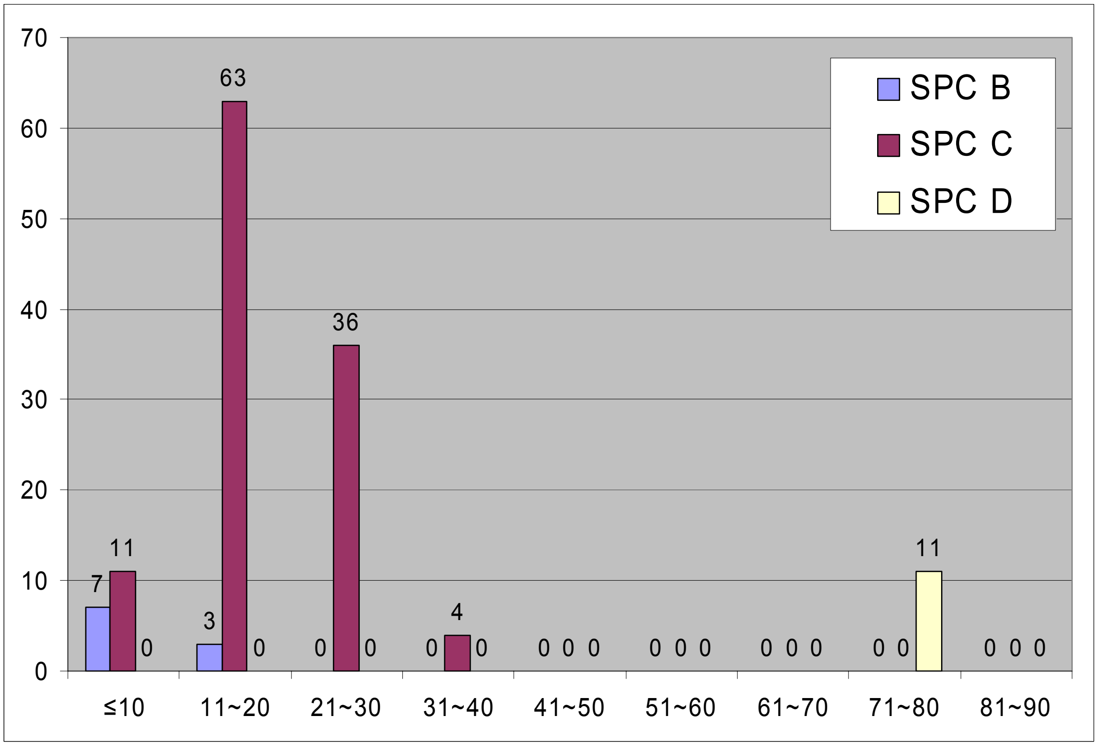


Figure 13: Distribution of Bridge Rank at the 50-Year Event
(For Bridge Rank is Greater than 0)

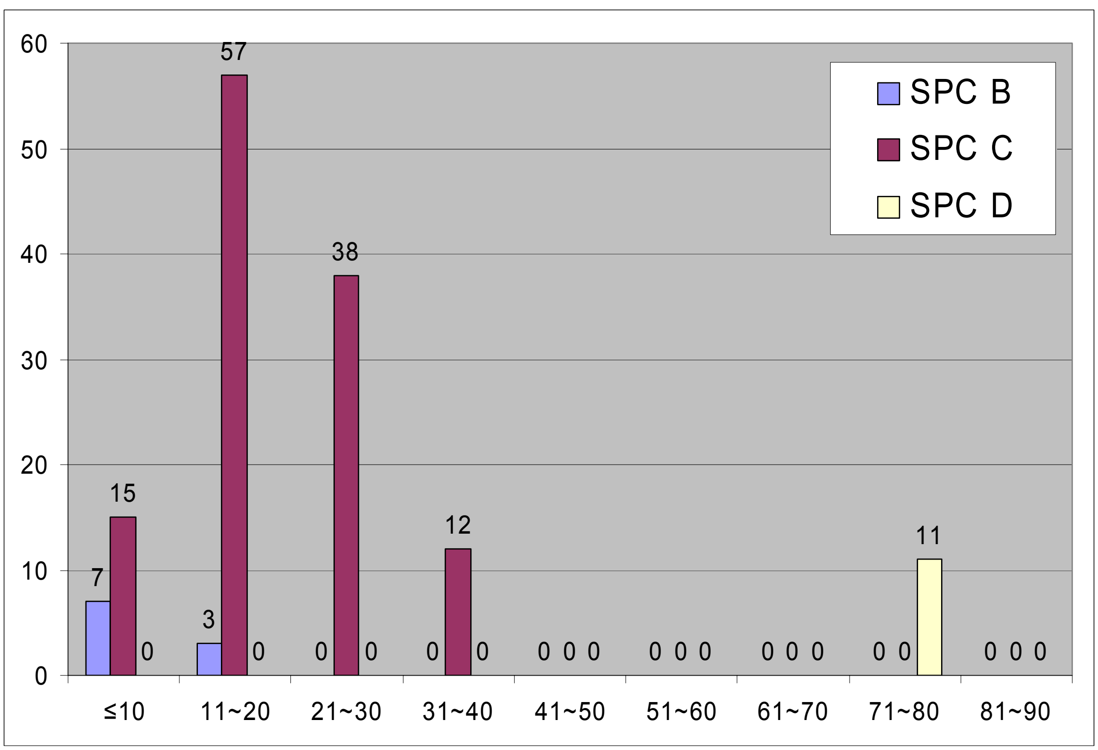


Figure 14: Distribution of Bridge Rank at the 250-Year Event
(For Bridge Rank is Greater than 0)

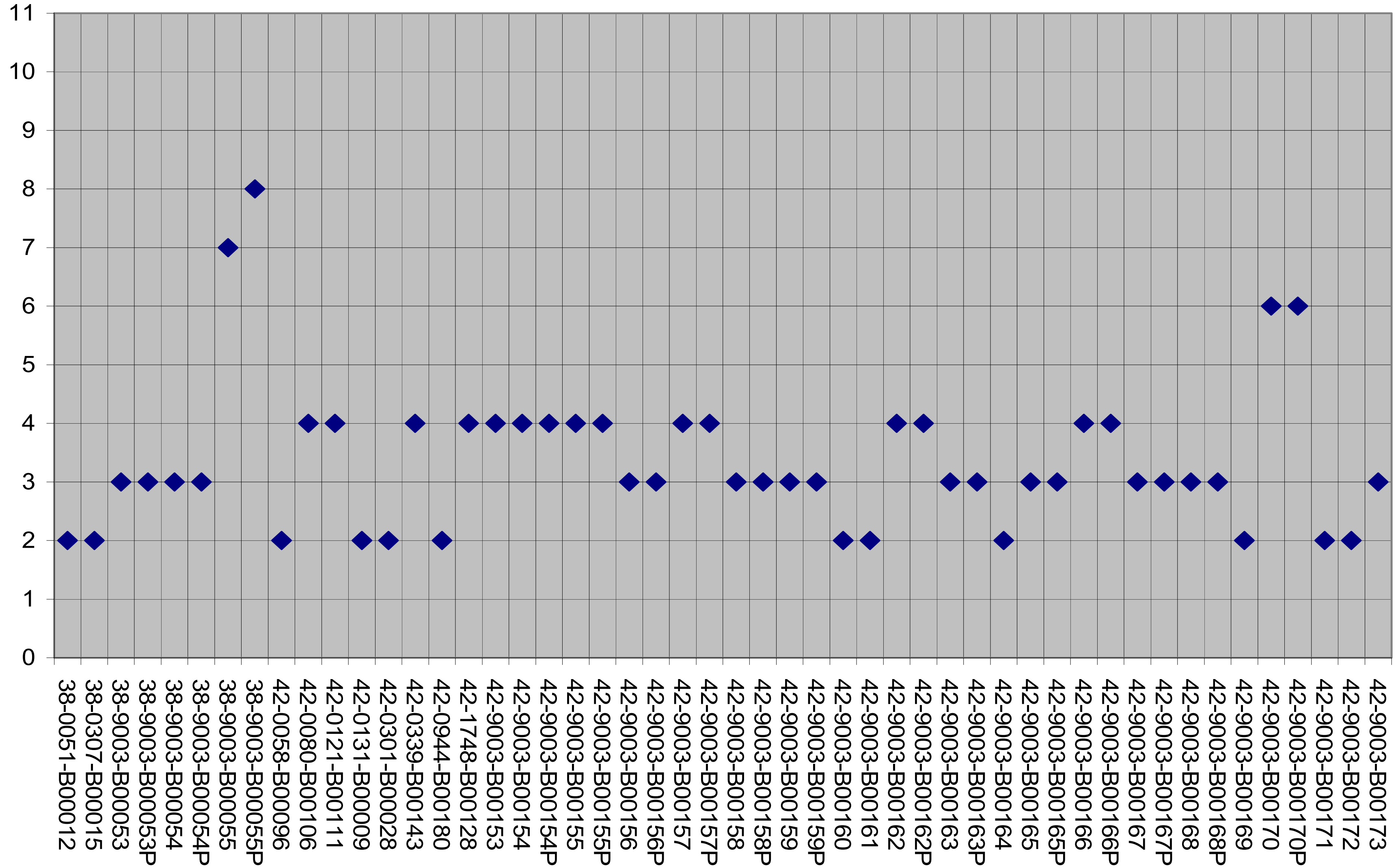


Figure 15: Number of Spans of Bridges on and over the Parkways in Western Kentucky

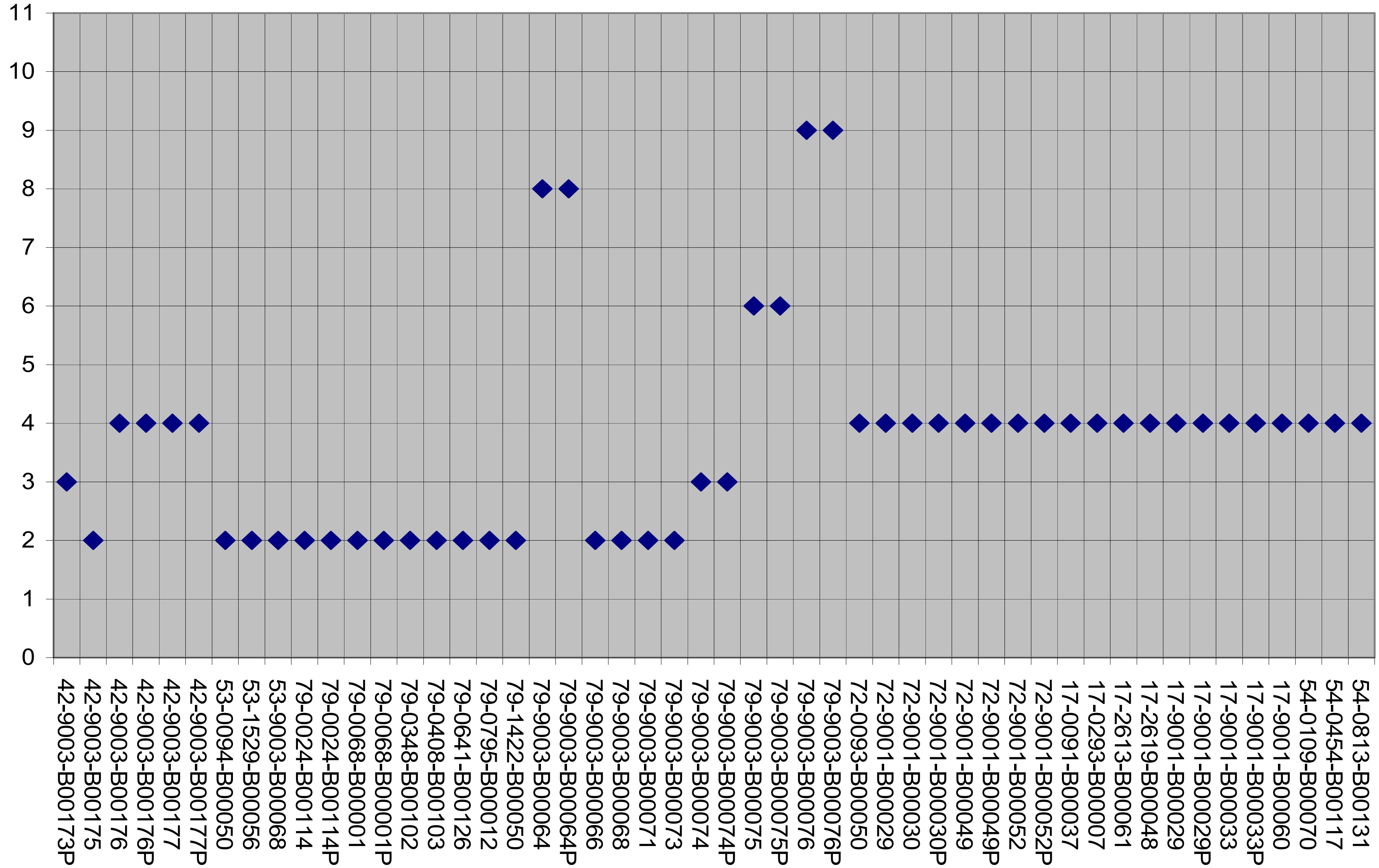


Figure 15 continued: Number of Spans of Bridges on and over the Parkways in Western Kentucky

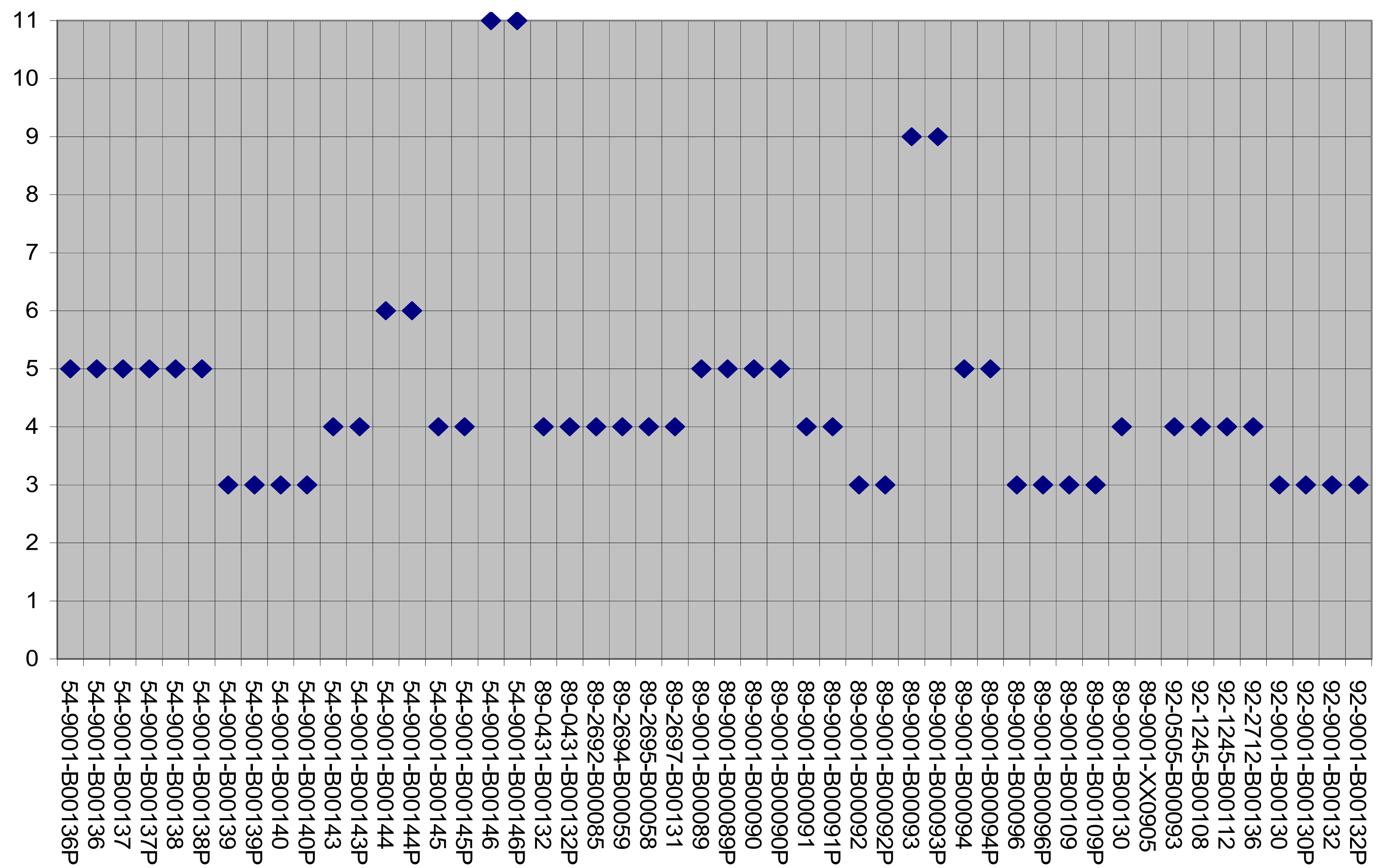


Figure 15 continued: Number of Spans of Bridges on and over the Parkways in Western Kentucky

