London Bridges Engineering Group

Bridge Condition Indicators Project

Structures Condition Survey of Borough Principal Road Network

Six Year Report – April 03 to March 09

London Bridges Engineering Group

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Executive Summary

The BCI project forms part of the strategy that is being developed by Transport for London (TfL) jointly with the London Technical Advisors Group (LoTAG) and London Bridges Engineering Group (LoBEG) for Asset Management across the Transport for London Road Network (TLRN) and the Borough Principal Road Network (BPRN).

Rectory Park Road Bridge

The BCI Project comprised

(i) Collating and reporting the condition of the BPRN structure stock over the period April 2003 to March 2009; and

(ii) Developing the management processes/tools to enable bridge managers to make best use of the collected data.

This report summarises the work undertaken as part of the BCI project between April 2003 and March 2009, which was divided into six phases (I) April 2003 – March 2004, (II) April 2004 – March 2005, (III) April 2005 – March 2006, (IV) April 2006 – March 2007, (V) April 2007 – March 2008, and (VI) April 2008 – March 2009.

Inventory and condition surveys were commissioned to collect data for the structures on the BPRN during every period. This enabled the calculation of the average condition of the structures, the *Condition Indicator*, and the average condition of their critical load bearing elements, the *Critical Indicator*.

The BPRN structures were found to have a *Condition Indicator* rating of 'GOOD' and a *Critical Indicator* rating of 'FAIR', indicating that:

- A moderate backlog of maintenance work exists on the structure stock, in particular the load bearing elements; and
- Maintenance work has been historically underfunded which has allowed the structure stock to deteriorate to its current condition. If the maintenance work continues to receive insufficient funds it is likely that a significant increase in the maintenance backlog will occur.

LoBEG and TfL acknowledged that the evaluation of Condition Indicators alone does not identify, or provide justification for appropriate levels of maintenance funding for the BPRN structures. Therefore, to support this work and improve the management of the structures the following tasks were undertaken:

1. Formulation of a comprehensive Maintenance Management and Planning Process
2. Implementation of an inspection regime in accordance with national good practice [1, 2] that will support effective and efficient management of the BPRN structures.
3. Development of tools that will assist bridge managers to determine and justify appropriate levels of maintenance funding.
4. Enhancement of the functionality of BridgeStation to support the Maintenance Management and Planning Process.

The aforementioned tasks are envisaged to support effective management of structures but do not relieve asset owners of their duty/obligation to achieve best value out of these processes.

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Glossary

Asset Management[1]	Asset management is a strategic approach that identifies the optimal allocation of resources for the management, operation, preservation and enhancement of the highway infrastructure to meet the needs of current and future customers.
Backlog[1]	The monetary value of work required to close the gap between the actual performance provided by an asset and the current required performance.
General Inspection[2]	General Inspections comprise a visual inspection (undertaken from ground level) of all parts of the structure that can be inspected without the need for special access equipment or traffic management arrangements.
Inventory[1]	Information on individual structures in the stock, including but not restricted to location, structural type, dimensions, construction information and records of use.
Preventative Maintenance[1]	Work carried out to maintain the condition of the structure by protecting it from deterioration or slowing down the rate of deterioration. Preventative maintenance is justified on economic grounds because it provides minimum whole life cost maintenance. By timely intervention preventative maintenance reduces the need for essential work and/or the likelihood of essential work arising prematurely in the future. Examples of preventative maintenance include re-pointing, repainting, minor defect repairs, silane impregnation, cathodic protection and re-waterproofing.
Principal Inspection[2]	Principal Inspections comprise a comprehensive close examination, within a touching distance, of all inspectable parts of a structure, utilising suitable inspection techniques, access equipment and/or traffic management works, as necessary.
Essential Reactive Maintenance[1]	Major structural repair work and especially that undertaken when part or all of a structure is considered to be, or about to become, structurally inadequate or unsafe. Examples of essential maintenance include major concrete, masonry and steelwork repairs, and scour repairs.
Routine Maintenance[1]	Minor work carried out on a regular or cyclic basis that helps to maintain the condition and functionality of the structure and reduce the need for other, normally more expensive, maintenance works. Examples of routine maintenance common to highway structures include cleaning out expansion joints and drainage systems, greasing of metal bearings, removal of vegetation, removal of blockages in watercourses including removal of silt.

Abbreviations

AM	Asset Management
AVF	Asset Value Factor
BCI	Bridge Condition Indicator
BPRN	Borough Principal Road Network
BSCI	Bridge Stock Condition Indicator
CI	Condition Indicator
CIPFA	Chartered Institute of Public Finance and Accountancy
CSS	County Surveyors' Society
DfT	Department for Transport
DMRB	Design Manual for Roads and Bridges
GI	General Inspection
GPG	Good Practice Guide
GRC	Gross Replacement Cost
LoBEG	London Bridges Engineering Group
LoTAG	London Technical Advisors Group
PI	Principal Inspection
SCI	Stock Condition Indicator
TfL	Transport for London
TLRN	Transport for London Road Network

1 Introduction

1.1 General

Transport for London (TfL), jointly with LoTAG and LoBEG, has developed a long-term strategy for Asset Management across the Transport for London Road Network (TLRN) and the Borough Principle Road Network (BPRN). The Bridge Condition Indicator (BCI) Project forms part of this strategy.

New Bournes Bridge

The BCI Project comprised:

(i) collating and reporting the condition of the BPRN structure stock over the period April 2003 to March 2009; and

(ii) developing the management processes/tools to enable bridge managers to make full and best use of the data collected.

The project comprised of six phases (I) April 2003 – March 2004, (II) April 2004 – March 2005, (III) April 2005 – March 2006, (IV) April 2006 – March 2007, (V) April 2007 – March 2008, and (VI) April 2008 – March 2009. This report summarises the work undertaken in each period of the BCI project between April 2003 and March 2009.

1.2 Project financial support

Financial support for the BCI project is provided by Transport for London.

1.3 Background

The highway network is the largest and most visible community asset for which many local authorities are responsible [3]. The Highways Act 1980 places a statutory obligation on authorities to maintain the public highway. In discharging this duty authorities should seek to comply with current good practice; Asset Management is widely recognised as representing current good practice in infrastructure management [1, 3, 4, 5].

Transport for London (TfL) fully recognises the need to adopt Asset Management for London's transport infrastructure [6]. In response to this, TfL, jointly with LoTAG and LoBEG, is developing and implementing Asset Management for the Transport for London Road Network (TLRN), the Borough Principal Road Network (BPRN) and other borough roads.

Highway structures are an integral component of the highway network, creating vital links and in some cases creating prominent community and historical features. Highway structures have long service lives and generally slow rates of deterioration. These characteristics make many highway infrastructure assets conducive to a 'save now, pay later' management approach, an approach which is thought to be widespread in the UK.

The Government has recognised that this approach neither meets the service requirements nor does it provide long-term value for money. To address this issue the Government is advocating [3] and fully supporting an Asset Management approach for highways[1].

1.4 Purpose and Objectives

The purpose of this project is to ensure that fundamental management information and activities are in place, and sustained, for the BPRN structures and that these align with recognised good practice. The project aims to:

- To provide information that assists authorities/bridge managers to check that highway structures are safe for use and fit for purpose
- To provide justification for investment in the on-going maintenance of the BPRN highway structures.
- To develop tools/procedures that will improve and streamline management activities.

The following are the key activities that facilitate in meeting the project objectives:

- Identify all highway structures on the BPRN;
- Develop and continually review/update/improve an inspection brief that ensures best use is made of inspections and that suppliers provide the required information.
- Implement an on-going regime of General and Principal Inspections for all the BPRN structures in accordance with accepted good practice, i.e. CSS inspection procedures.
- Evaluate the condition score for the BPRN structures, using the inspection information, in accordance with the CSS Guidance[7, 8, 9 and 10];
- Produce a report on the results, interpretation and recommendations.
- Support Asset Management Planning

1.5 Scope and Duration

The scope of the project is:

- To collate inventory and condition data for the BPRN structure stock and evaluate the Condition Indicator values for the stock throughout the six phases of the project: (I) April 2003 – March 2004, (II) April 2004 – March 2005, (III) April 2005 – March 2006, (IV) April 2006 – March 2007, (V) April 2007 – March 2008, and (VI) April 2008 – March 2009.
- Continually review and improve asset management planning processes.

[1] In 2009 the Department for Transport made an additional £23m available to local authorities to support data collection and the development of asset management practices.

1.6 Project Team

The **Royal Borough of Kingston upon Thames** (hereafter referred to as RBK) acted as the lead borough on behalf of LoBEG for this project, managing the overall team which consisted of:

- **Capita Symonds** managed the Inspection programme during the first 6 year cycle of inspections. Their responsibilities mainly comprised of:
  - Maintaining the six year inspection inventory of the BPRN highway structures;
  - Liaising with the boroughs, for each phase of the inspections, to ascertain whether they wished to undertake the inspections in-house and seeking costs/programme from those who wished to do so;
  - Preparing draft tender documents, for the boroughs that did not undertake the inspections in-house, for inspections to be procured through competitive tendering; inviting and assessing the tenders and making recommendations to the Project sponsor on the contract award;
  - Reviewing the inspection reports with the aim of approving the final versions; and
  - Providing technical support to LoBEG Asset Management Working Group on the technical documents prepared by the Group.
- **Atkins** provided specialist bridge management support to the LoBEG BCI project. The specialist support related to,
  - Inspection practices;
  - Condition indicators;
  - Maintenance prioritisation (including Risk Based Maintenance);
  - Lifecycle planning and
  - Financial planning.
- **Camden Consultancy Service** were involved in incorporating BCI tools and functionalities into the BridgeStation based on their research and pilot studies. They worked closely with the Project Sponsor, Atkins, and Capita Symonds during the first 6 year cycle of inspection.
- Inspection teams appointed by RBK, carried out structures inspections and prepared Roads 277 Forms, namely Enfield Borough Council, Surrey County Council and Capita Symonds.
- Some Boroughs carried out their own inspections and prepared Roads 277 Forms for the structures in their boroughs. Whilst the inspection in the other boroughs were undertaken by Consultants procured through competitive tendering.
- TfL Street Management were responsible for the funding and overseeing the progress of the project.

1.7 Project Deliverables

Project Deliverables include:

- Identification of all highway structures on the BPRN;
- Development and delivery of 6-year Inspection Programme (divided into six phases)
- Inspection Briefs for each of the six phases;
- Structures condition data/inspection reports;
- Updated database of structures: Interim Database and BridgeStation;
- BCI Values for the BPRN structure stock;
- BCI Reports: annual and 6-year.
- Improved processes to support Asset Management Planning

1.8 Summary of Report Content

The contents of this report are summarised in Table 1:

Table 1: Contents of Report

Section	Description
1. Introduction	Provides a brief description of the project background, project team and overall objectives of the project.
2. Background	Describes the previous and current inspection practices and emphasises the need for inspections.
3. BPRN Structure Stock	Provides a description of the Borough Principal Road Network (BPRN), BPRN structures – types and quantities.
4. Inspection Regime	Presents the first six-year (April 2003 to March 2009) and the next six-year (April 2009 – March 2015) inspection programmes
5. Compiling Inspection Data	Describes the process for compiling the inspection data – previous practices (Spreadsheet database) and current practices (BridgeStation).
6. Condition Indicator for the BPRN	Presents the detailed results for the BPRN structure stock – Structure Type Condition Indicators, Borough Condition Indicators and Condition Index for the entire BPRN stock.
7. Condition Based Maintenance Planning	Presents the current and future developments for improved management of BPRN structures.
8. Conclusions, Lessons Learned and Recommendations	Draws conclusion and lessons learned from the current work.
9. References	Lists the documents referred to for the purpose of this project.
Appendices	Provides supporting information including: • Inspection Forms • Inspection Report Formats • Inspection Briefs • Condition Indicator Values and Graphs

2 Background

2.1 The Purpose of Inspections

Management of Highway Structures: A Code of Practice [1] states that:

> ***'The overall purpose of inspection, testing and monitoring is to check that the highway structures stock is safe for use and fit for purpose and to provide the data required to support the Good Management Practice identified in this Code'***

Inspections form the basis for maintenance planning and other management activities and facilitate in:

- ***Collation/Compilation of Data:***
  - To compile, verify and maintain inventory data, e.g. structure type, dimensions and location, for all the highway structures the authority is responsible for.
  - To collate data on current condition, performance and environment of the structure e.g. severity and extent of defects, material strength and loading.
- ***Ensuring Asset Safety/Function:*** To check/determine if the asset is safe for use and fit for purpose, i.e. the asset is able to perform its required function.
- ***Identification of Maintenance Needs:*** To support the identification, planning and programming of maintenance (or improvement) activities necessary to achieve safety, functional and aesthetic requirements;

2.2 The Need for Good Inspection Information

A sound knowledge of the asset is fundamental to bridge management, not just at a high level, but in sufficient detail to support the maintenance planning and other management activities and also support decision making. It is essential to maintain the quality and consistency of inspection data to support:

- ***Asset Specific Decisions:*** The majority of the inspection work involves collecting relevant data and describing defects in terms of their type, location, extent, severity and, if possible, cause. Thus accurate reporting is essential to enable the asset manager and/or the relevant parties to make appropriate decisions concerning the safety and maintenance of the structure.
- ***Justification for Funding:*** Enable bridge managers in determining and justifying the appropriate levels of maintenance funding.
- ***Bridge Management Techniques:*** Consistency is vital to current and developing bridge management techniques, e.g. Bridge Condition Indicator calculation, prioritising maintenance, asset valuation/depreciation, lifecycle planning, long-term financial planning and trending and comparison (of any of these) between authorities. To ensure that these approaches are suitably supported, it is essential that the inspection data collated for these purposes is consistent and accurate.

2.3 Current Inspection Practices

All inspections undertaken by the Boroughs, after 2002, have been carried out in accordance with the guidelines set out in 'Guidance Note on Bridge Inspection Reporting' published by CSS in July 2002[9].

A CSS style inspection proforma is completed during all General and Principal Inspections. The CSS proforma comprises[2]:

- Basic Inventory Data, i.e. Bridge name, Road name, O.S. Grid Reference, Number of spans, etc.;
- Bridge elements, i.e. list of all bridge elements for which a condition score should be recorded;
- Element Condition Reporting, i.e. information is reported for each bridge element separately in terms of 'Severity', 'Extent' of defects and 'Defect Type';
- Maintenance Works, i.e. Work required, Work priority and Cost of Work;
- Inspection Dates;
- Relevant comments from the Inspector and the signing off Engineer to include additional information that may be beneficial for decision making and/or future purposes;
- Detailed description of Work Required

A CSS Inspection Proforma for bridges can be found in Appendix A.

In addition to the CSS forms, inspectors are required to include a ROADS 277 (Appendix B) form giving all details of the structure. A written report of the observations, findings, causes and recommended remedies with a Routine Maintenance Schedule and a Risk Assessment Form is also submitted in the specified format.

2.4 Previous Inspection Practices

Prior to 2002, inspections were undertaken in accordance with the guidelines set out in BD63/94 [11], a DMRB standard that described the inspection and reporting requirements for highway structures.

For every inspection (General or Principal), a BE 11 form was completed to include the

- General structure details, i.e. structure name, no., Reference, etc.
- Inspection Details, i.e. type and date of inspection,
- Condition of elements, i.e. Extent and Severity of defects;
- Type of action/works required;
- Priority of required works and reason for priority allocation;
- Approximate cost of required works; and
- Additional comments from the inspector.

A BE11 Form for bridges can be found in Appendix C.

In addition to the BE 11 forms, inspectors were required to complete a ROADS 277 form (Appendix B) giving all details of the structure.

3 BPRN Structure Stock

3.1 General

Before TfL came into existence, London had Principal Roads (A Roads) managed by the boroughs and trunk roads managed by the Highways Agency. In 1999, when TfL was formed the Strategic Road Network was defined (i.e. Transport for London Road Network, TLRN) which included, all the trunk roads and a proportion of the more important Borough A Roads. The remaining A roads make up the Borough Principal Road Network (BPRN).