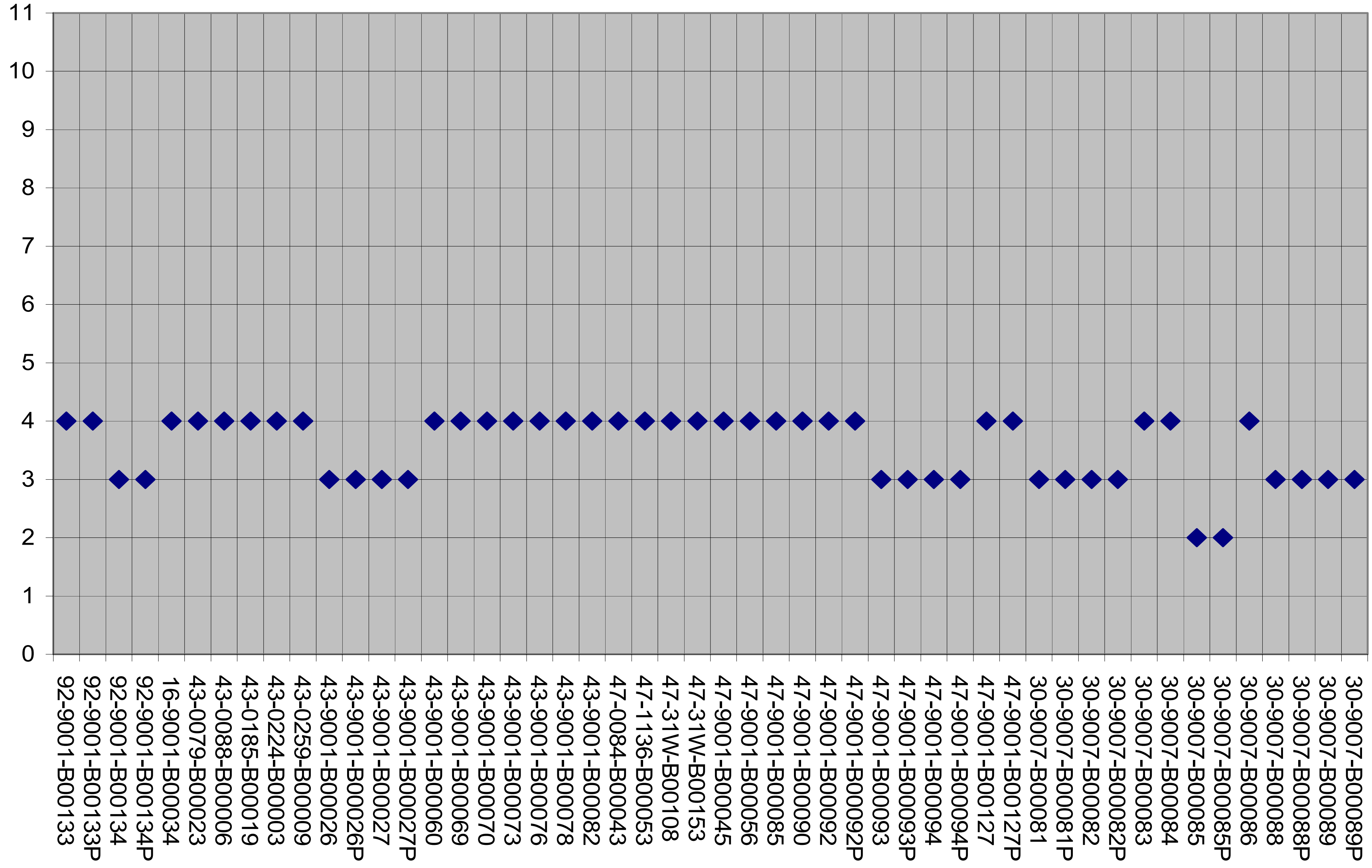


Figure 15 continued: Number of Spans of Bridges on and over the Parkways in Western Kentucky

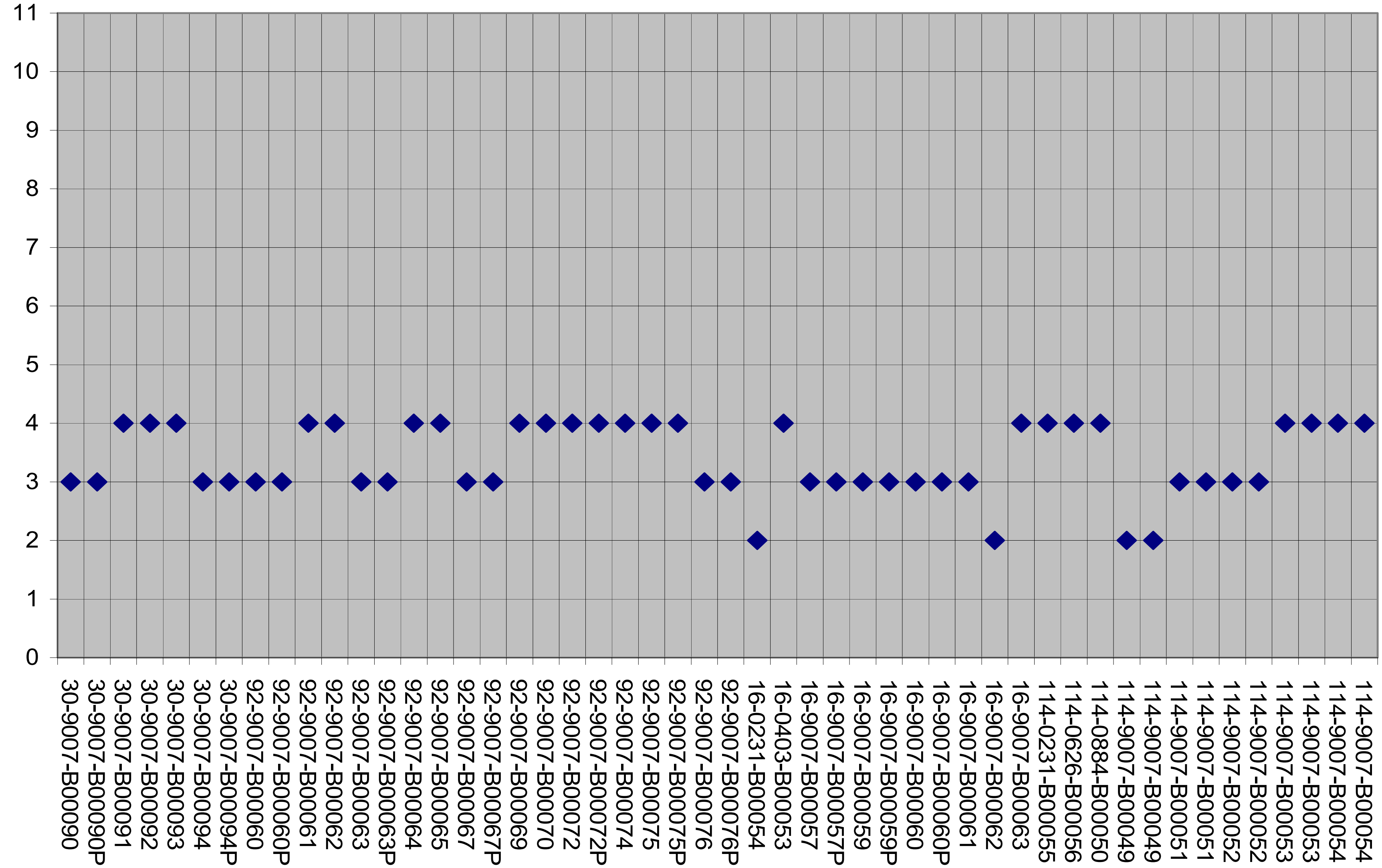


Figure 15 continued: Number of Spans of Bridges on and over the Parkways in Western Kentucky

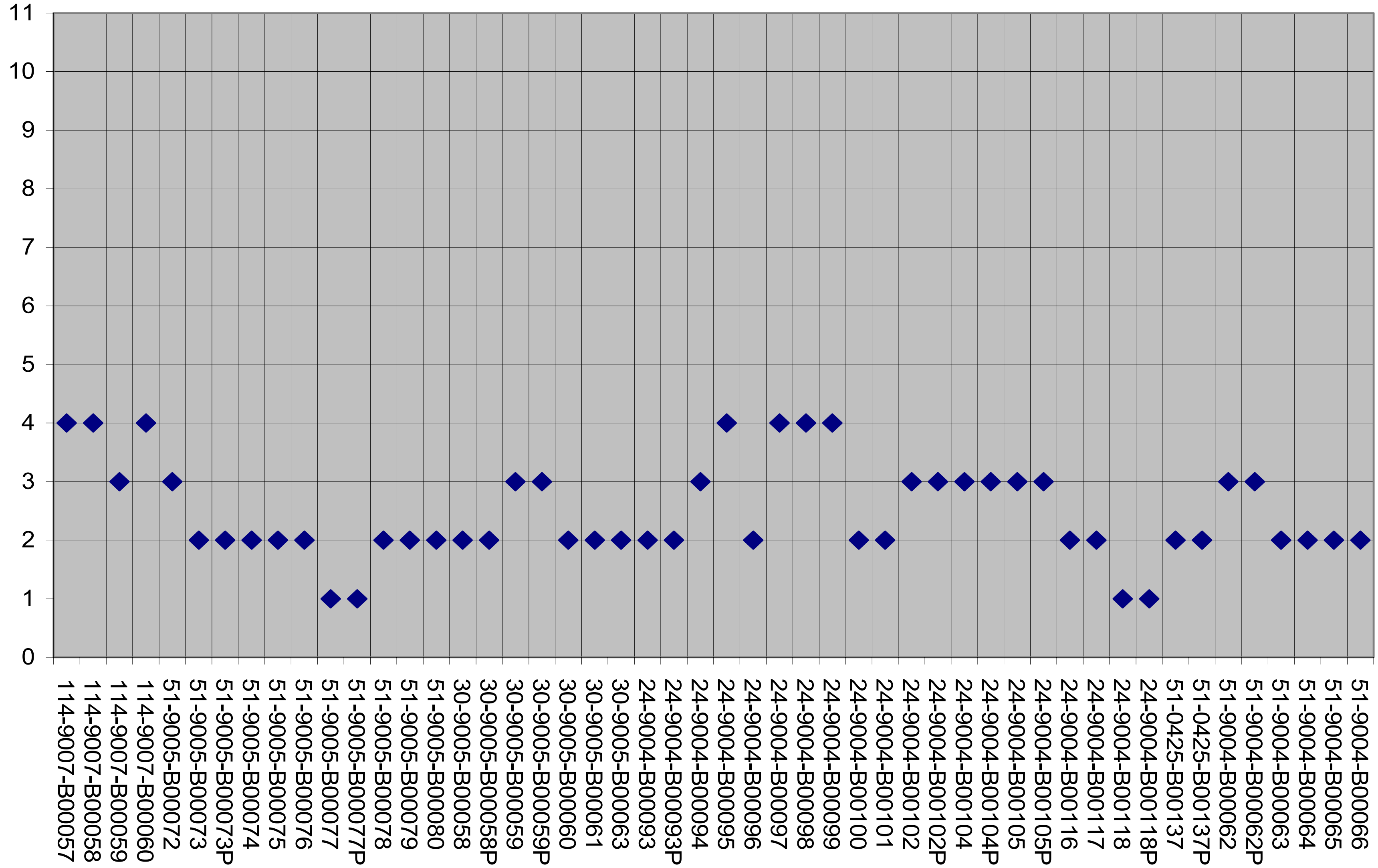


Figure 15 continued: Number of Spans of Bridges on and over the Parkways in Western Kentucky

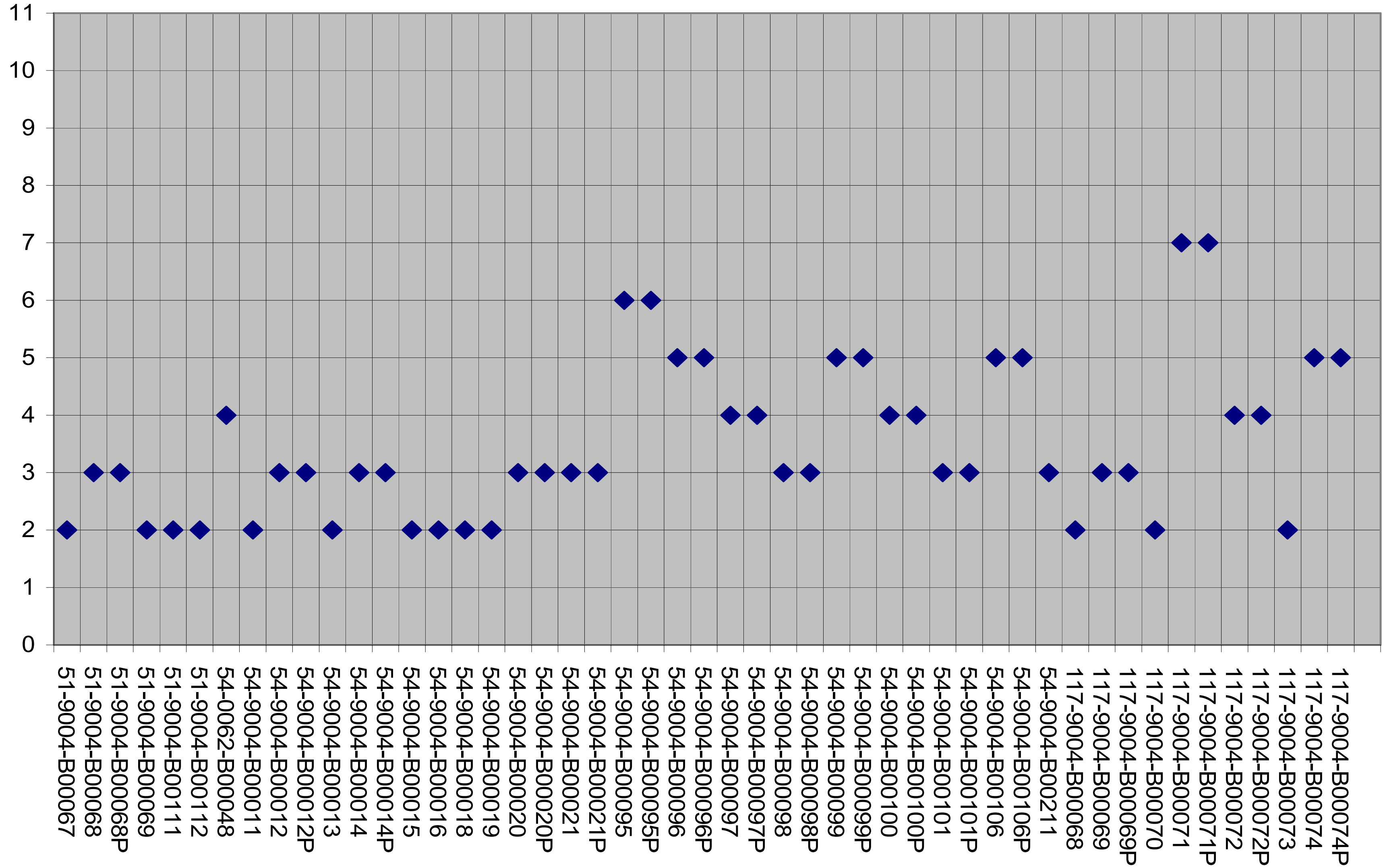


Figure 15 continued: Number of Spans of Bridges on and over the Parkways in Western Kentucky