One of the first tasks of the BCI Project was to identify the highway structures on the BPRN. The BRPN comprises around 1120 km of strategic network (A class roads) which is managed by the 33 Boroughs [12]. The BPRN includes all borough owned structures that are located on the UKPMS Principal Road Network including, but not limited to, bridges, subways, culverts, footbridges, retaining walls etc. as defined by BridgeStation Database.

NOTE: Road over railway bridges owned wholly or in part by a borough are included in the BPRN whereas Railtrack owned road over railway bridges are excluded from the BPRN.

The BPRN is shown in Figure 1.

Figure 1: Borough Principal Road Network

3.2 Structure types and definitions

The structure types covered by the BCI Project are listed in Table 2 with their definitions.

Table 2: Structure Types and Definitions

Structure Types	Description
Bridge: Vehicular	A structure with a span of 1.5m or more spanning and providing passage for vehicular traffic over an obstacle, e.g. watercourse, railway, road.
Bridge: Pedestrian/cycle	As for vehicular bridge, but provides passage for pedestrians and cyclists.
Cantilever road sign	A structure with a single support that projects over the network in order to carry a traffic sign
Chamber/cellar/vault	An underground room or chamber with a plan dimension of 1.5m or more
Culvert	A drainage structure with a span of 0.9m or more passing beneath a network embankment that has a proportion of the embankment, rather than a bridge deck, between its uppermost point and the road running courses
High Mast Lighting	Lighting columns over 20m in height
Retaining Wall	A wall associated with the network where the dominant function is to act as a retaining structure (>1.35m)
Sign/signal gantry	A structure spanning the network, the primary function of which is to support traffic signs and signalling equipment
Structural earthworks - reinforced/strengthened soil/fill structure	A structure associated with the network where the dominant function is to stabilise the slope and/or retain earth. All structures with an effective retained height of 1.5m or greater.
Subway: Pipe	Subways that provide passage for utility service pipes and cabling
Tunnel	An enclosed length of 150 metres or more through which vehicles pass.
Underpass (or subway): Pedestrian	A structure with a span of 1.5m or more that provides passage for pedestrians
Underpass: Vehicular	The underpass includes approach slab, retaining walls, bridge, drainage, etc.
Special structure	For example, moveable bridges, Tower Bridge

3.3 Data Collection

The procedure followed to establish the condition of BPRN structures and evaluate their condition scores is described below.

- ***Step 1: Identify Structures on BPRN*** - boroughs were asked to identify the structures owned by them and located on the BPRN as defined by the UK Pavement Management System (UKPMS)[2] Principal Road Network. Structure types mainly included bridges, footbridges, culverts, subways, retaining walls and tunnels. Inspection reports, Roads 277 Forms and other data on these structures were forwarded by the boroughs to the project team.
- ***Step 2: Review of Inspection Data*** – existing inspection data was deemed inadequate for the Condition Indicator calculation if:
  - the inspection was carried out before 1st January 2001 i.e. to reduce the likelihood that the condition of a structure had significantly changed since its last inspection; and
  - there was insufficient data to be translated to the CSS BCI format (Ref. 2) i.e. prior to this survey BPRN inspections did not use the CSS BCI procedure.
- ***Step 3: Perform CSS Style Inspections*** – any structure from Step 1 that satisfied the criteria in Step 2 was identified for a CSS style inspection. Inspections were performed, using the CSS pro forma between April 2003 and March 2009.
- ***Step 4: Enter Data into CSS Spreadsheet*** – existing inspection data and the data collected from the CSS style inspections were entered into the CSS BCI Spreadsheet to calculate the Condition Indicator for each structure.
- ***Step 5: Upload Data into BridgeStation*** – Phase VI onwards inspection data is imported into BridgeStation and Condition Indicators are calculated within BridgeStation. Bridge Station can now provide 'Bridge Specific' pro forma to ensure that the same elements are reported from one inspection to the next thus ensuring consistency over time. See Section 5.3 for details of BridgeStation.

3.4 Number of Structures

Table 3 below lists the number of different type of structures, adding to a total of 611 structures. The change in the total number of structures over the six year period could be attributed to the following:

- A number of structures, which had previously been inspected in several parts, were amalgamated into one;
- Some structures were demolished and some filled e.g. subways that were no longer in use;
- Some new built structures were added to the stock.

[2] UKPMS is the standard system for the assessment of UK local road network conditions and for the planning of investment and maintenance on paved carriageways, kerbs, footways and cycle-tracks within the UK.

Table 3: Count of Structures

Structure Type	Number of Structures included in BCI calculation	Number of Structures in the stock	Number of Inspection Reports
Bridges (except Thames Bridges)	275	308	303
Retaining Walls	142	217	273
Footbridges	35	41	49
Pipe Subways	15	22	36
Underpasses/Tunnels	34	38	18
Culvert	56	66	0
Subways	52	58	107
Thames Bridges		-	13
Gantries			0
Basement		1	0
River Walls	1	-	0
Embankment		4	0
Mast		5	0
Vault	1	2	0
Miscellaneous		-	122
Total	**611[A]**	**762**	**921[B]**

NOTE A: Condition data was available for 611 structures which have been included in this report for the purpose of evaluating the BCI for the stock.

NOTE B: The 762 structures in the stock are covered by a total of 921 inspection reports, that is, some of the larger structures are sub-divided for inspection and management purposes.

4 Inspection Regime

4.1 General and Principal Inspections

The BCI Project included an on-going regime of General and Principal Inspections of the highway structures on the BPRN, in accordance with good practice, i.e. CSS Inspection Procedures [9] and the Code of Practice for Management of Highway Structures [1]. It is recommended [1, 2] that all highway structures should be subjected to

- A regular General Inspection not more than two years following the previous General or Principal Inspection; and
- A regular Principal Inspection not more than six years following the previous Principal Inspection unless a risk assessment has been carried out to define an alternative interval.

The first six year (2003 – 2009) inspection programme was developed in accordance with the aforementioned intervals and is summarised in Table 4, section 4.3.

4.2 Inspection Brief and Contracts

An Inspection brief/specification was issued by the RBK, for every phase (I – VI) of inspections, to every party (consultant or borough) undertaking the inspections.

The inspection brief that was issued for the Phase V inspections is presented in Appendix D. The briefs generally comprised of:

- Scope of Works which included:
  - A list of highway structures for which General and Principal Inspections needed to be undertaken
  - Existing information on the listed structures, e.g. Inspection reports, assessment reports, 277 forms, etc.
- Standards and guidance documents to be followed for carrying out inspections and collating/reporting the inspection data.
- Procedures for undertaking inspections, in particular:
  - Ensuring public safety by bringing immediate attention to defects having safety implications
  - Arranging access and traffic management to carry out inspection works
  - Ensuring compliance with Health and Safety requirements
  - Reporting of element condition information, i.e. format and additional information
- Content and format of GI and PI reports, e.g. report front and back covers, standard forms to be included in the report (CSS inspection form, 277 forms, risk assessment form, etc.) electronic format (word/excel/pdf), etc. A copy of GI and PI report layout is presented in Appendix E and F, respectively.

4.3 Inspection Programme

The first six year inspection programme is summarised in Table 4 below

Table 4: First Six Year Inspection Programme

Structure Inspections	Year						Total
	03-04	04-05	05-06	06-07	07-08	08-09	
Principal Inspection (PI)	116	238	198	121	125	143	**941**
General Inspection (GI)	129	321	239	301	306	286	**1582**
Total	**245**	**559**	**437**	**422**	**431**	**429**	**2523**

4.4 Future Inspection Programme

The second six year inspection programme has also been developed in accordance with the aforementioned GI/PI intervals (Section 4.1) and is summarised in Table 5 below.

Table 5: Second Six Year Inspection Programme

Structure Inspections	Year						Total
	09-10	10-11	11-12	12-13	13-14	14-15	
Principal Inspection (PI)	163	168	174	121	107	147	**880**
General Inspection (GI)	303	265	293	311	329	286	**1787**
Total	**466**	**433**	**467**	**432**	**436**	**433**	**2667**

4.5 Conclusions and Lessons Learned

The development/delivery of the inspection programme supported the identification of the BPRN structures and also provided clarity on which structures the London Boroughs are responsible for.

Due to significant inconsistencies within the inventory and condition data LoBEG recognised the importance of having consistent element inventories and the impact these have on the BCI values for the stock. This led LoBEG to start developing a Good Practice Guide (GPG) on creating structure inventories to achieve consistent practice for identifying element inventories, condition reporting and BCI evaluation.

5 Compiling Inspection Data

5.1 Handover

The inspection reports (hard and electronic copies) produced by the Consultants were sent to the boroughs, whereas the reports produced by the boroughs, once finalised, remained with the boroughs. All final reports were subsequently sent to Camden Consultancy Service for uploading the information into the BridgeStation.

5.2 Interim spreadsheet database

For all the phases, except Phase VI, data from the CSS inspection forms was input manually into an Interim Database to evaluate the BCI scores for each individual structure in the stock. In Phase VI the BCI scores were calculated within BridgeStation.

The Interim Database was a Microsoft Excel file which was used to

- store condition data for all the BPRN structures;
- calculate the BCI values for each individual structure based on the condition data;
- produce BCI histograms/graphs based on the calculations;
- evaluate the condition index for each structure type (Bridges, Retaining Wall, etc.); and
- evaluate the Condition Index for the stock.

Figure 2 presents a screenshot of the Main screen of the interim spreadsheet database.

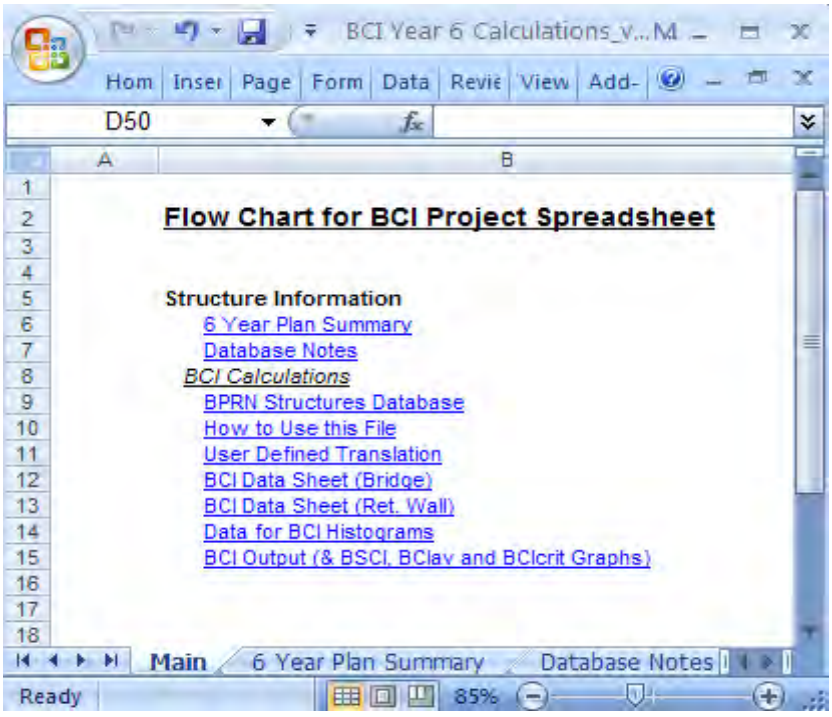


Figure 2: Interim Spreadsheet Database

5.3 BridgeStation database

BridgeStation is an Asset Management System designed specifically to manage bridges and other highway structures. BridgeStation was developed by Camden Consultancy Service in conjunction with the London Bridges Engineering Group (LoBEG). The BridgeStation database is utilised for:

- Recording Structure Inventory;
- Uploading/updating Inspection Data;
- Uploading/updating Inspection Regime; and
- Uploading/updating Routine Maintenance Schedule.

Figure 3 below presents a screenshot of the BridgeStation user interface for an individual structure.

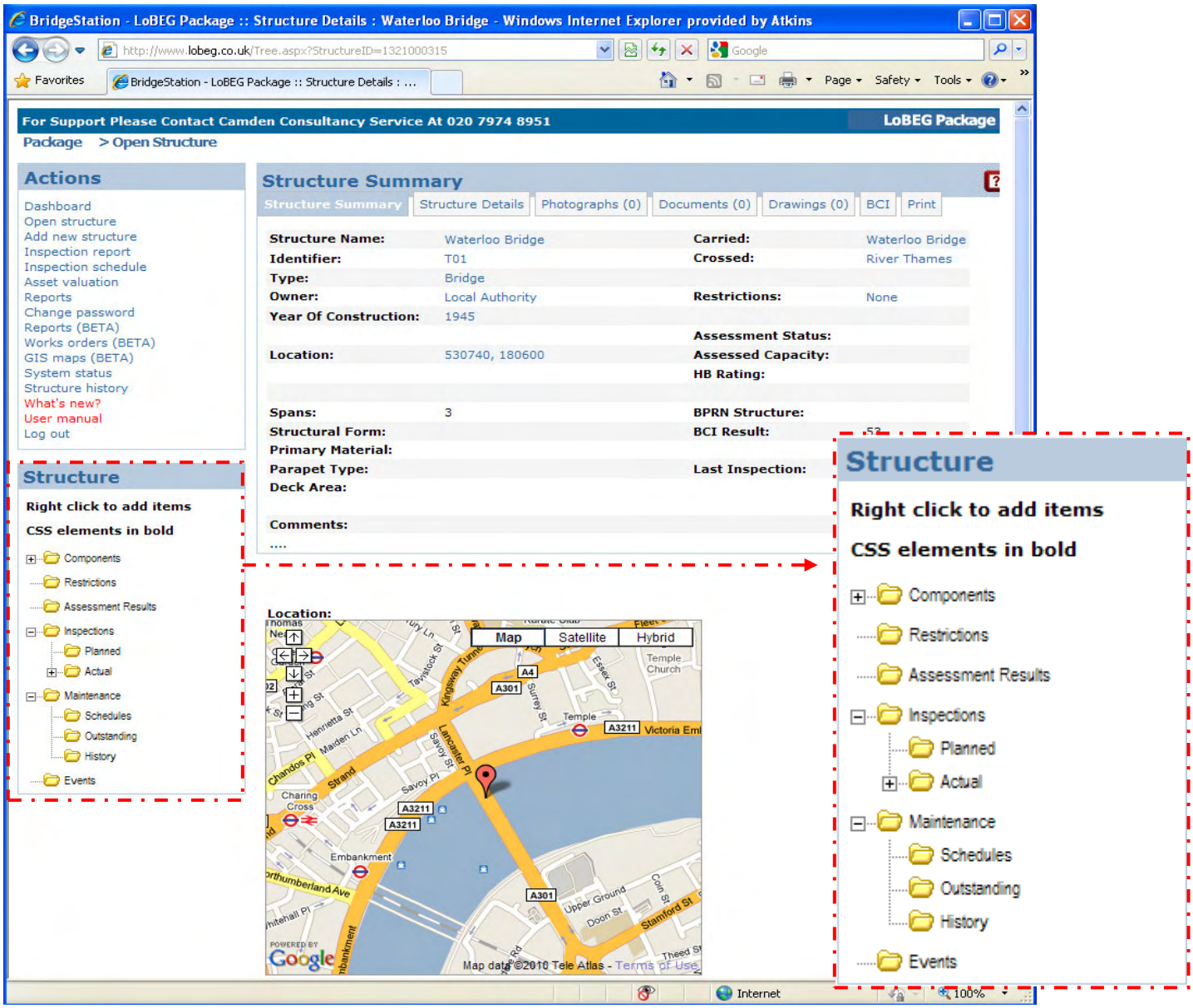


Figure 3: BridgeStation Database

After the development of BridgeStation, the data from Interim Spreadsheet Database was migrated/bulk imported into BridgeStation. This required a considerable amount of data validation and cleansing, e.g. matching up of structure names used in the interim database to those used in the BridgeStation's database, or cleansing the data for errors, e.g. structure reference numbers where a letter had been used in place of a number and vice versa.