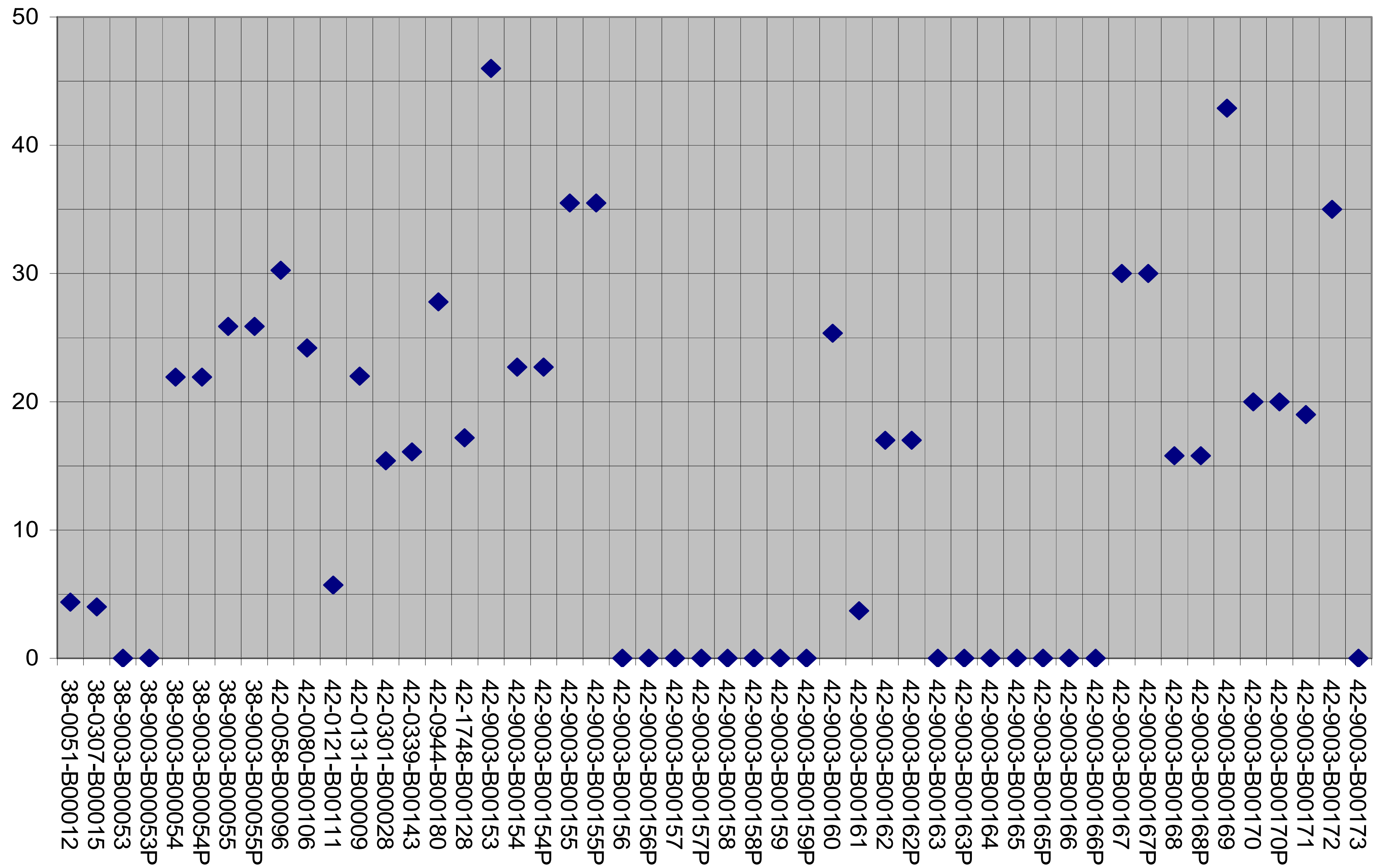


Figure 16: Skew Angle of Bridges on and over the Parkways in Western Kentucky

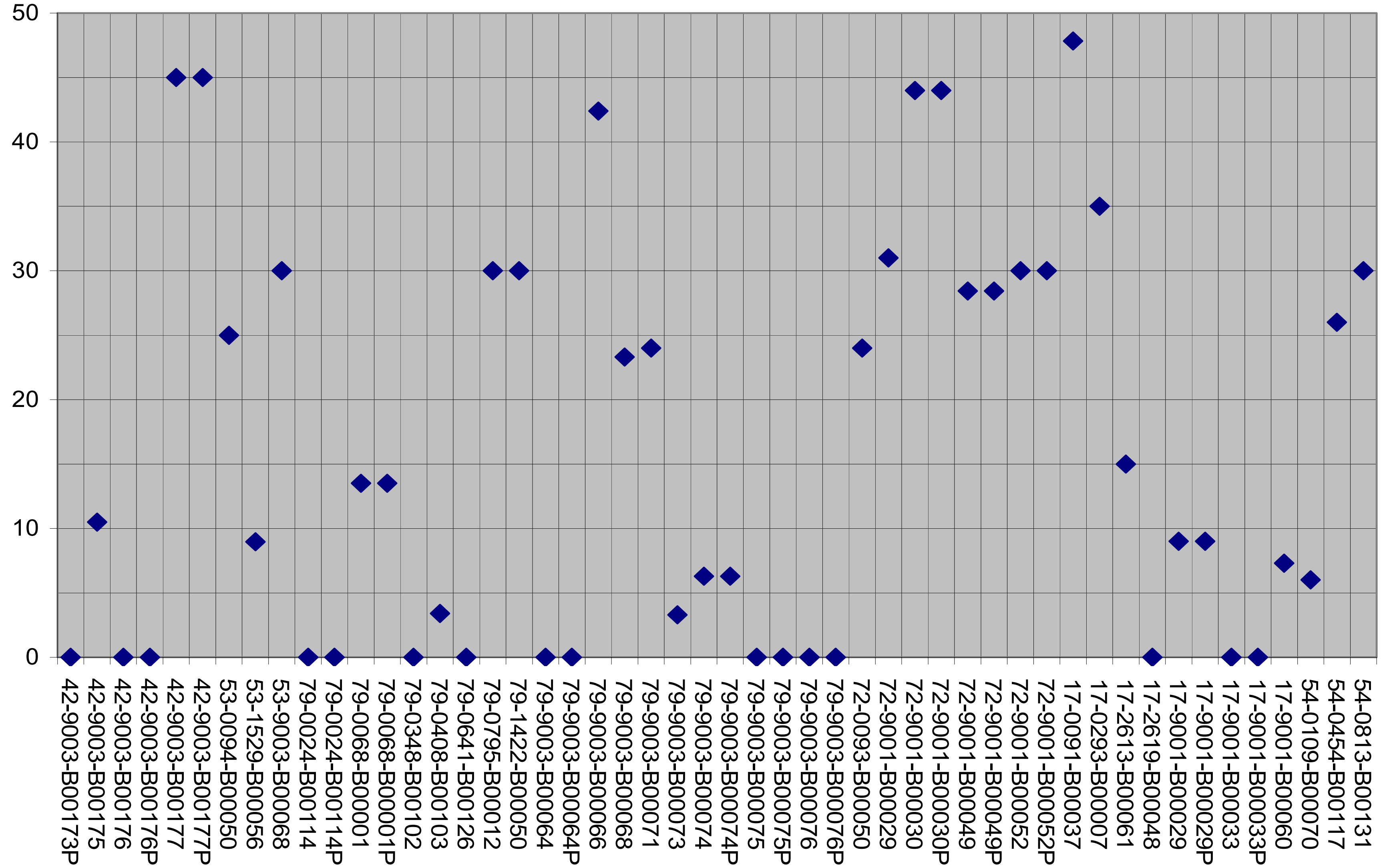


Figure 16 continued: Skew Angle of Bridges on and over the Parkways in Western Kentucky

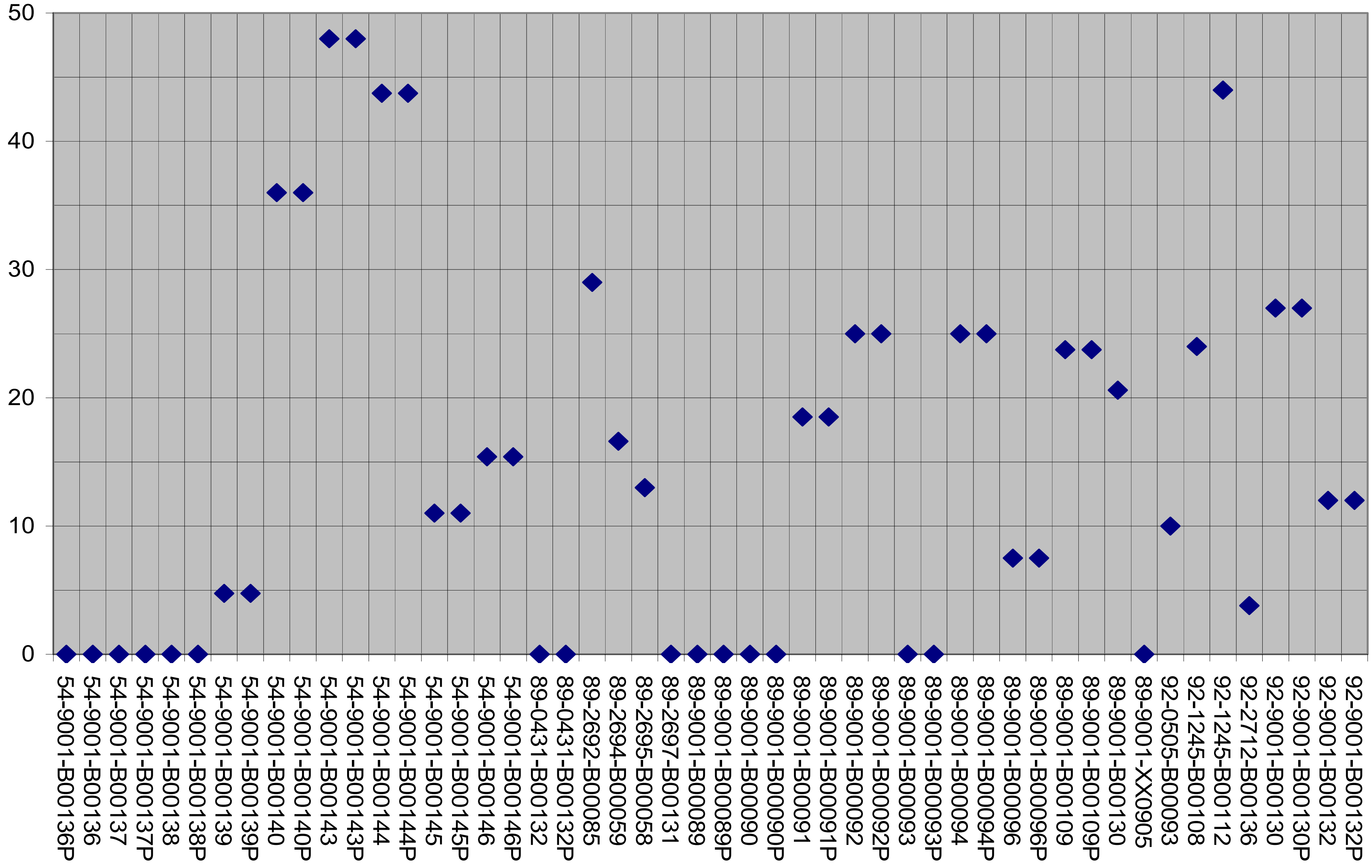


Figure 16 continued: Skew Angle of Bridges on and over the Parkways in Western Kentucky

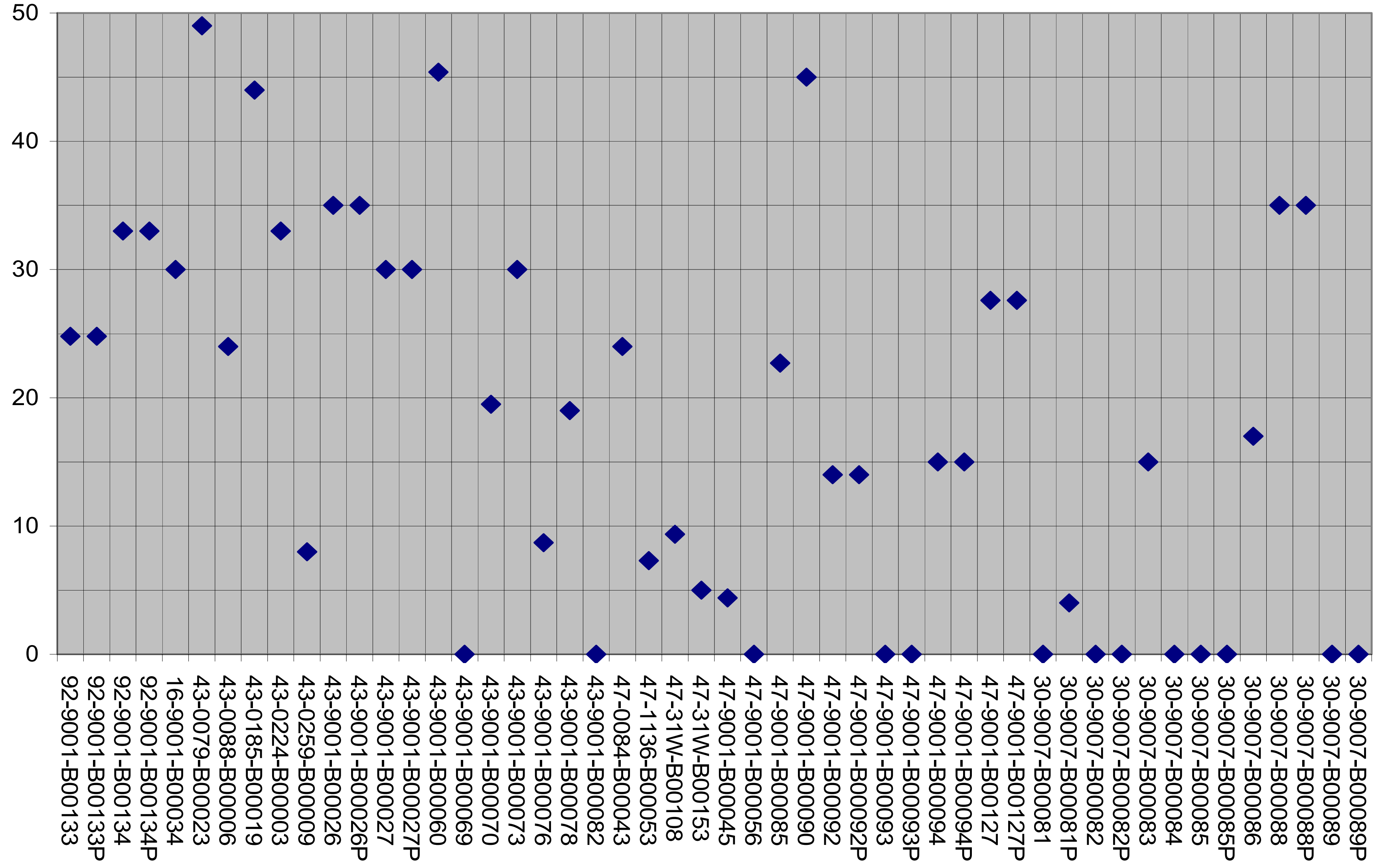


Figure 16 continued: Skew Angle of Bridges on and over the Parkways in Western Kentucky

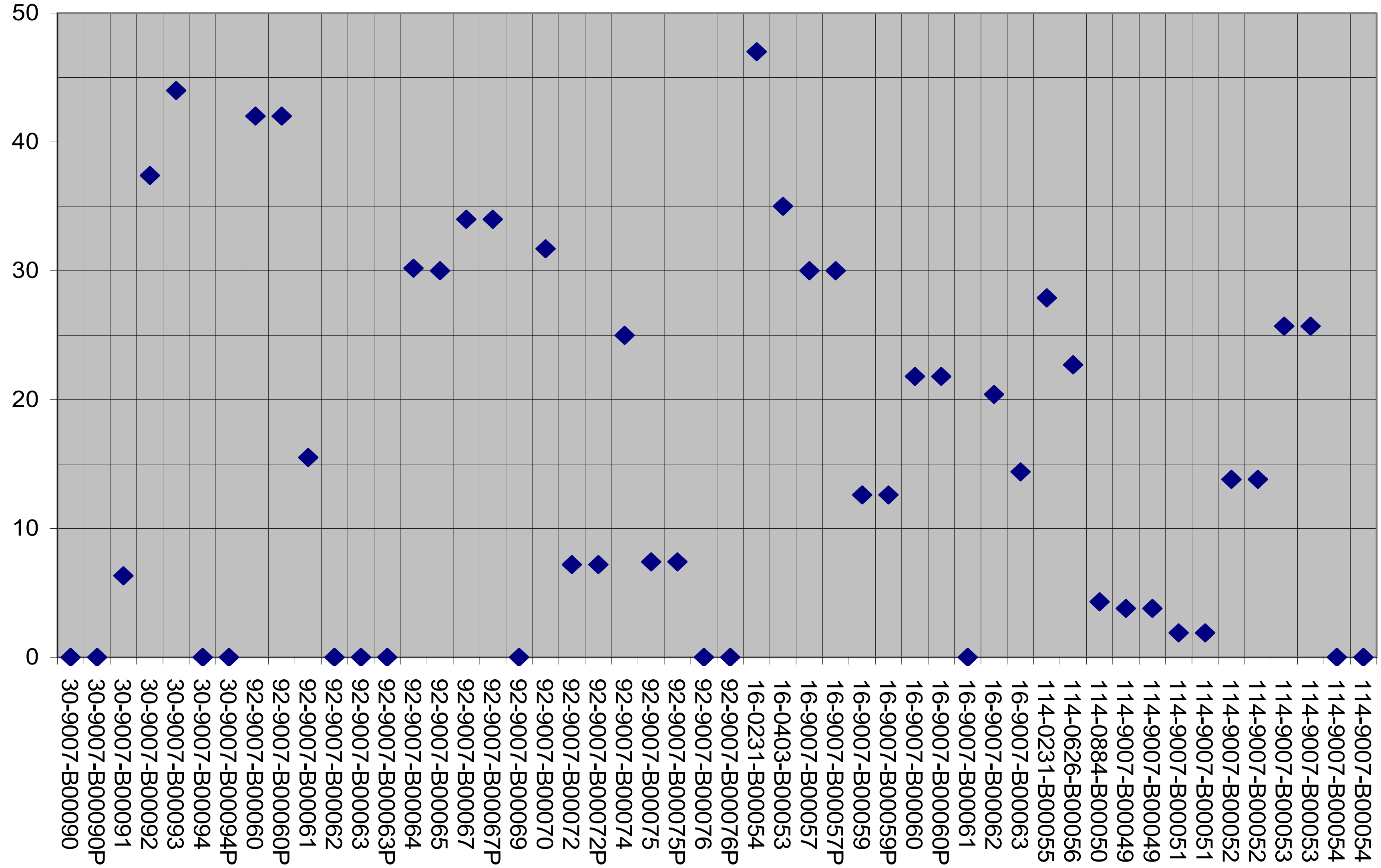


Figure 16 continued: Skew Angle of Bridges on and over the Parkways in Western Kentucky