The current inspection data, from the Consultants and the Boroughs, is received in the form of PDF reports or Microsoft Excel CSS Proforma. The data that is in the Microsoft Excel CSS ProForma format can be imported into BridgeStation using a software application that automatically reads the CSS Pro Forma. However, there is also some manual cleansing required in matching up structure names used by engineers on the CSS proforma to those of the BridgeStation's database.

BridgeStation is regularly updated when new information is received on existing structures, e.g. condition from latest inspection, etc. However, adding new structures to BridgeStation is left to the discretion of the borough.

5.4 Conclusions and Lessons Learned

The Interim Spreadsheet Database proved beneficial in testing and trialling the evaluation of Condition Indicator scores for the stock. Over the years inspectors, engineers and managers became increasingly familiar with the Interim Database. However with the migration of the Interim Database to BridgeStation inspectors, engineers and managers are slowly gaining momentum in familiarising themselves with BridgeStation. The migration has been a slow process and required considerable effort as a significant amount of data cleansing and validation had to be undertaken to ensure the quality of inspection information. This again reinforced the need for consistent element inventories and condition reporting.

It is considered that there is still a lack of clarity within BridgeStation which may gradually be addressed as it evolves and as more and more inspectors/engineers/managers become increasingly familiar with the system.

6 Condition Indicator for the BPRN

6.1 Evaluating the Bridge Condition Indicator

The evaluation of Bridge Condition Indicators (BCI) has been undertaken in accordance with the 'Guidance Document for Performance Measurement of Highway Structures, Part B1: Condition Performance Indicator', issued by CSS Bridges Group and Highways Agency in 2007[10].

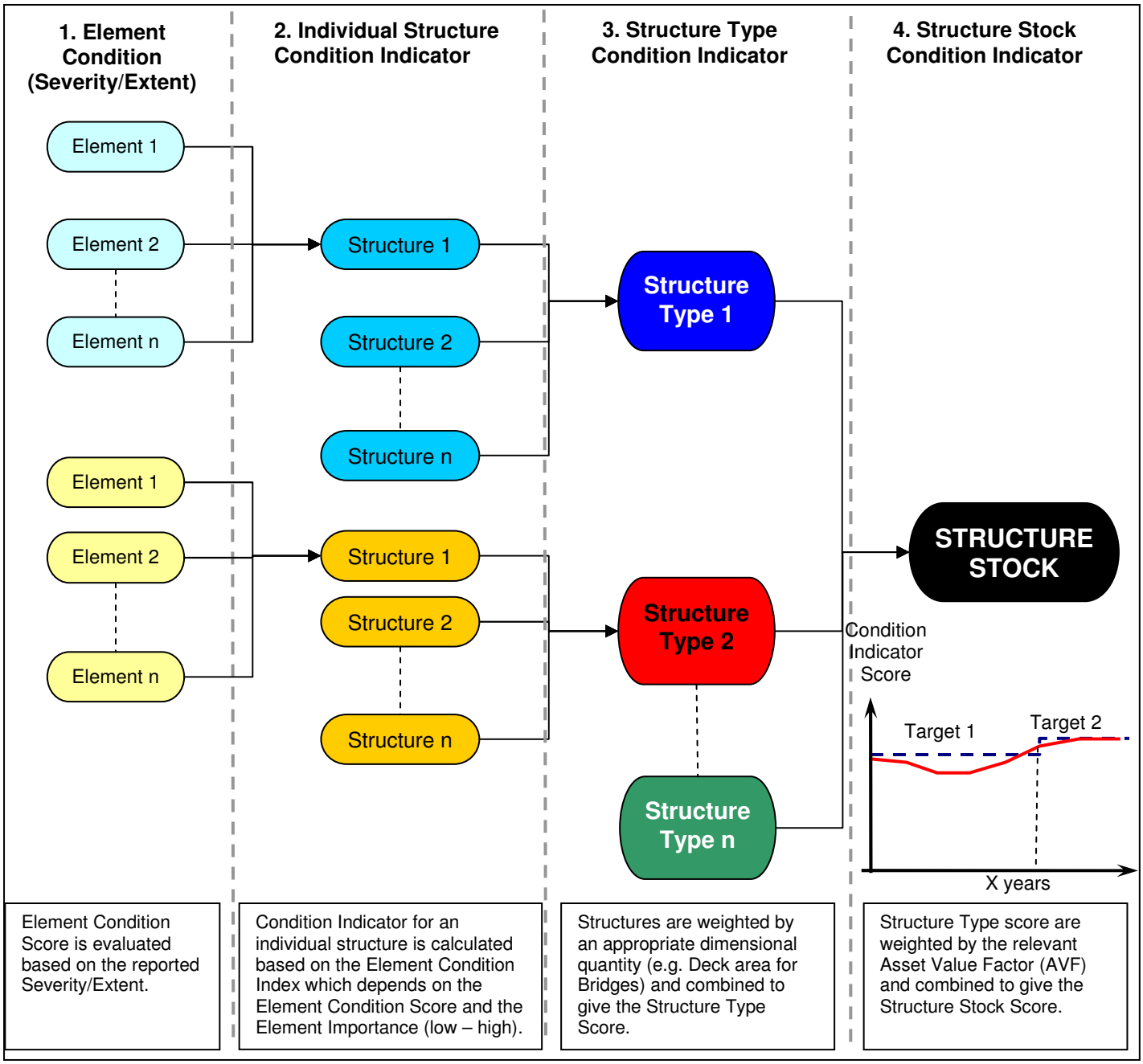


Figure 4: Evaluating Bridge Condition Indicators for the stock

The process for evaluating the BCI is illustrated in Figure 4, where:

- Element Condition, in terms of Severity and Extent, is used to evaluate the **Element Condition Scores** at element level.
- The Element Condition Scores and Element Importance are used to evaluate the **Condition Indicator (CI)** for an individual structure. Two condition indicators are calculated for each structure, which are defined as:
    - ***BCI_{av}:*** The average BCI for a structure taking into account the condition of all structural elements on the structure. This score provides an overview of the average structure condition.
    - ***BCI_{crit}:*** The condition score of the load bearing element which is in worst condition, this score provides an indication of the criticality of the structure with regards to the load bearing capacity.
- The CI scores for individual structures are used to evaluate the **Structure Type Condition Indicator**, e.g. BCI for all Bridges (1, 2….n), weighted according to the deck area, is used to evaluate the BCI for the overall stock of Bridges.
- The Structure Type Condition Indicator for each structure type (e.g. Bridges, Retaining Walls, Tunnels, etc.), weighted according to the relevant Asset Value Factor (AVF), is used to evaluate the **Structure Stock Condition Indicator**. Table 6 lists the structures that have been used for calculating the Stock Condition Indicator, along with the corresponding Asset Value Factors. Two condition indicators are evaluated for a stock of structures:
    - ***Stock Condition Indicator* –** the weighted average of the individual Condition Indicator scores, this score provides an overview of the average stock condition.
    - ***Critical Stock Indicator* –** the weighted average of the Critical Indicator scores, this score provides an indication of the criticality of the stock with regards to load carrying capacity.

Table 6: Structures included in the evaluation of the BCI scores for the stock

Structure Type (BPRN)	Included?	Asset Value Factor (AVF)[10]	Comments
Basement	No		No AVF defined.
Bridge	Yes	0.2	
Culvert	No		No AVF defined.
Footbridge	Yes	0.2	Treated as Bridges
Pedestrian Subway	No		No AVF defined.
Pipe Subway	No		No AVF defined.
Retaining Wall	Yes	0.1	
Tunnel	Yes	0.5	
Vault	No		No AVF defined.

The following sections present the Condition Indicators which have been evaluated for the BPRN stock.

6.2 BCI for Structure Type

The BCI_{av} and BCI_{crit} values evaluated, over the six year period, for the different structure types are summarised in Table 7 below. No condition data was available for Vaults and Basements prior to 2006-07, as these structures were excluded from previous inspection regime due to ownership issues.

Table 7: BClav and BClcrit for BPRN Structures

	Structure Type	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09
BCI Average	Basement (Ave)					100.00	100.00
	Bridge (Ave)	84.42	85.19	86.96	85.52	85.06	83.81
	Culvert (Ave)	89.71	91.00	87.86	89.70	89.57	89.72
	Footbridge (Ave)	91.68	91.95	88.87	88.70	88.84	87.08
	Pedestrian Subway (Ave)	84.84	85.04	85.34	86.06	85.41	85.79
	Pipe Subway (Ave)	98.85	98.56	93.98	91.28	91.37	88.92
	Retaining Wall (Ave)	91.76	89.38	88.39	85.90	85.41	84.88
	Tunnel (Ave)	82.69	83.34	92.60	93.46	92.65	89.52
	Vault (Ave)				99.00	99.00	99.00
BCI Critical	Basement (Crit)					100.00	100.00
	Bridge (Crit)	73.39	74.94	78.59	72.62	70.92	72.21
	Culvert (Crit)	92.24	92.35	85.23	86.42	84.22	84.56
	Footbridge (Crit)	85.81	88.48	83.45	86.91	86.73	85.54
	Pedestrian Subway (Crit)	83.84	83.98	84.36	88.49	87.74	84.28
	Pipe Subway (Crit)	99.53	98.51	90.60	85.26	85.15	84.12
	Retaining Wall (Crit)	97.81	98.13	93.93	90.81	90.16	89.11
	Tunnel (Crit)	79.89	79.88	93.68	95.47	93.20	86.02
	Vault (Crit)				100.00	100.00	100.00

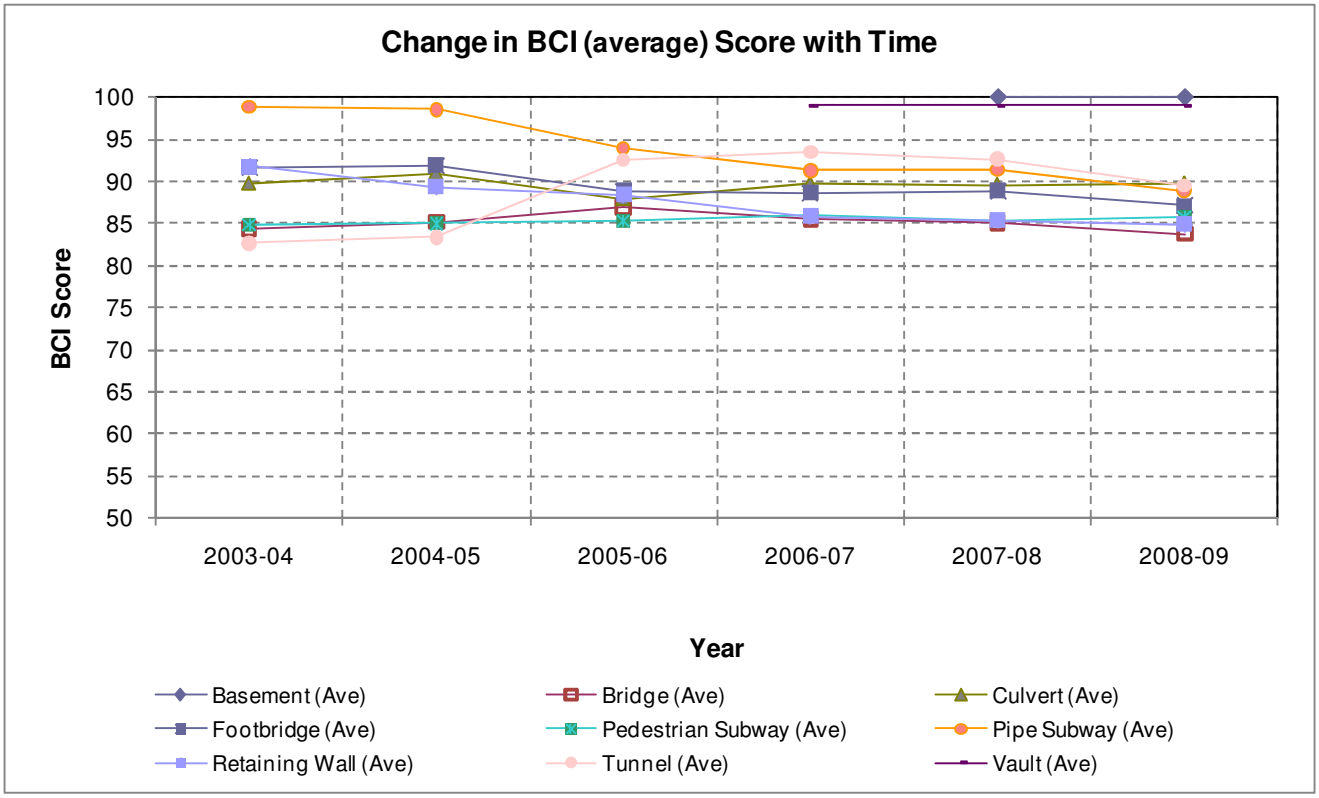


Figure 5: Trend of BCI (average) over the 6 year Period

Figure 5 present the change in BCI average scores, for each structure type, over the six year period. The figure indicates that the BCI average for the different structure types has been above 80 throughout the six year period. The increment and decrement in the values during the six year period can be attributed, but not limited to:

- Improvement in individual structure scores due to maintenance and treatment of structures;
- Deterioration of structures due to little or no maintenance;
- Demolition/De-commissioning of some structures in the stock;
- Addition of new structures to the stock.

Figure 6 presents the change in BCI critical scores, for each of the structure type, over the six year period. The figure indicates that the BCI critical for the different structure types has been above 80, for all structure types except Bridges that have a critical score below 75, throughout the six year period.

Appendix G1 presents the change in BCI scores over the six year period separately for each structure type.

An interpretation of these results is presented in section 6.5.