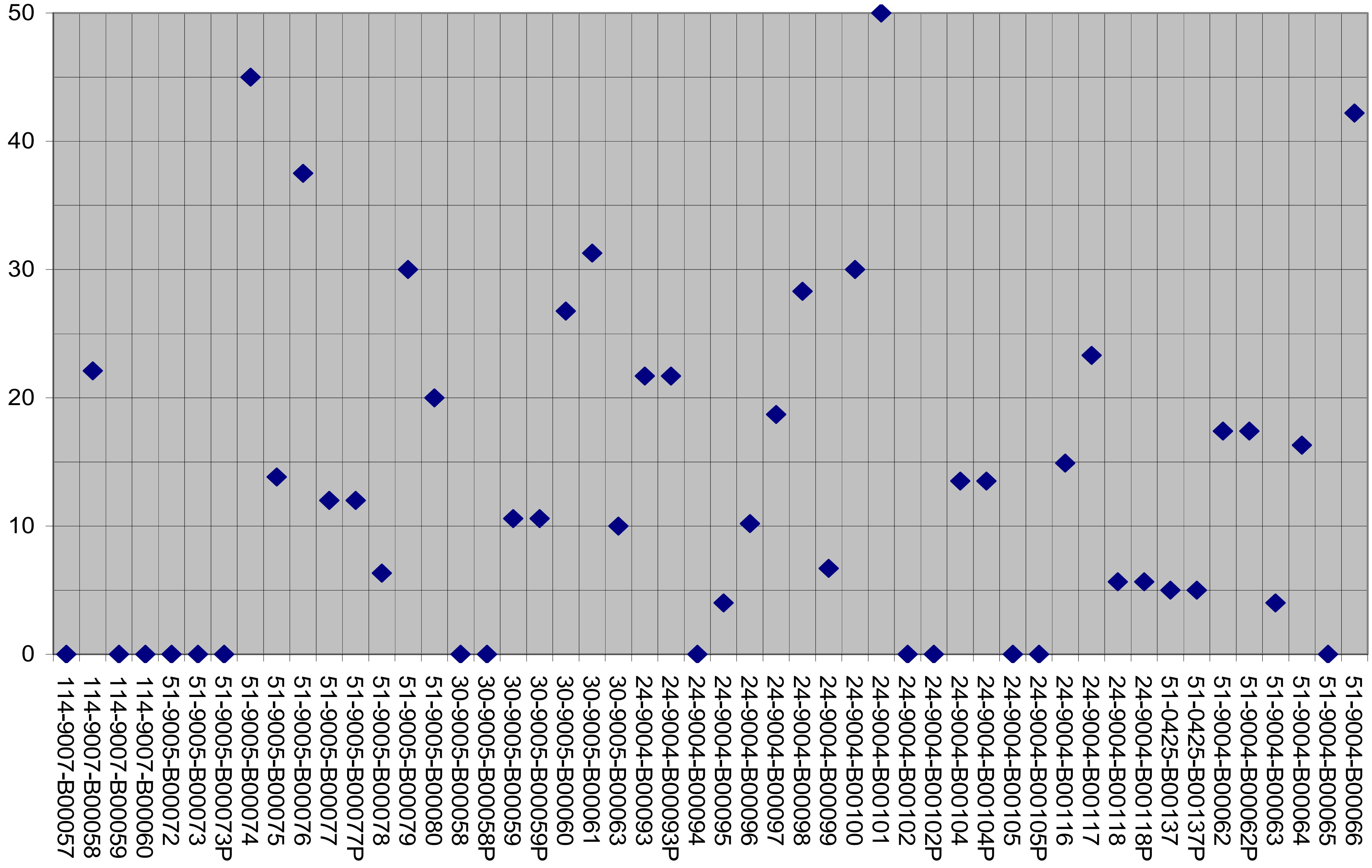


Figure 16 continued: Skew Angle of Bridges on and over the Parkways in Western Kentucky

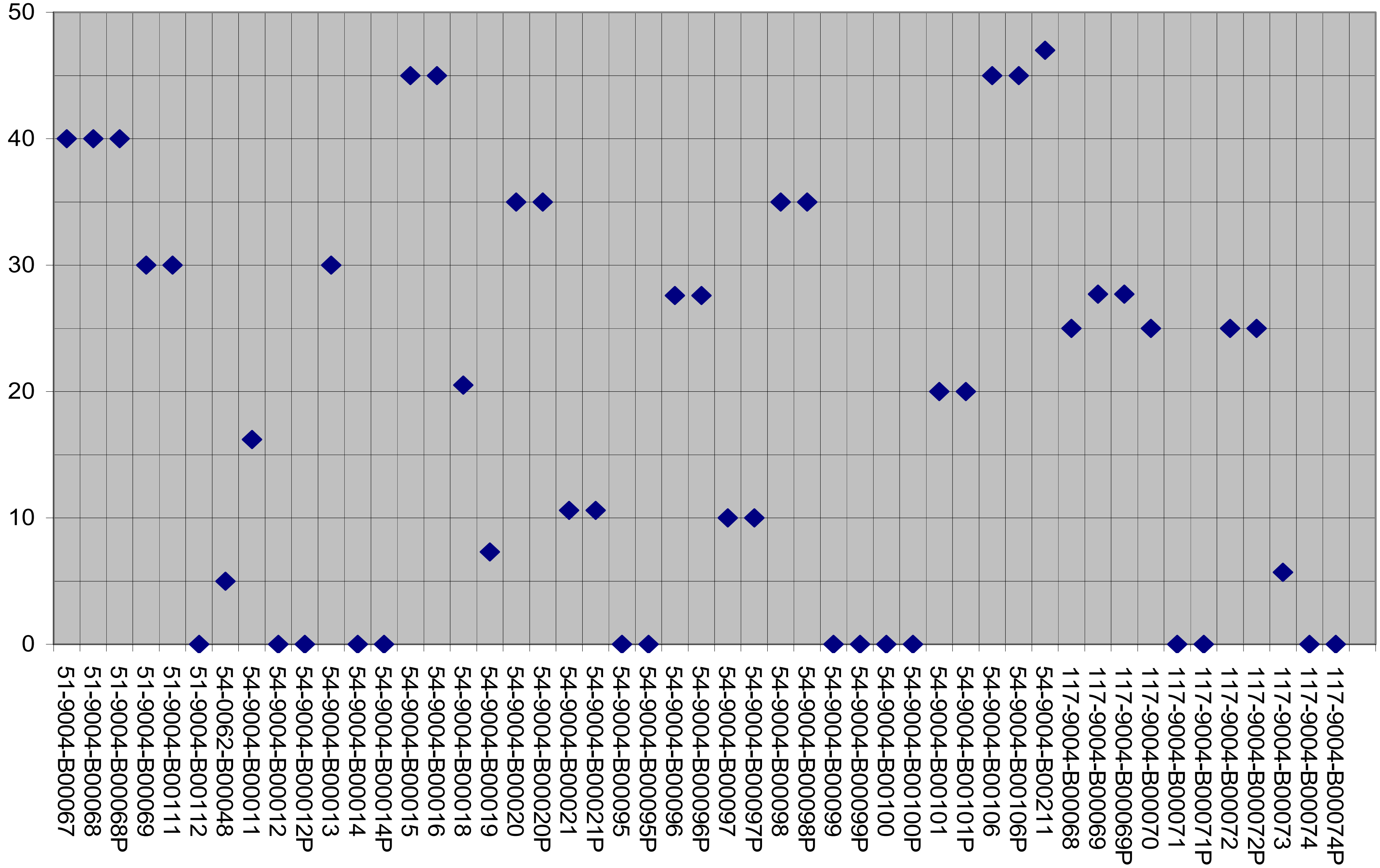


Figure 16 continued: Skew Angle of Bridges on and over the Parkways in Western Kentucky

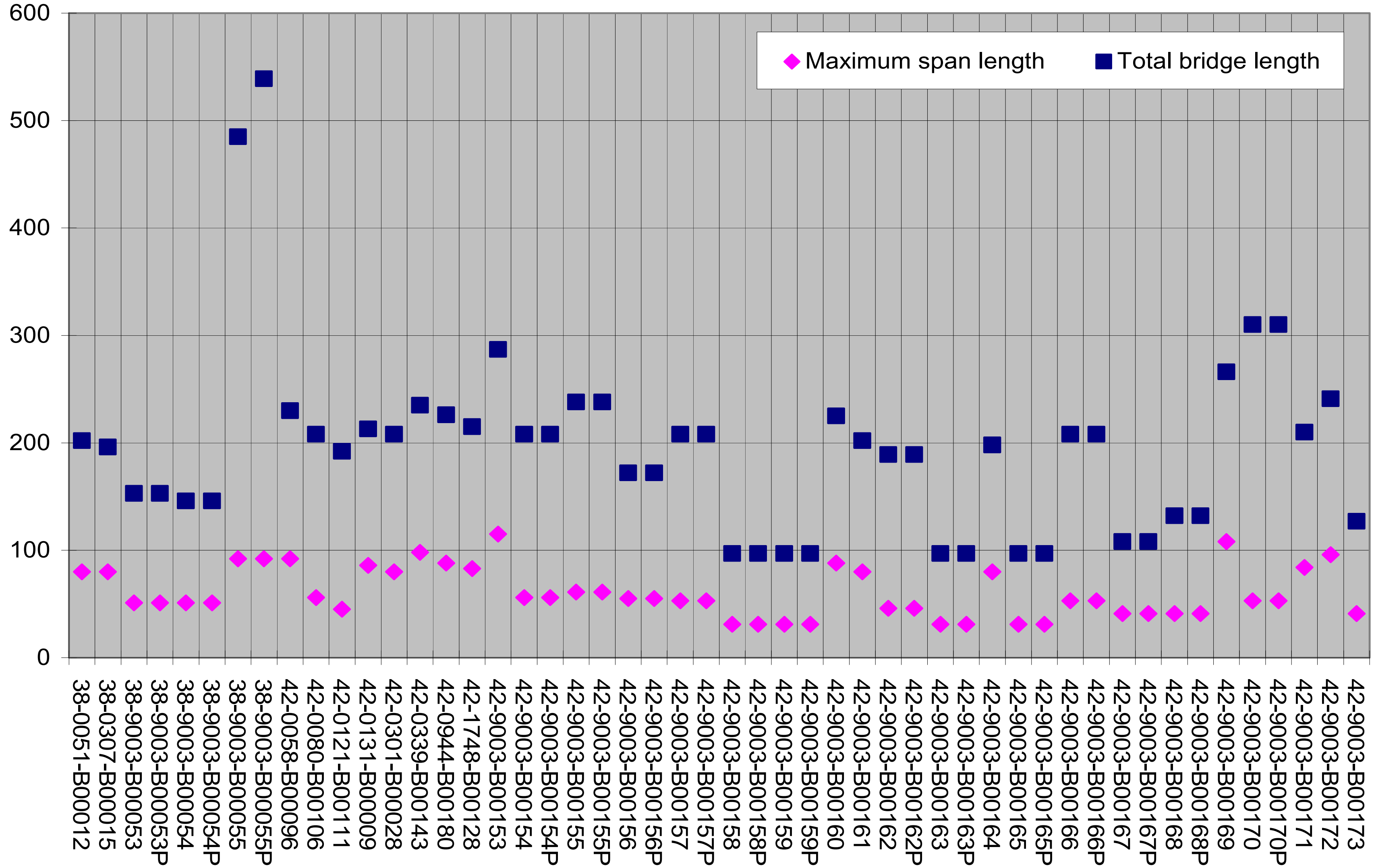


Figure 17: Maximum Span Length and Total Length of Bridges on and over the Parkways in Western Kentucky

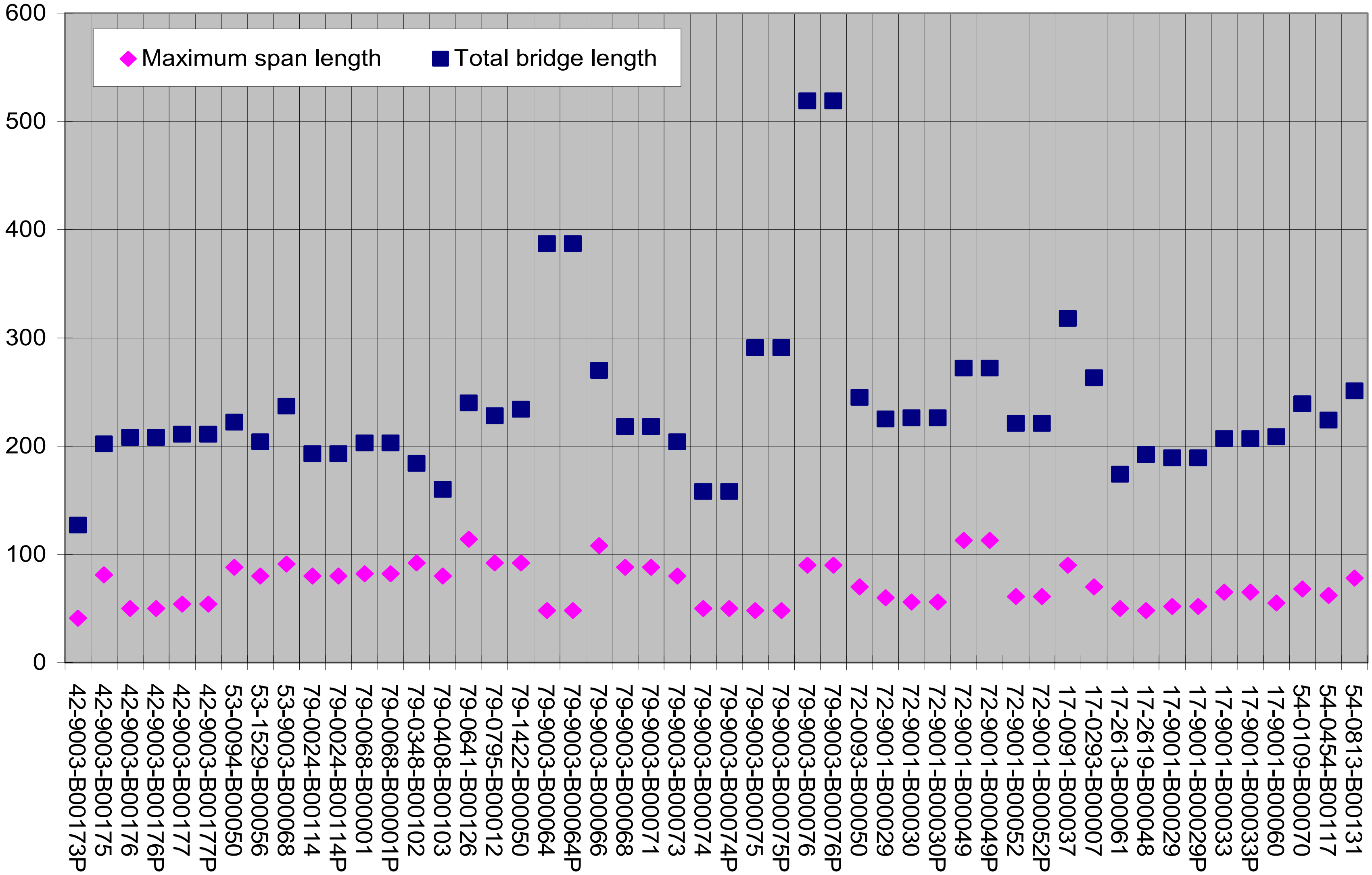


Figure 17 continued: Maximum Span Length and Total Length of Bridges on and over the Parkways in Western Kentucky

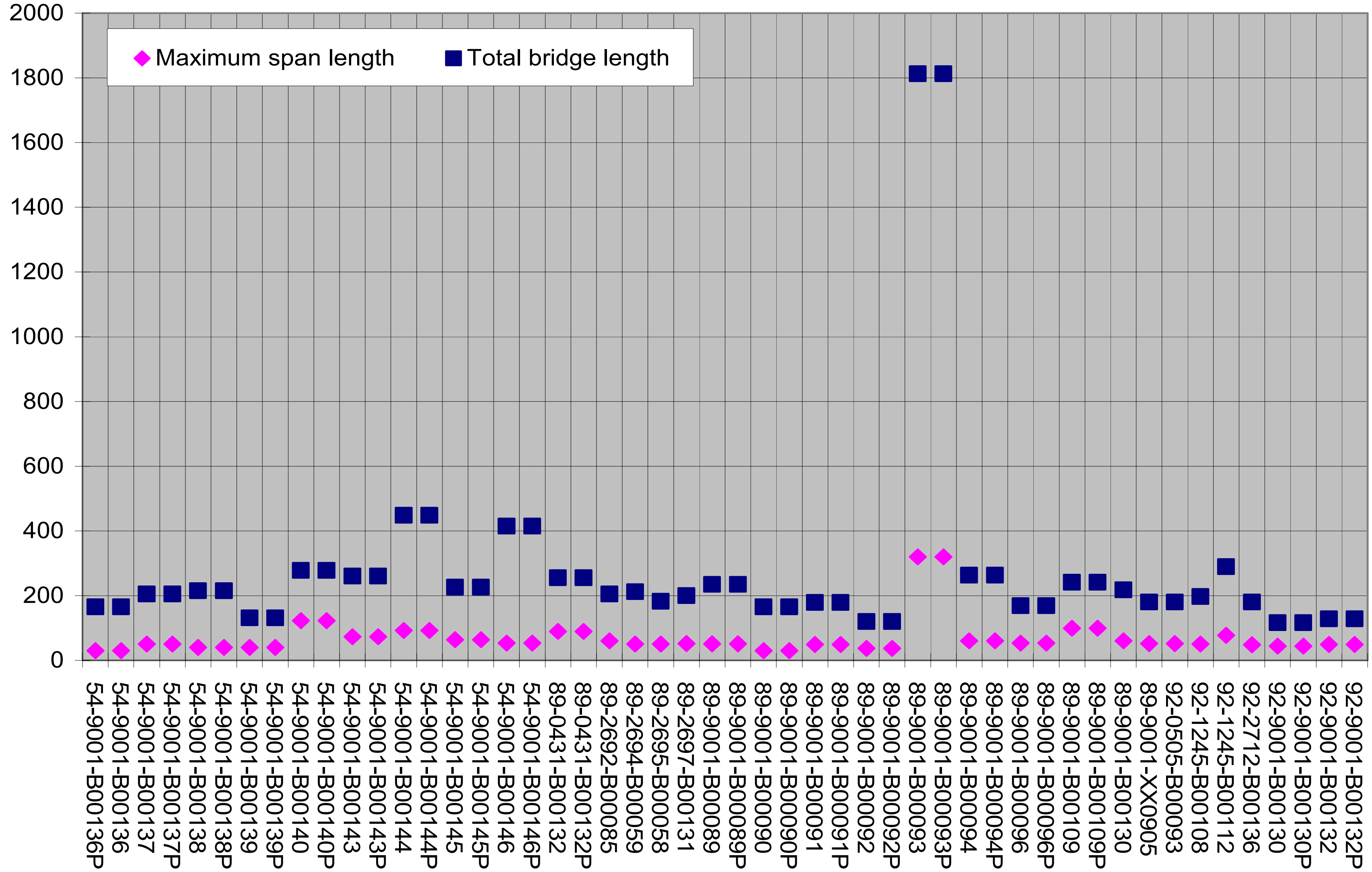


Figure 17 continued: Maximum Span Length and Total Length of Bridges on and over the Parkways in Western Kentucky

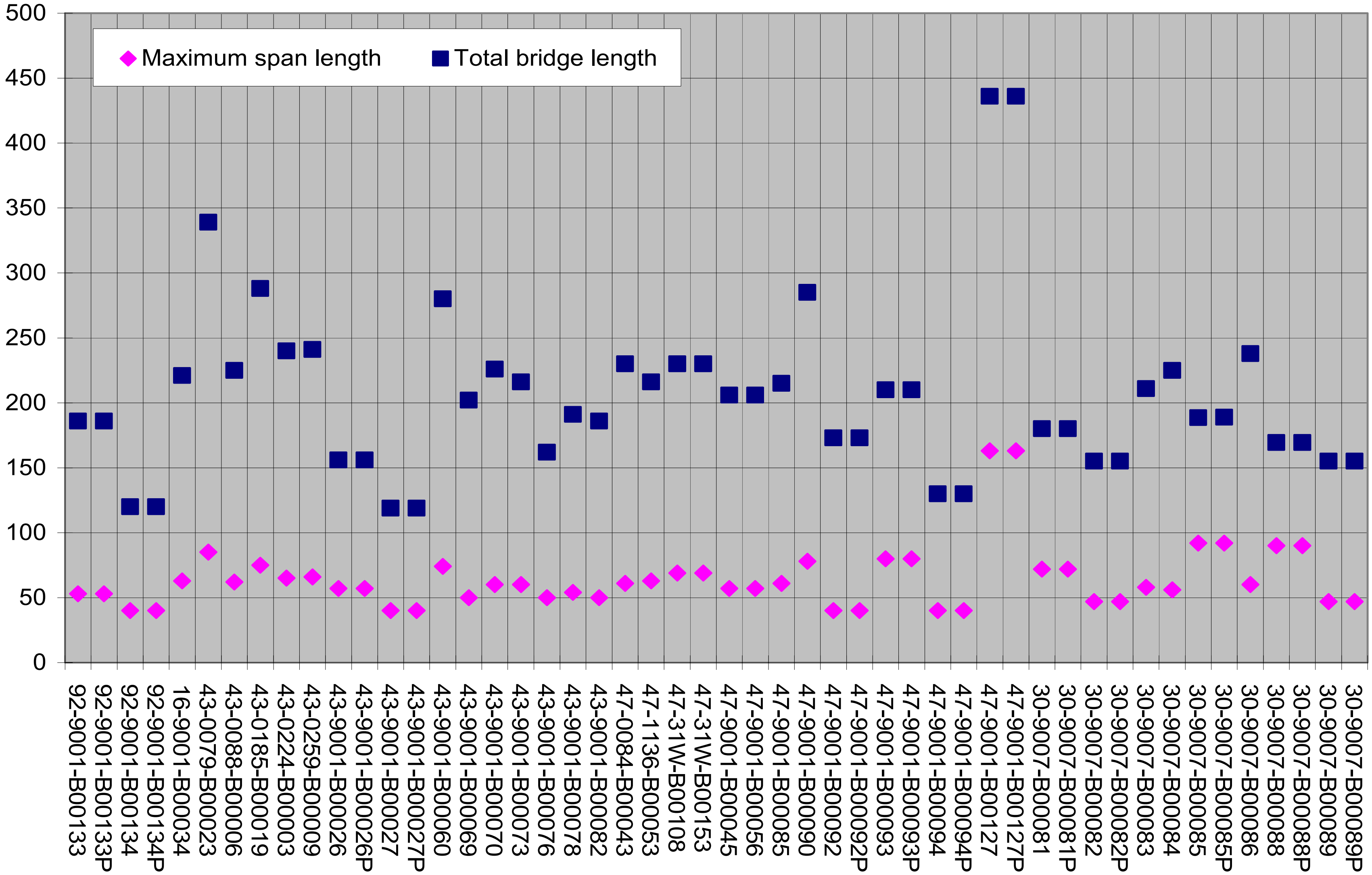


Figure 17 continued: Maximum Span Length and Total Length of Bridges on and over the Parkways in Western Kentucky

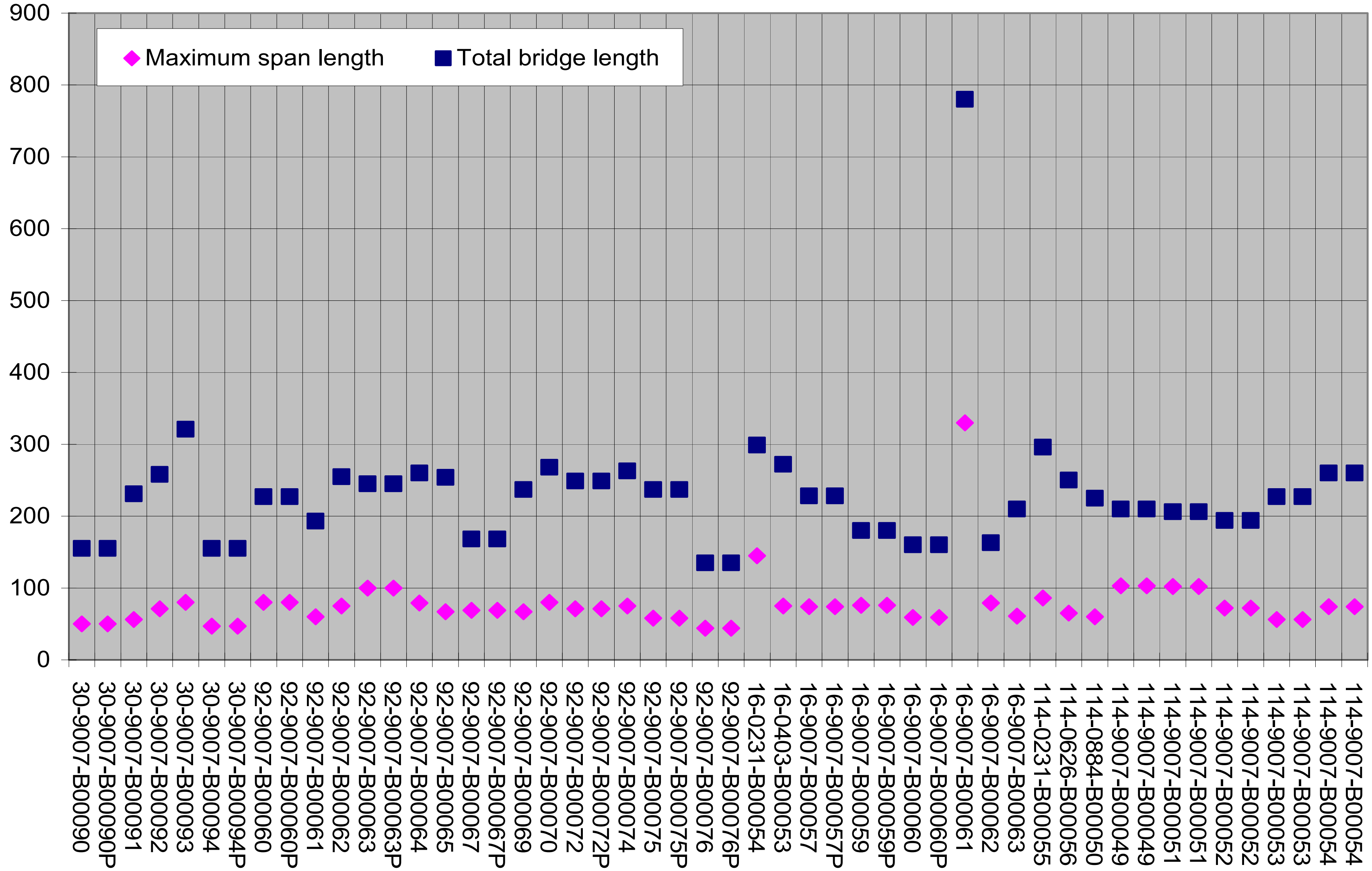


Figure 17 continued: Maximum Span Length and Total Length of Bridges on and over the Parkways in Western Kentucky

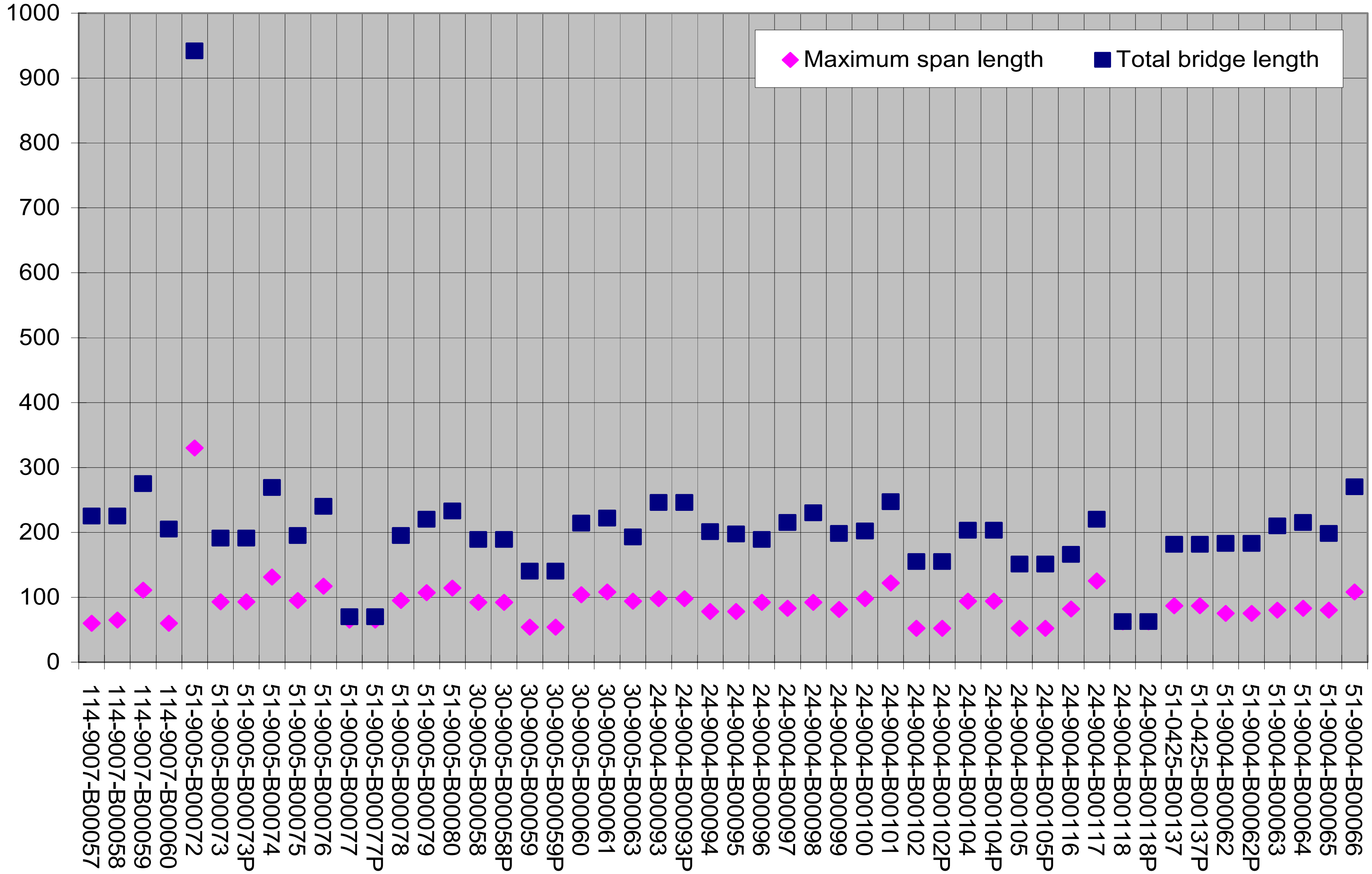


Figure 17 continued: Maximum Span Length and Total Length of Bridges on and over the Parkways in Western Kentucky

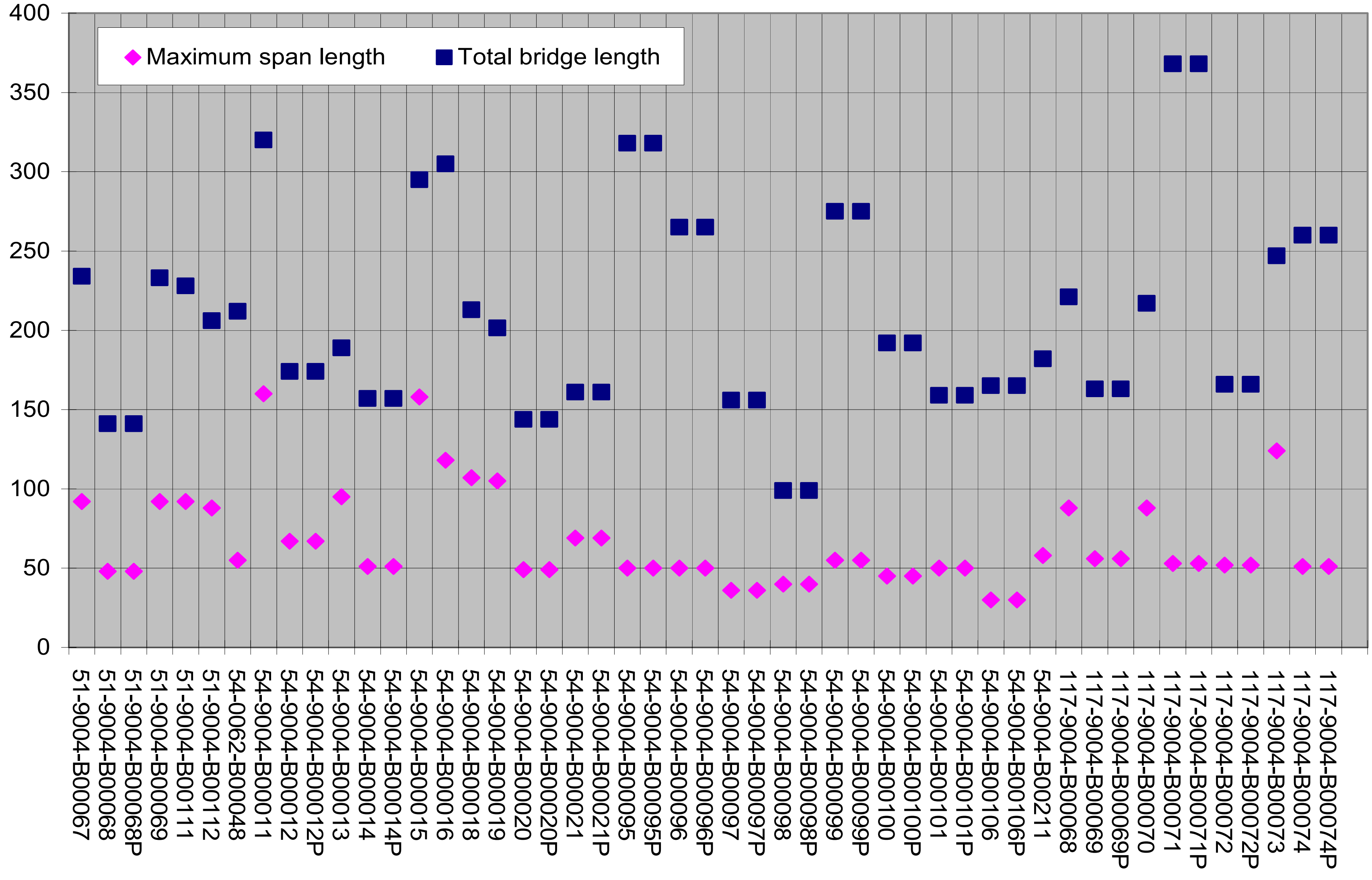


Figure 17 continued: Maximum Span Length and Total Length of Bridges on and over the Parkways in Western Kentucky