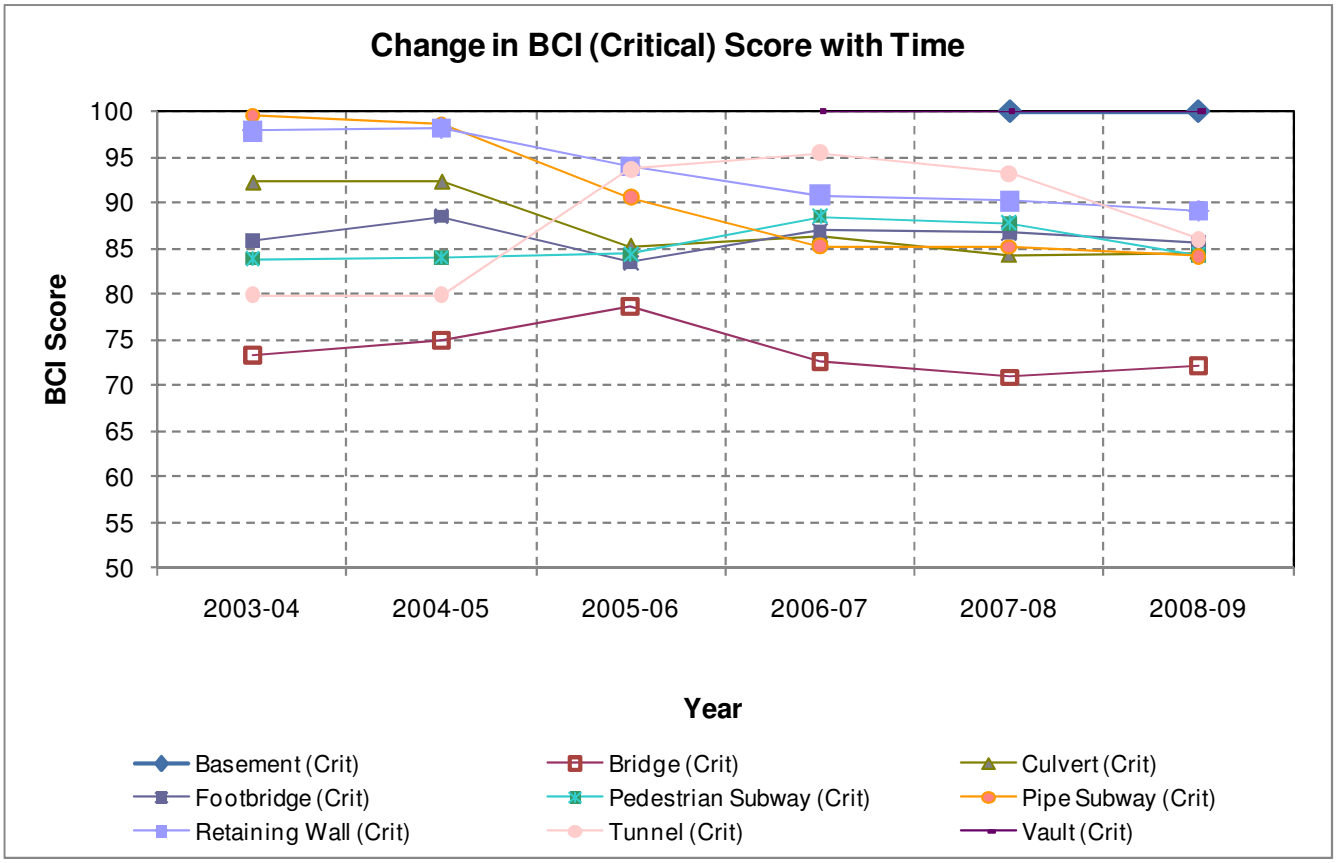


Figure 6: Trend of BCI (critical) over the 6 year Period

6.3 Stock Condition Indicators for Boroughs

Figure 7 - Figure 12 present the BSCI average and critical scores for each of the Boroughs from 2003 – 04 to 2008 – 09, respectively.

The figures indicate that:

- In 2003 – 04, no BSCI scores have been evaluated for eight boroughs, i.e. Brent, Islington, Kensington and Chelsea, Lambeth, Royal Kingston, Southwark, Tower Hamlets and Training. This could be attributed to no inspections being undertaken and thus inspection data not being available.
- The average BSCI for the majority of the Boroughs, throughout the six year period, has been above 80.
- The critical BSCI for most of the Boroughs, throughout the six year period, has been above 70.

Appendix G2 presents the Average and Critical BSCI scores, for each Borough, for each year within the six year period. Appendix G3 presents the change in the Average and Critical BSCI scores, for each Borough, over the six year period.

An interpretation of these results is presented in section 6.5.