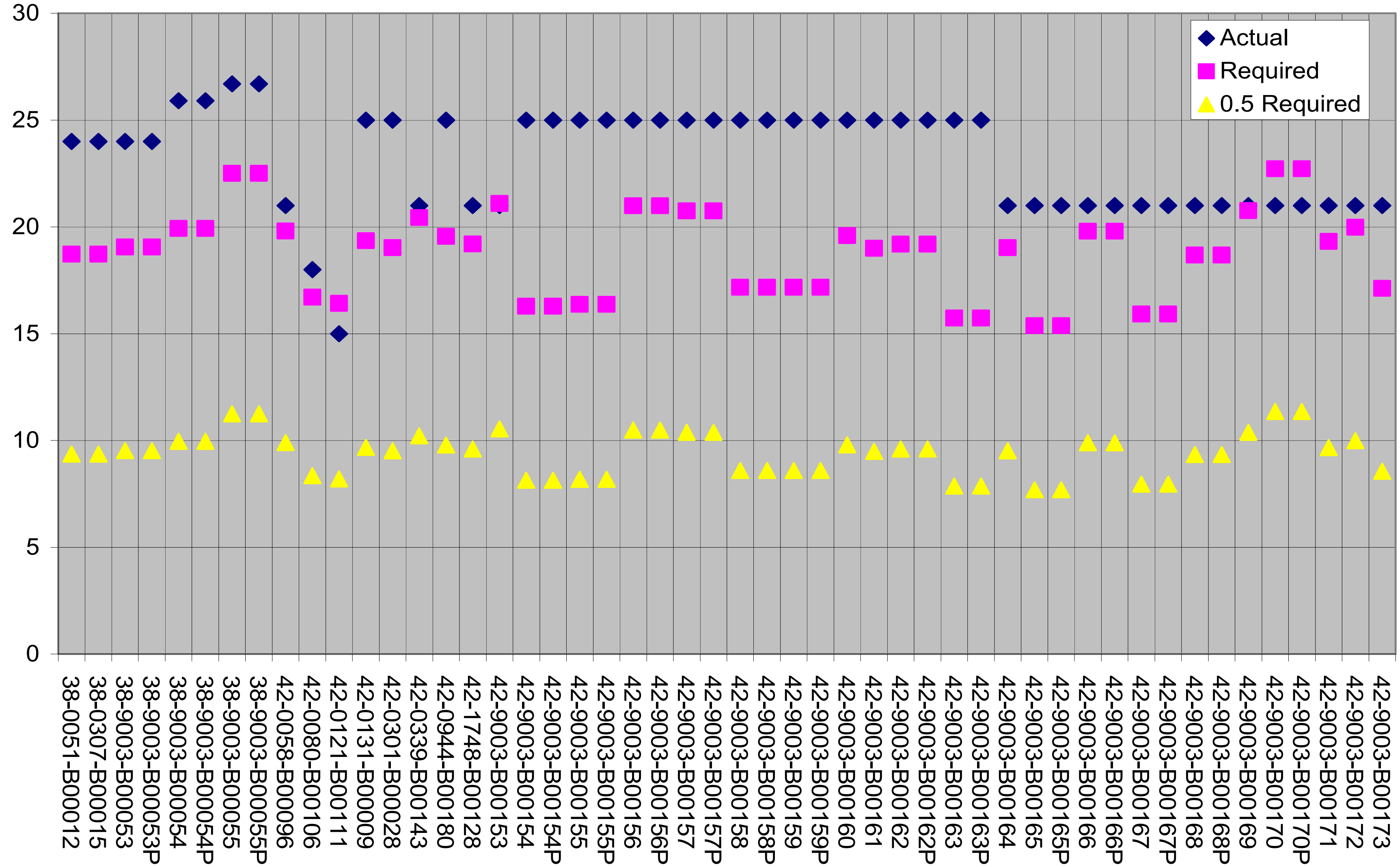


Figure 18: Seat Width of Bridges on and over the Parkways in Western Kentucky

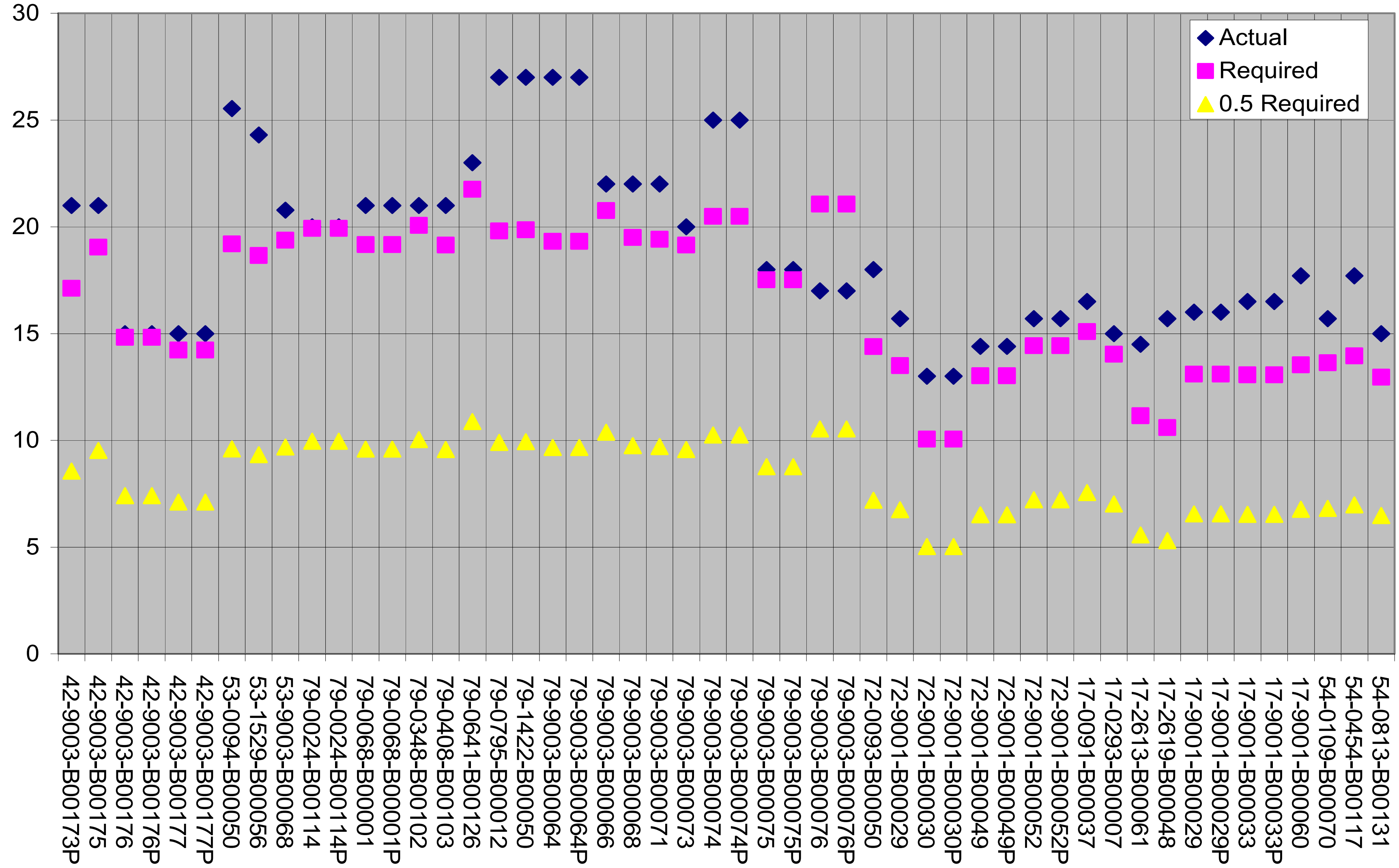


Figure 18 continued: Seat Width of Bridges on and over the Parkways in Western Kentucky

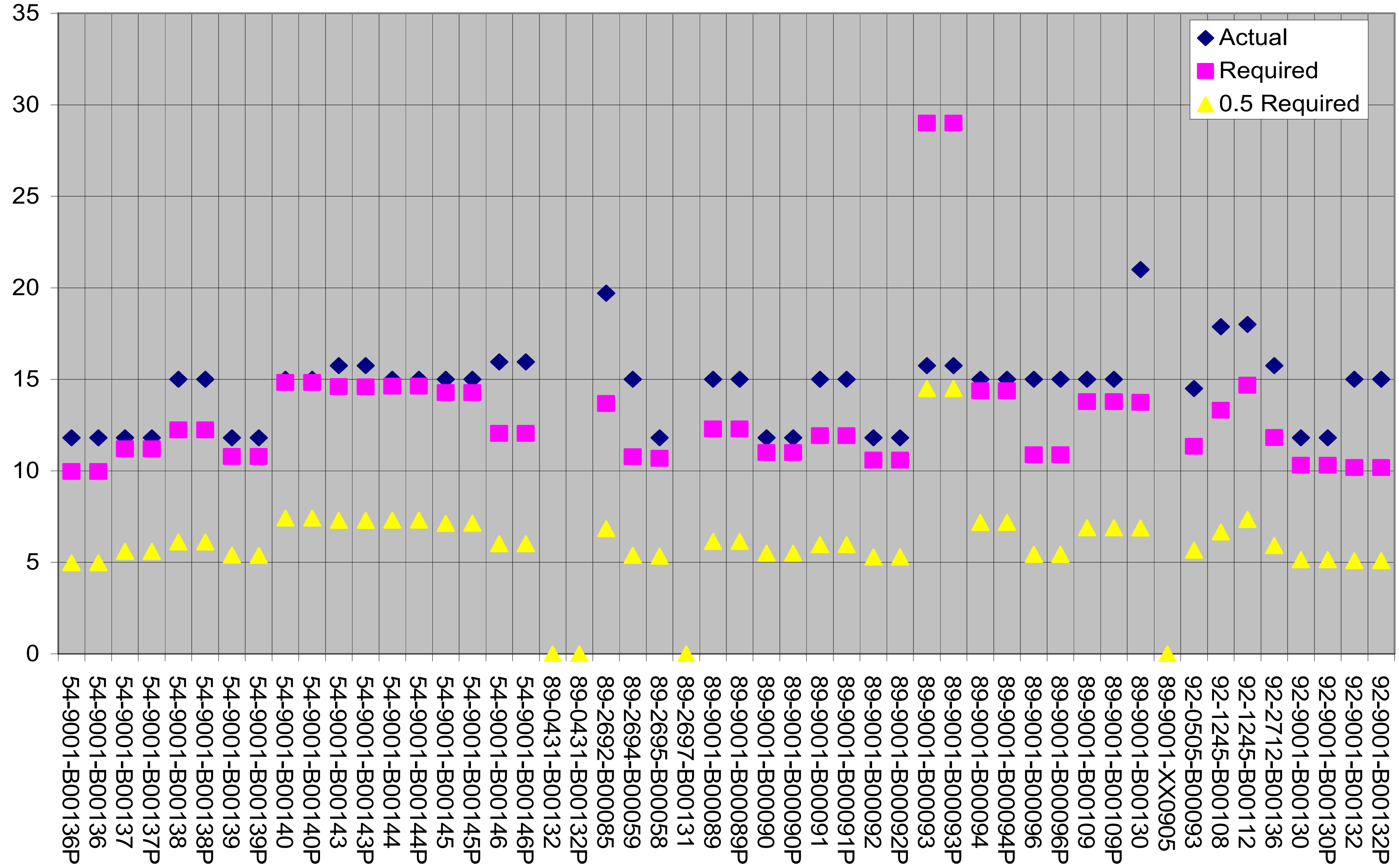


Figure 18 continued: Seat Width of Bridges on and over the Parkways in Western Kentucky

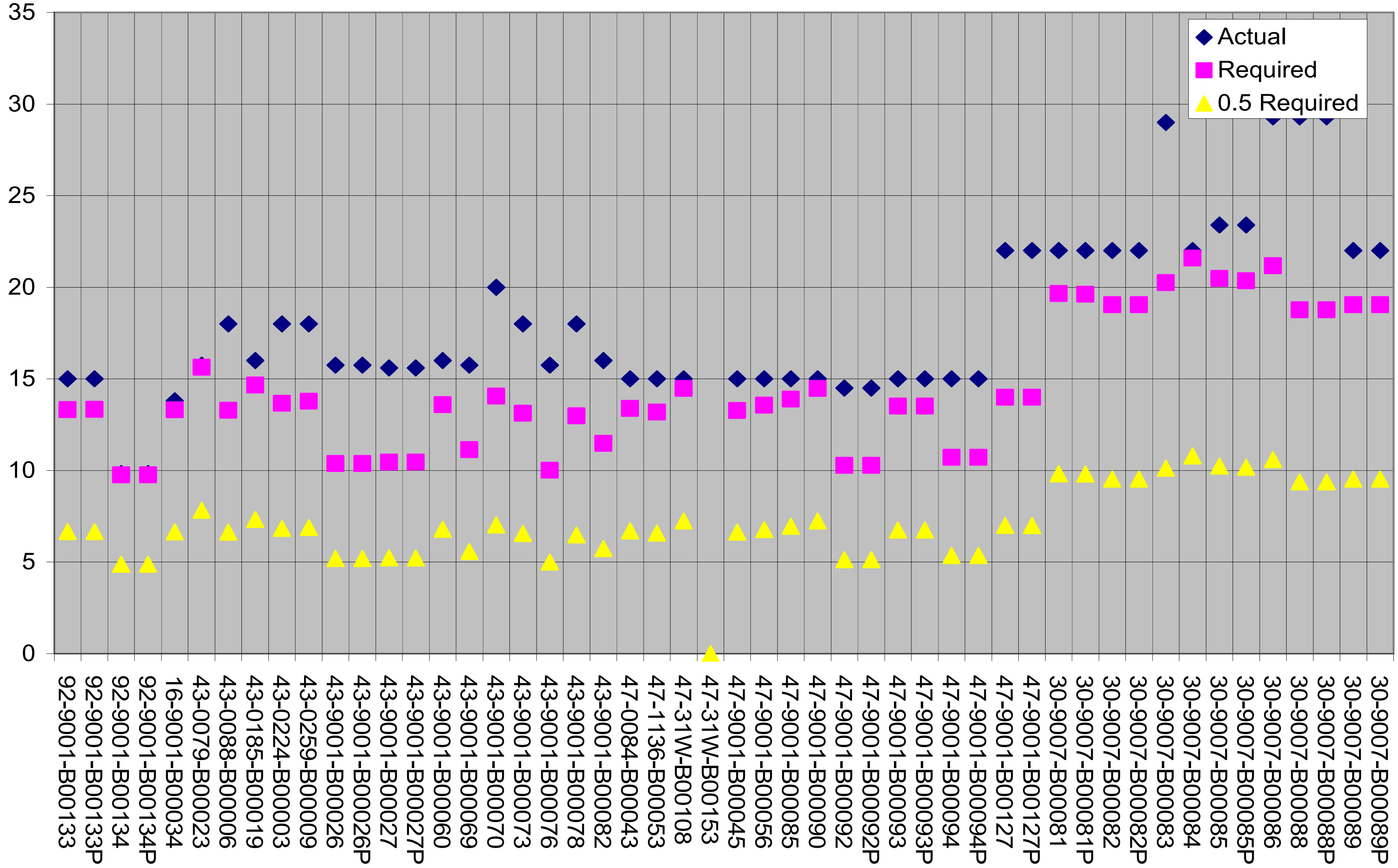


Figure 18 continued: Seat Width of Bridges on and over the Parkways in Western Kentucky

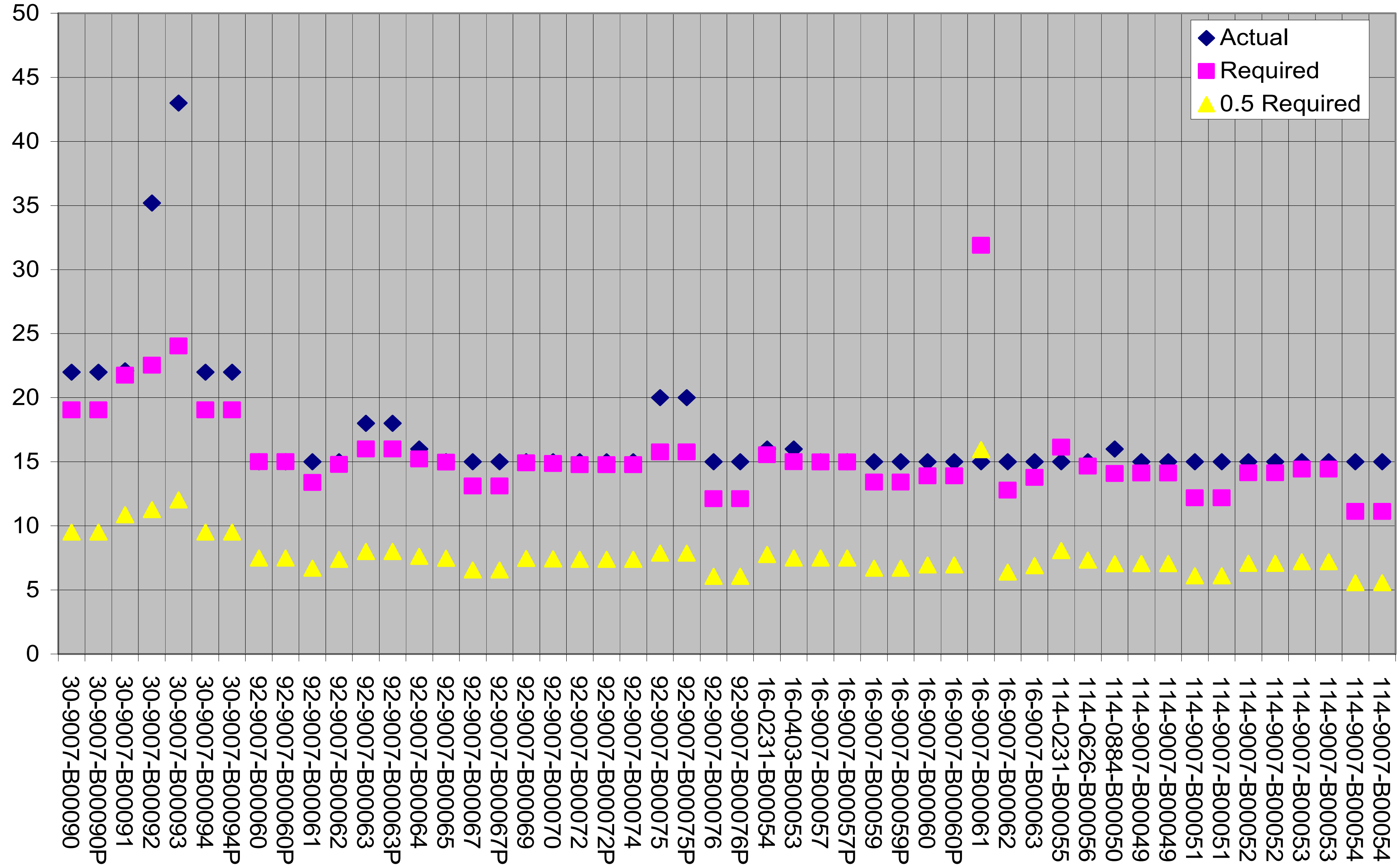


Figure 18 continued: Seat Width of Bridges on and over the Parkways in Western Kentucky

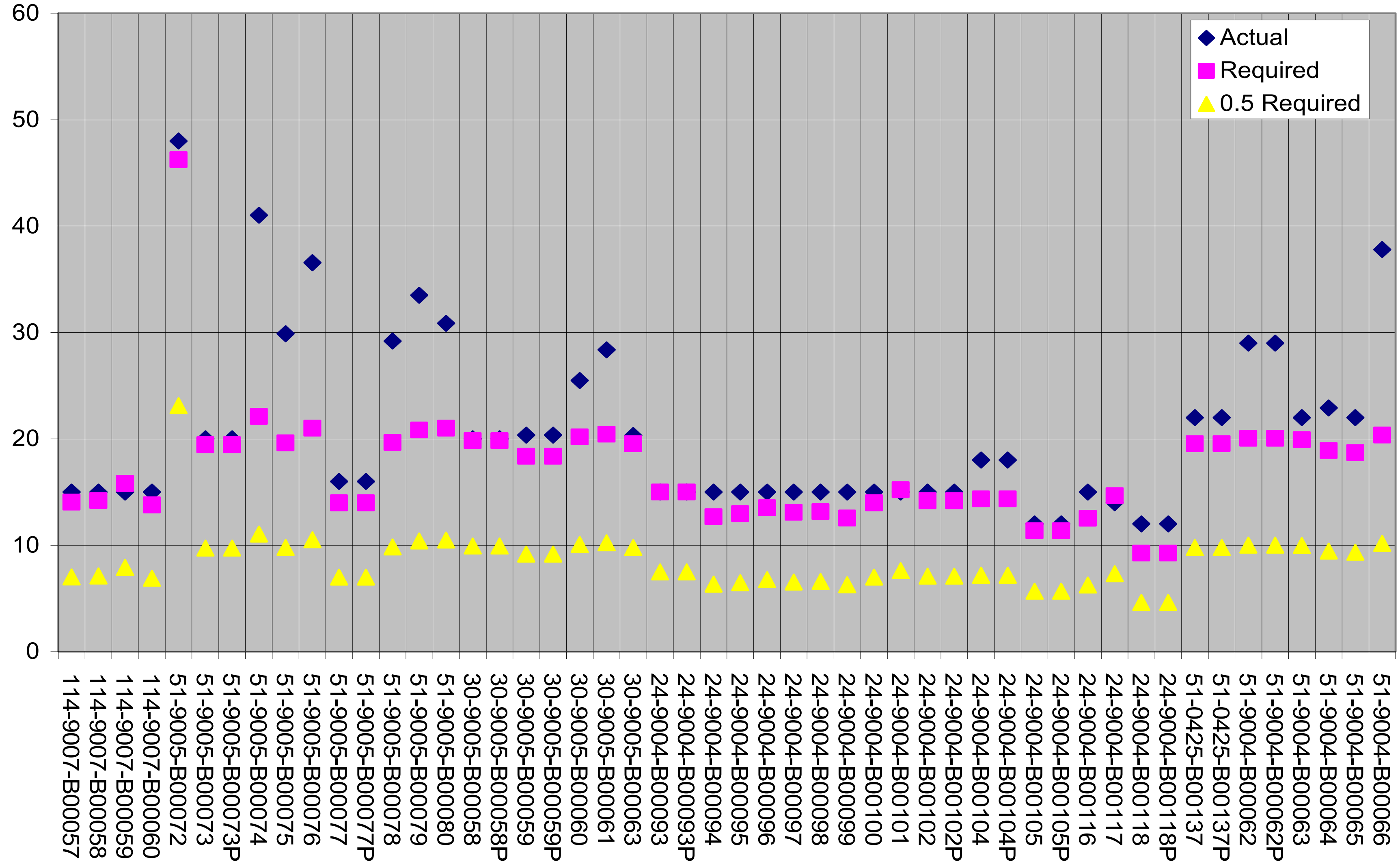


Figure 18 continued: Seat Width of Bridges on and over the Parkways in Western Kentucky

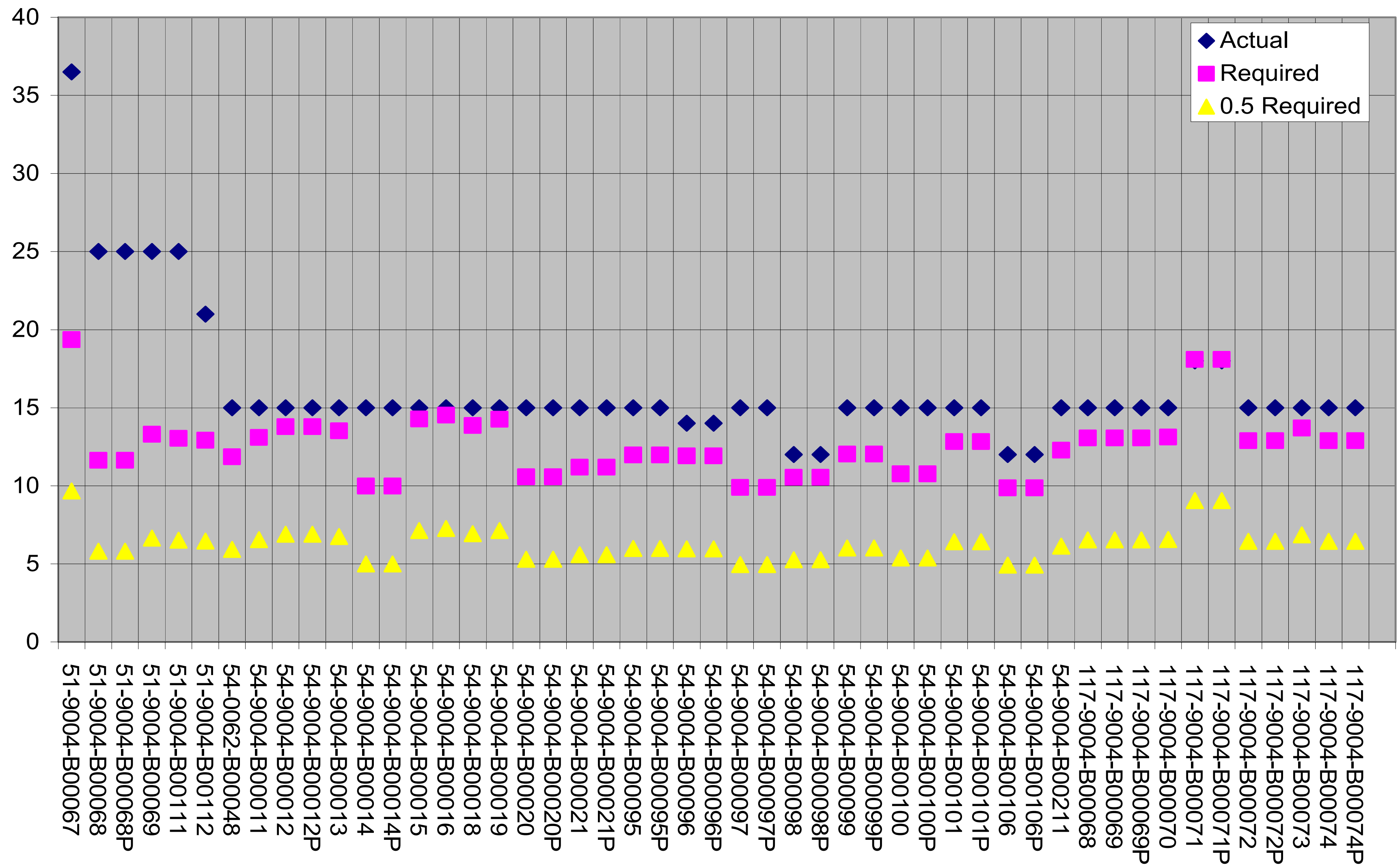


Figure 18 continued: Seat Width of Bridges on and over the Parkways in Western Kentucky

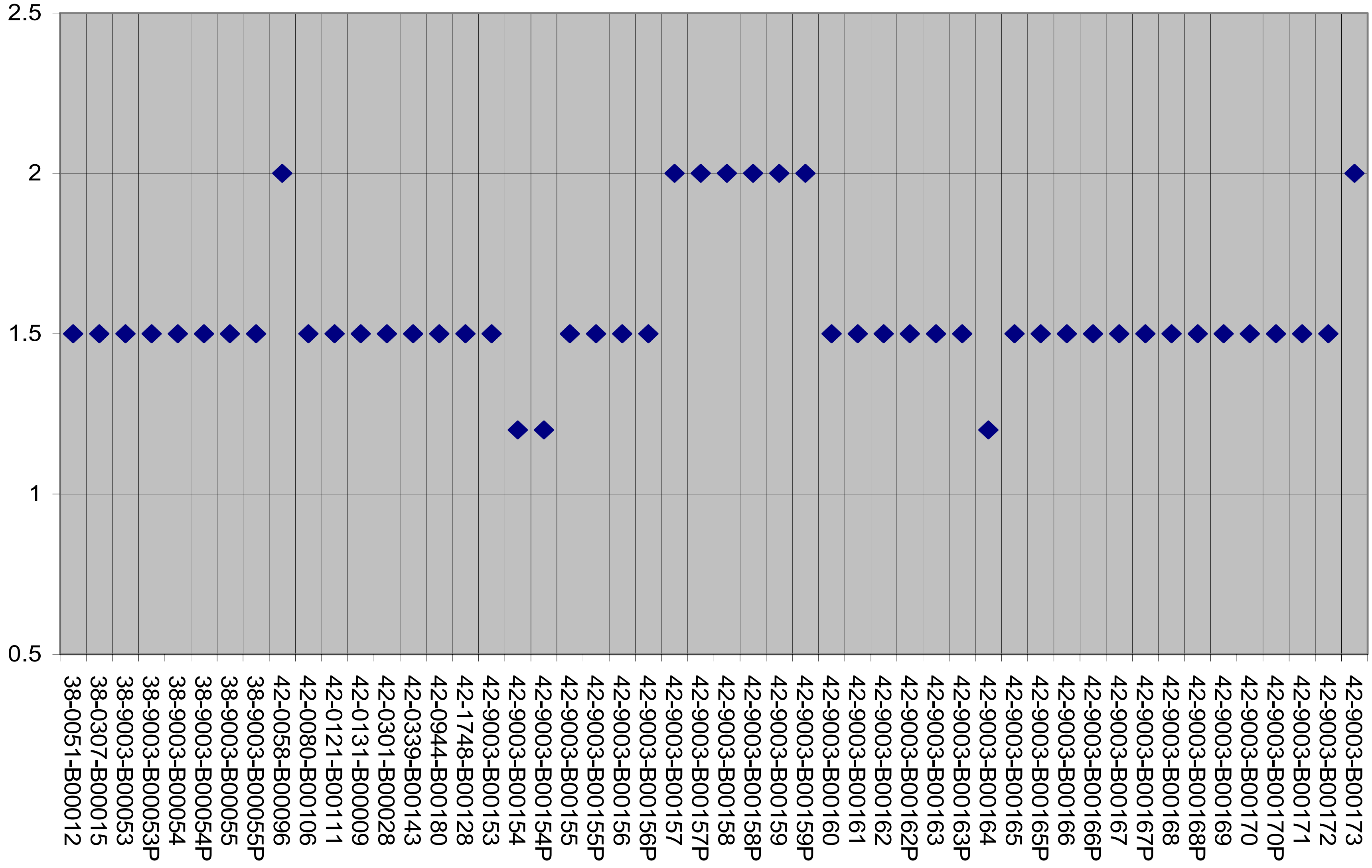


Figure 19: Site Coefficient of Bridges on and over the Parkways in Western Kentucky

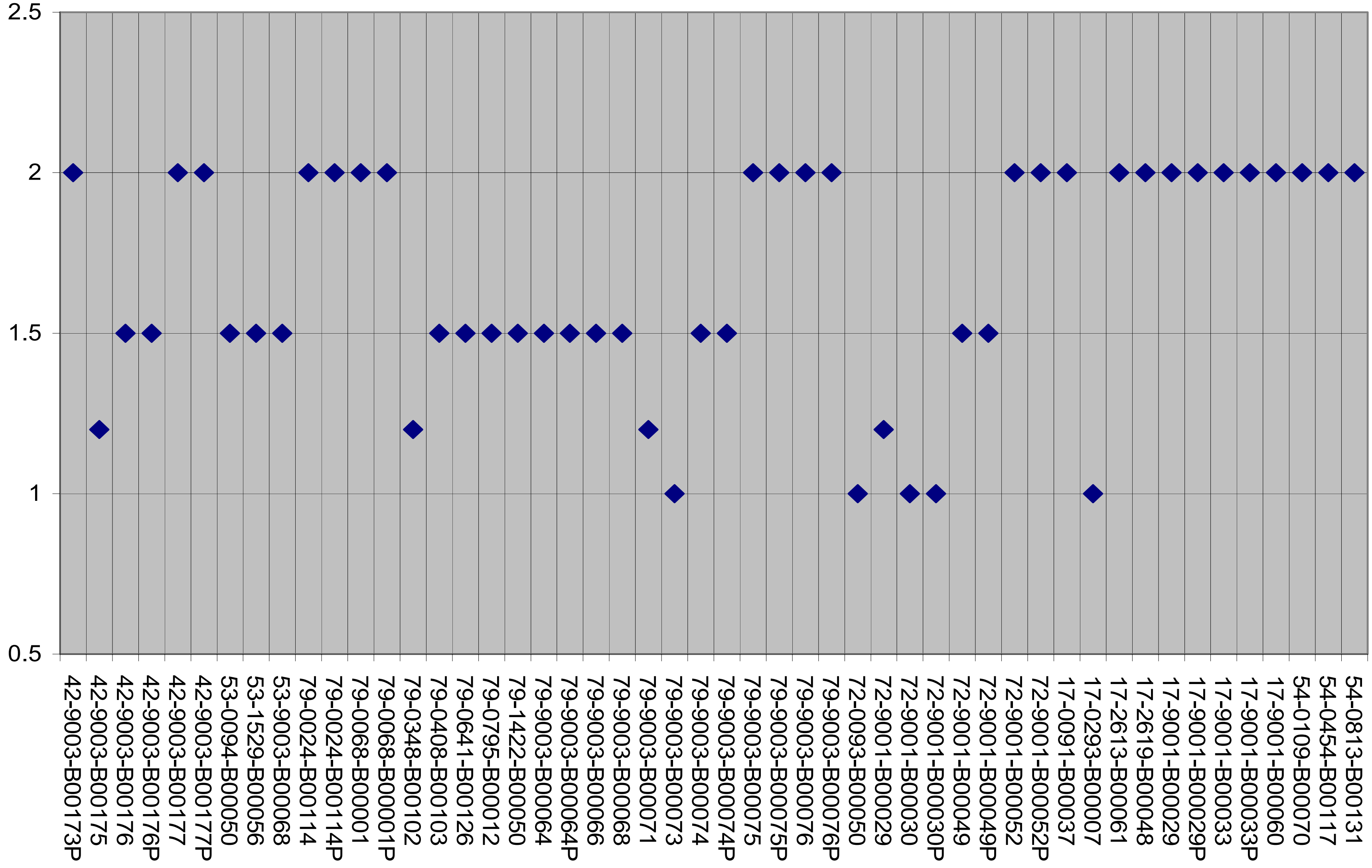


Figure 19 continued: Site Coefficient of Bridges on and over the Parkways in Western Kentucky

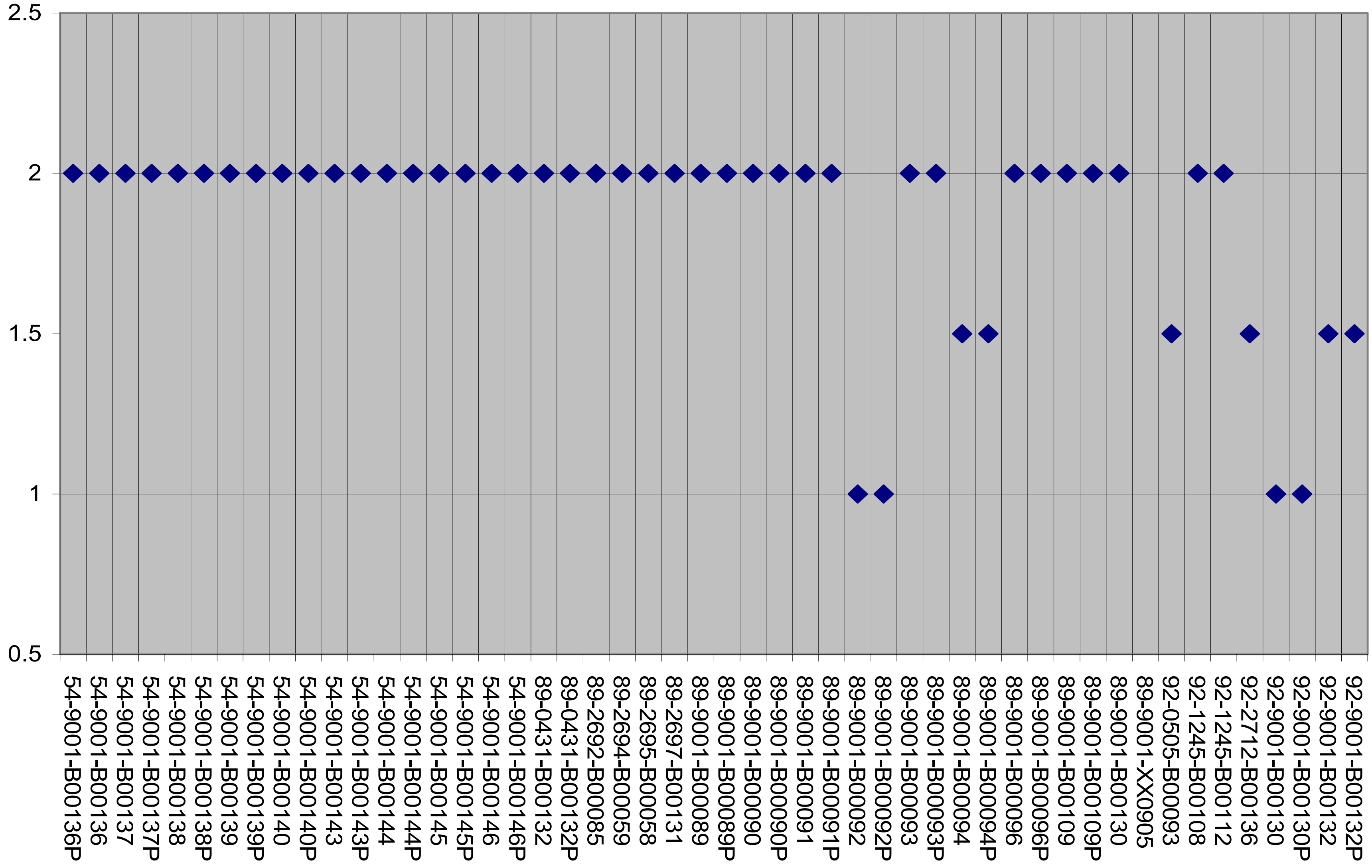


Figure 19 continued: Site Coefficient of Bridges on and over the Parkways in Western Kentucky

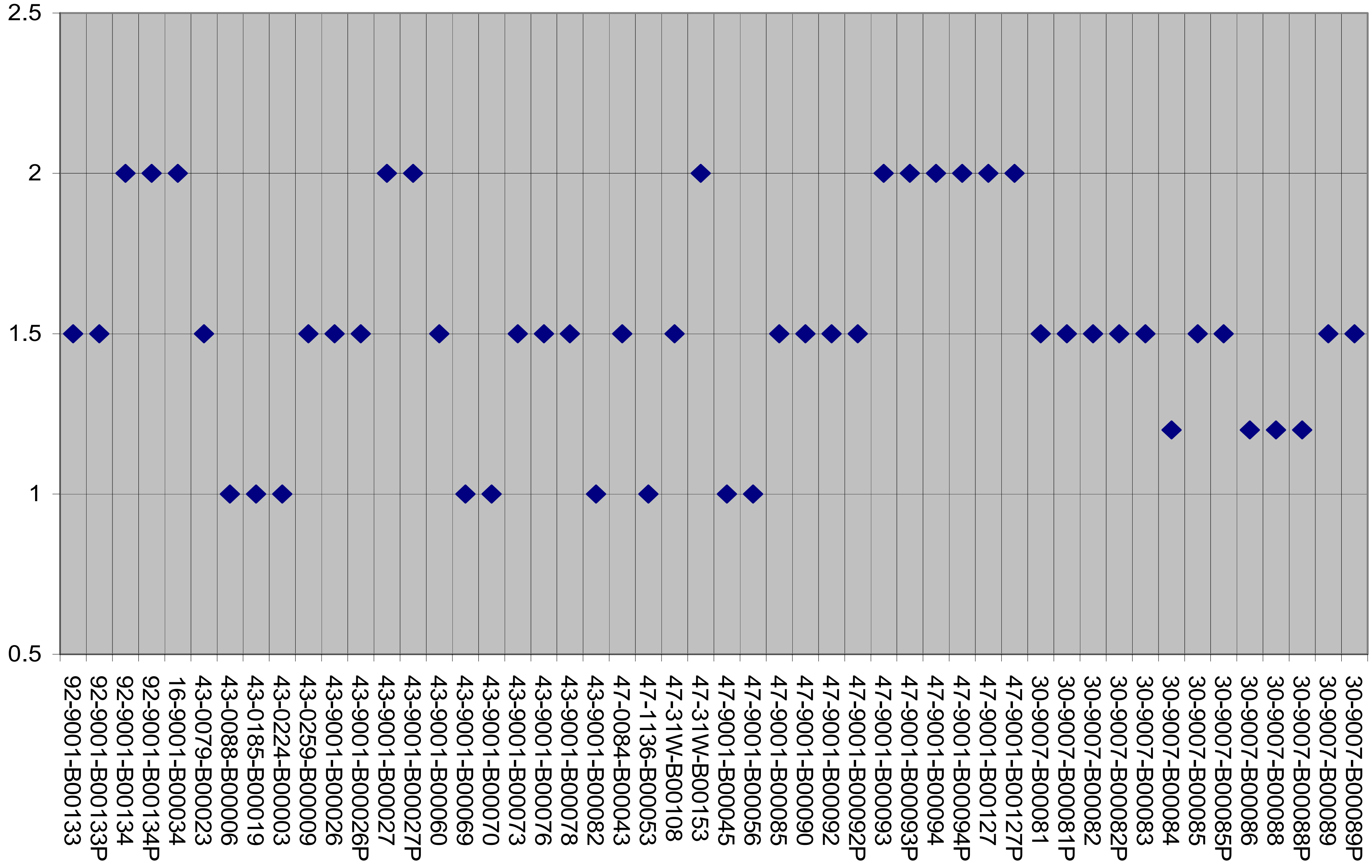


Figure 19 continued: Site Coefficient of Bridges on and over the Parkways in Western Kentucky

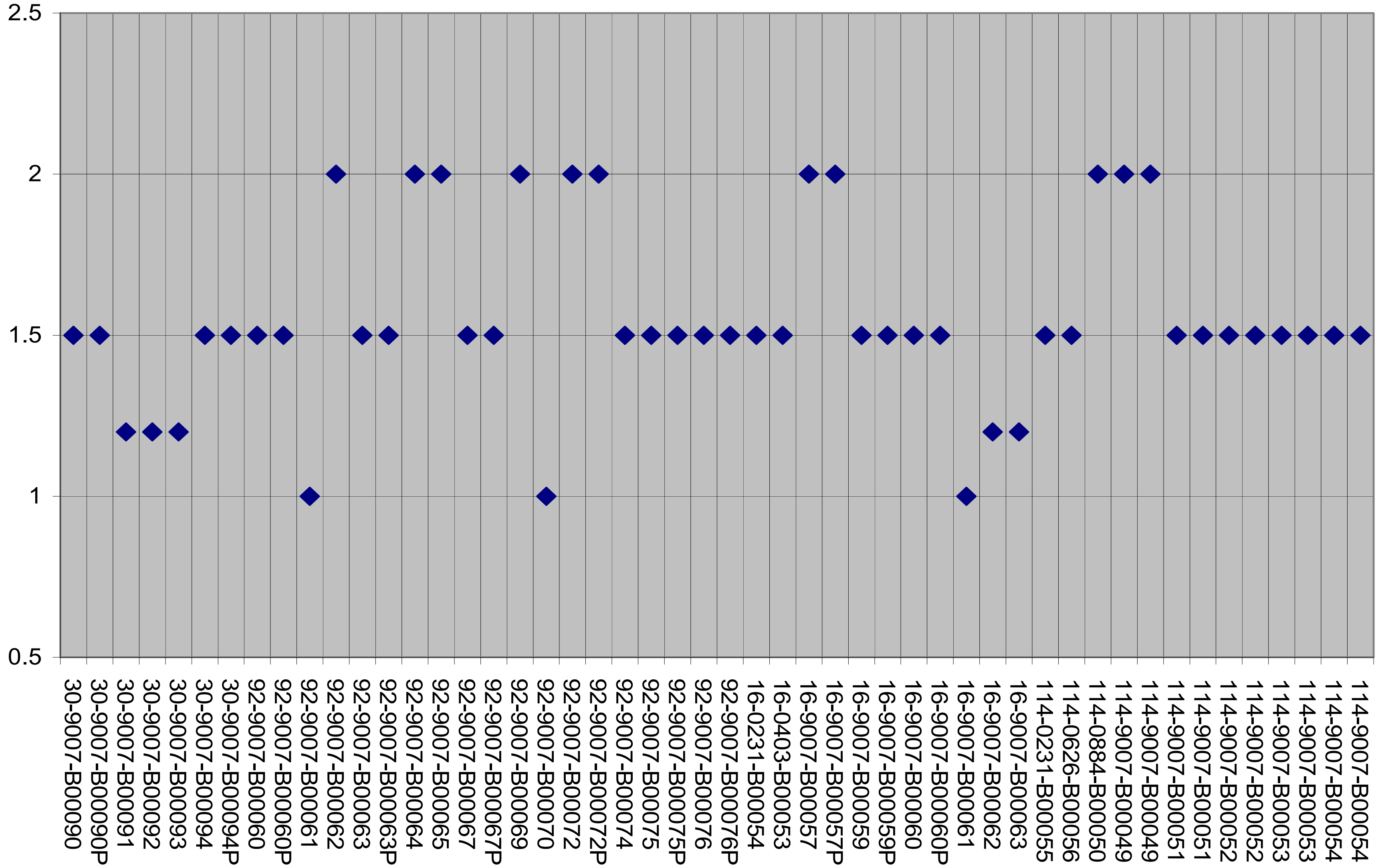


Figure 19 continued: Site Coefficient of Bridges on and over the Parkways in Western Kentucky

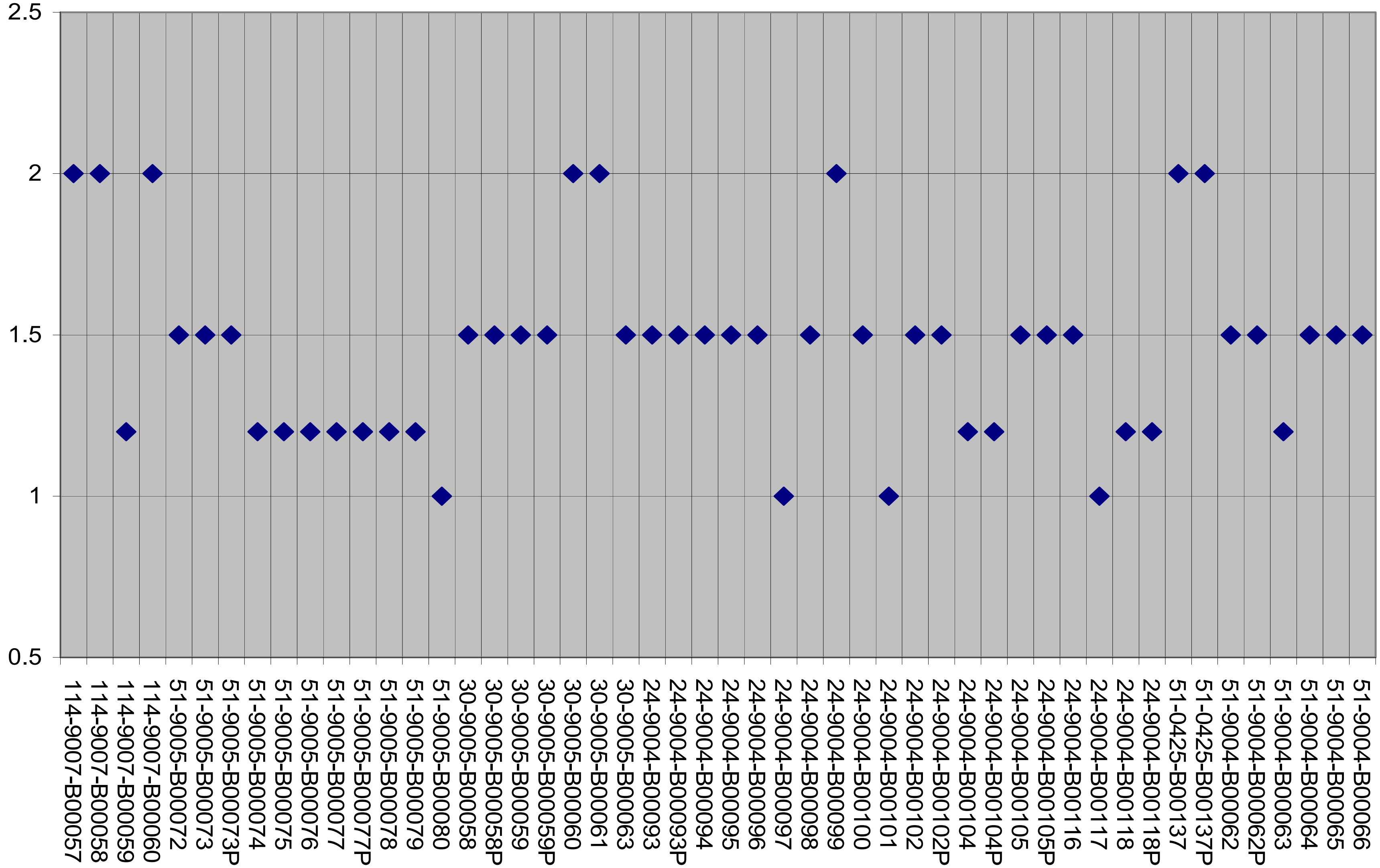


Figure 19 continued: Site Coefficient of Bridges on and over the Parkways in Western Kentucky

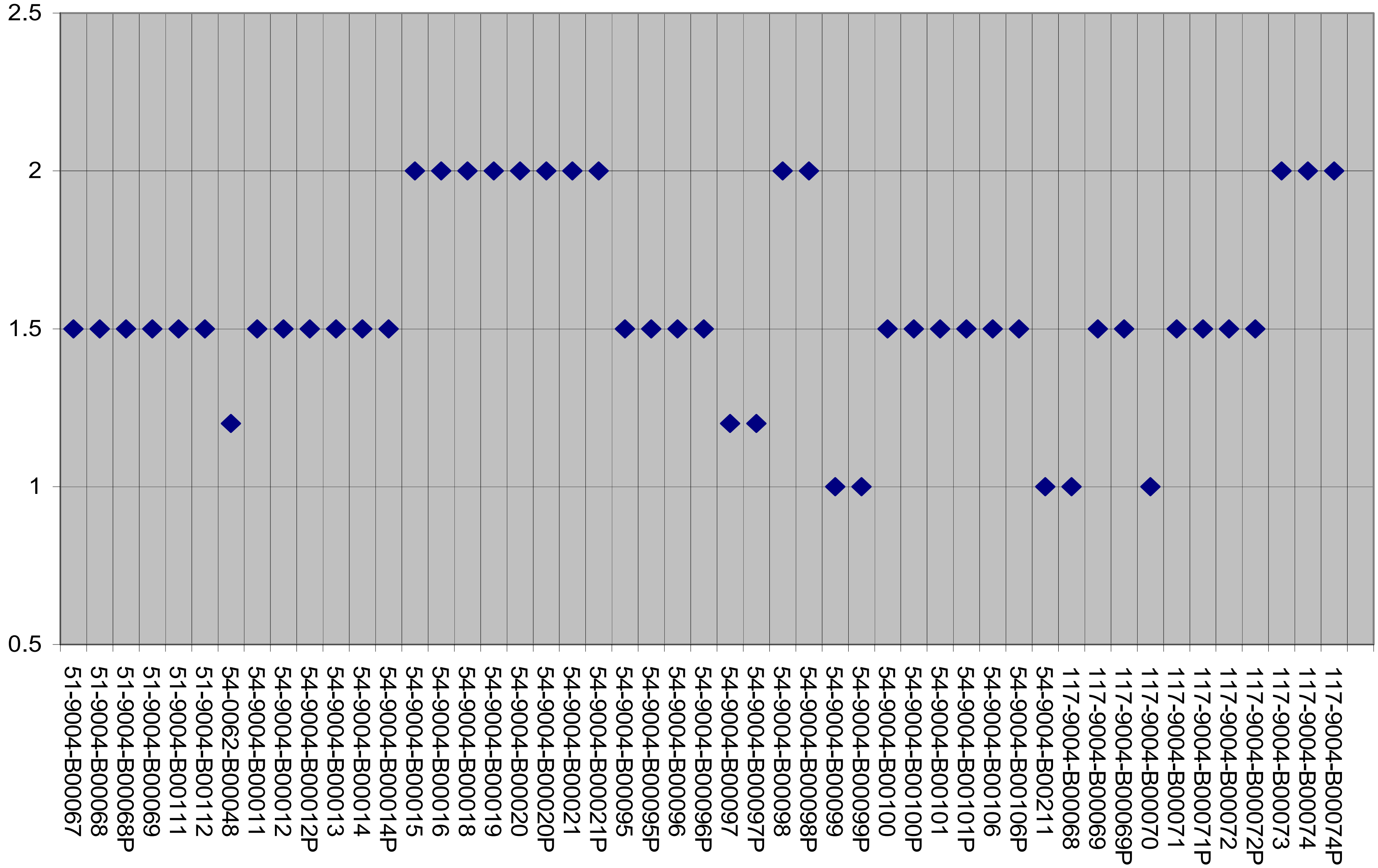


Figure 19 continued: Site Coefficient of Bridges on and over the Parkways in Western Kentucky

REFERENCES

American Association of State Highways and Transportation Officials (1993), *Standard Specifications for Highway Bridges*, Washington D.C.

Bolt, B. A. (1993). *Earthquakes*, W. H. Freeman and Company, New York.

Buckle, I. G., and Friedland, I. M. (1995). *Seismic Retrofitting Manual for Highway Bridges*, Federal Highway Administration, US Department of Transportation. Publication No. FHWA-RD-94-052.

Harik, I. E., Deitz, D., Hill, C., and Guo, M. W. (1997). *Seismic Evaluation of Highway Bridges in Kentucky*, Kentucky Transportation Cabinet, Department of Transportation. Report No. KTC-96-5.

National Earthquake Information Center (2003). *US Geological Survey*, Department of Interior. Colorado, Denver.

Raymond A. H., William J. Amrhein, Kenneth E. W., Dennis R. B., and John J. T. (1991). *Bridge Inspector's Training Manual 90*, Federal Highway Adinistration, US Department of Transportation, Publication No. FHWA-PD-91-015.

Street, R., Wang, Z., Harik, I. E., and Allen, D. (1996). *Source zones, recurrence rates, and time histories for earthquake affecting Kentucky*, Kentucky Transportation Center, Unversity of Kentucky, KTC-96-4.

Sutterer, K. G., Harik, I. E., Allen, D. L., Street, R. (2000). *Ranking and Assessment of Seismic Stability of Highway Embankments in Kentucky*, Kentucky Transportation Cabinet, 1-88.

Terzaghi, K., Peck, R.B. (1967). *Soil Mechanics in Engineering Practice* (2nd ed.), John Wiley & Sons, New York.

Yu Ouyang (1990). *Seismic Analyses of Bridges on Priority Routes in Western Kentucky*, Kentucky Transportation Center Research Report (KTC-96-4), Addendum to KTC-96-4, 2001

For more information or a complete publication list, contact us at:

KENTUCKY TRANSPORTATION CENTER
176 Raymond Building
University of Kentucky
Lexington, Kentucky 40506-0281

(859) 257-4513
(859) 257-1815 (FAX)
1-800-432-0719
www.ktc.uky.edu
ktc@engr.uky.edu