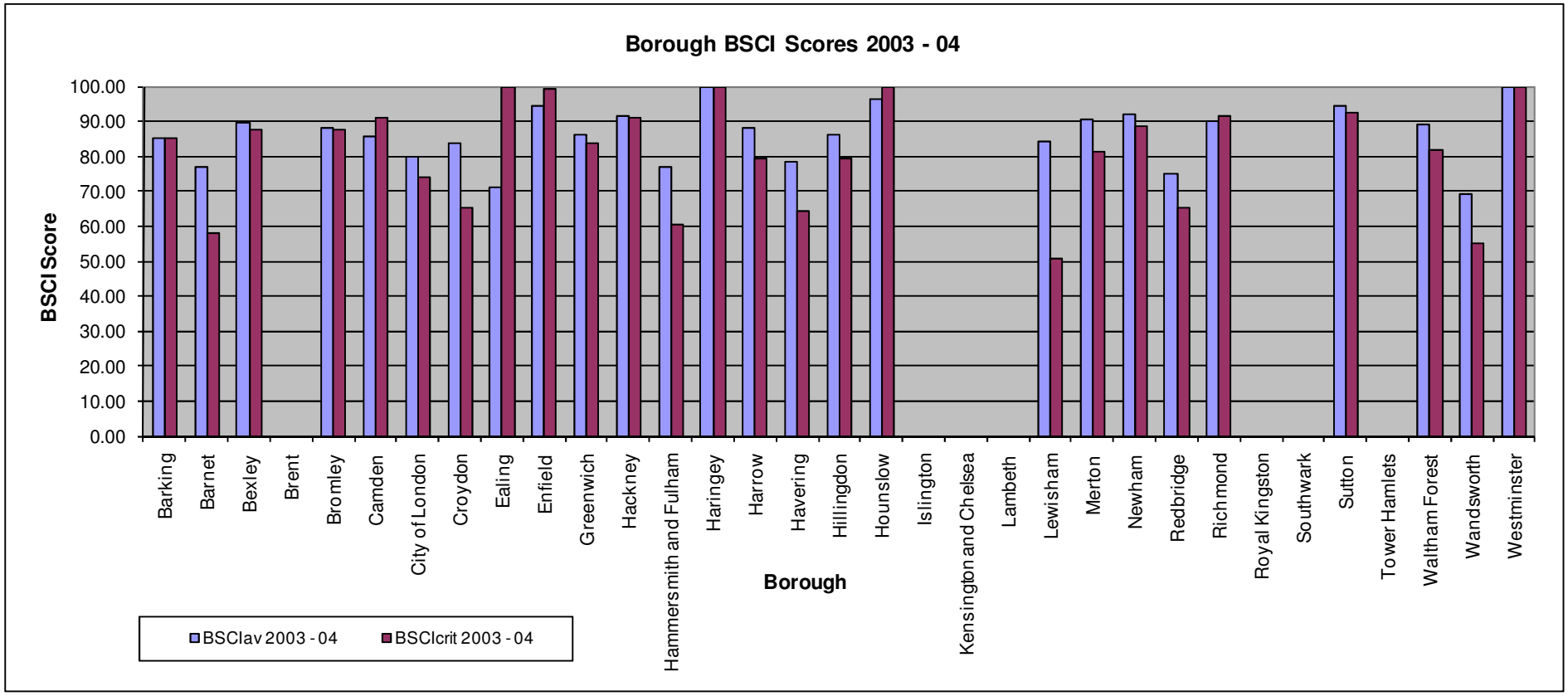


Figure 7: Borough BSCI Scores 2003 – 04

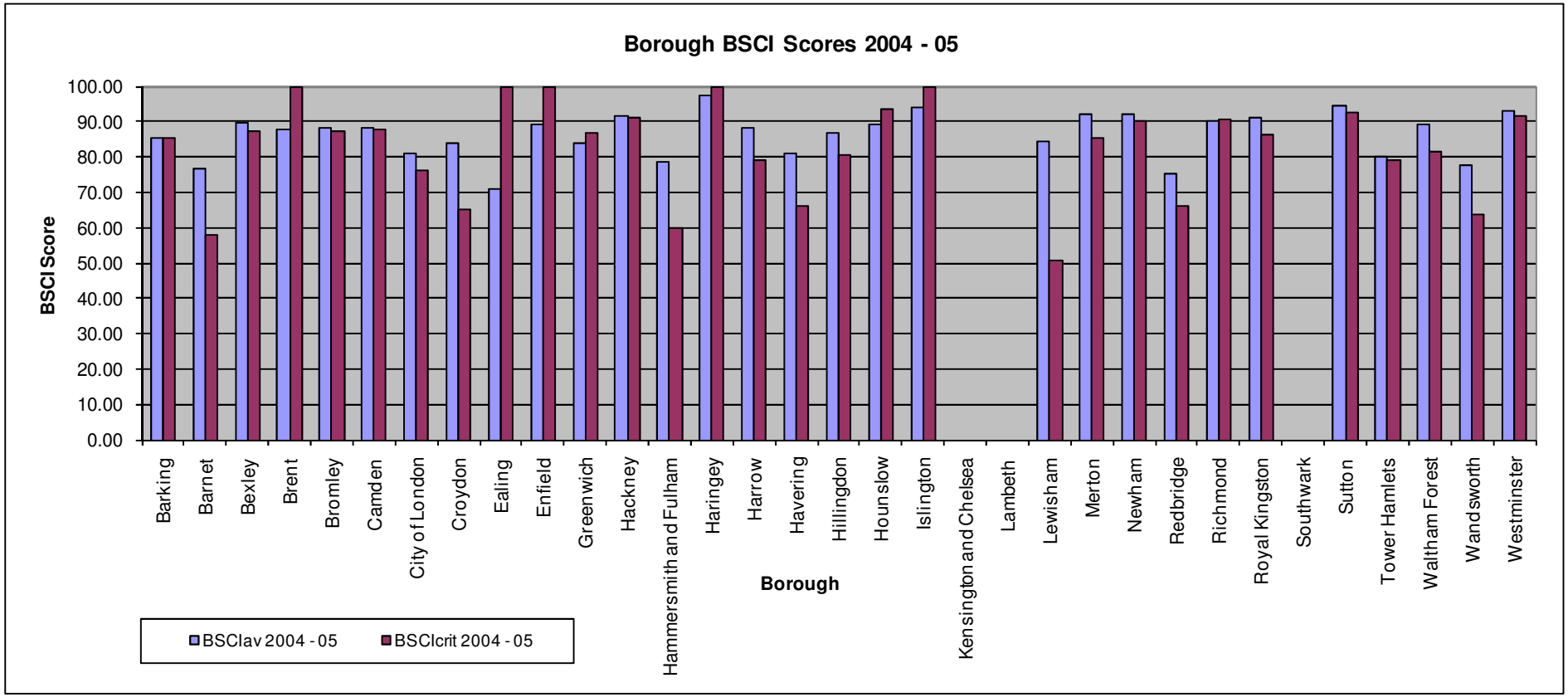


Figure 8: Borough BSCI Scores 2004 – 05

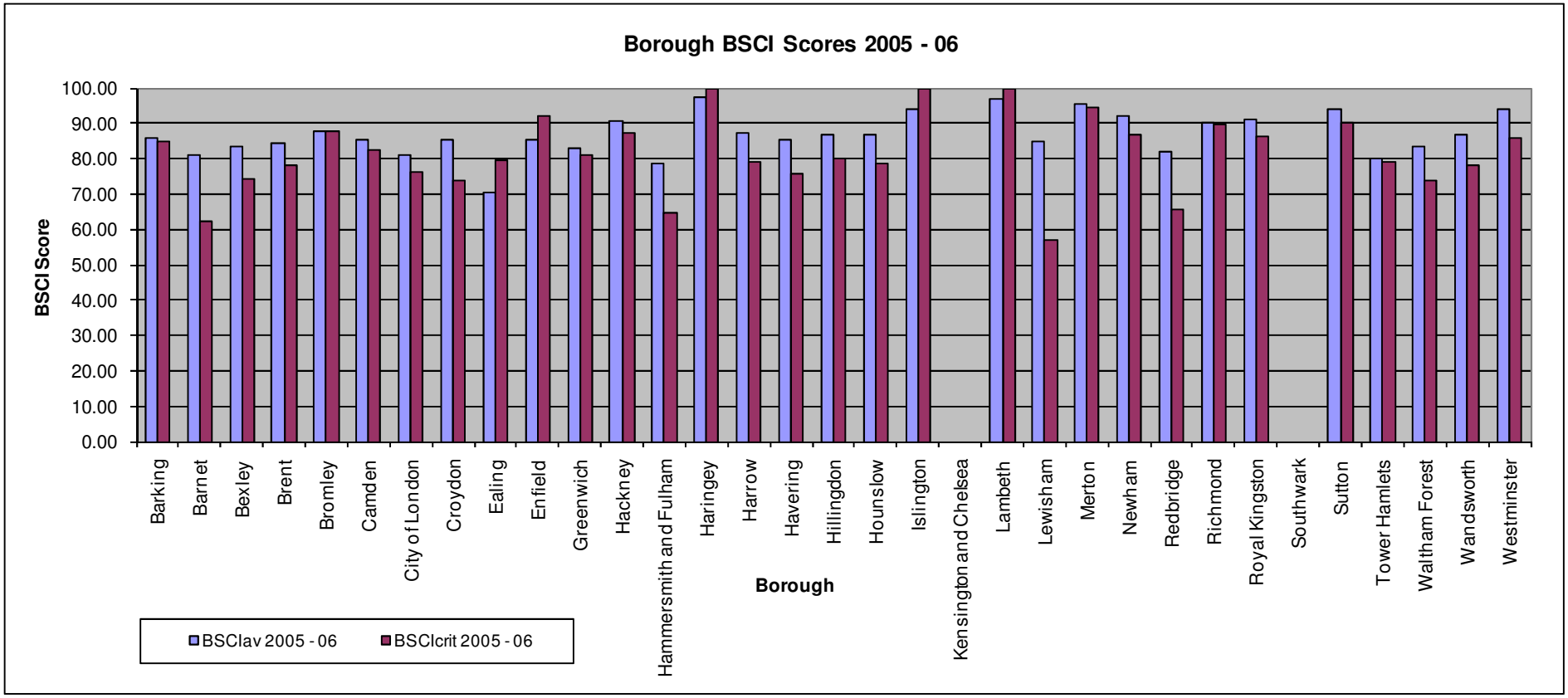


Figure 9: Borough BSCI Scores 2005 – 06

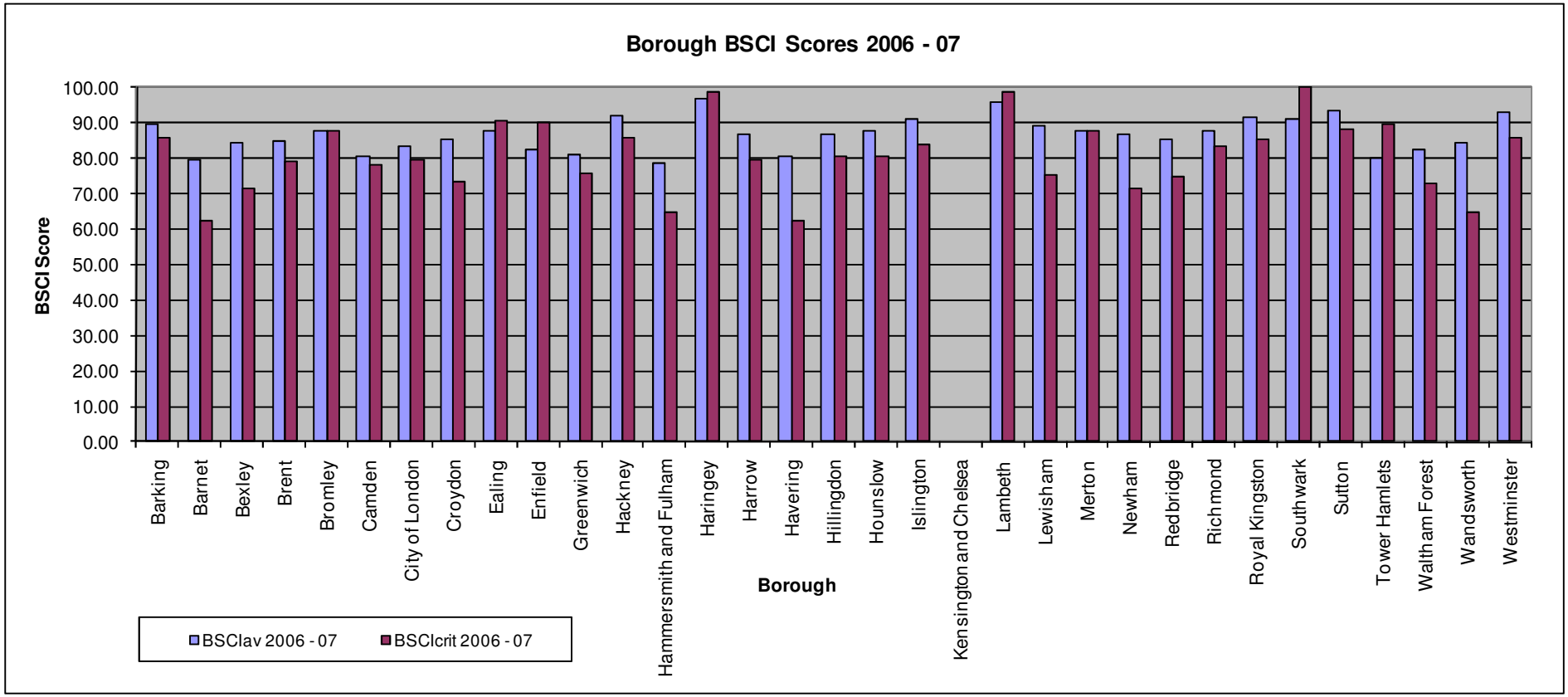


Figure 10: Borough BSCI Scores 2006 – 07

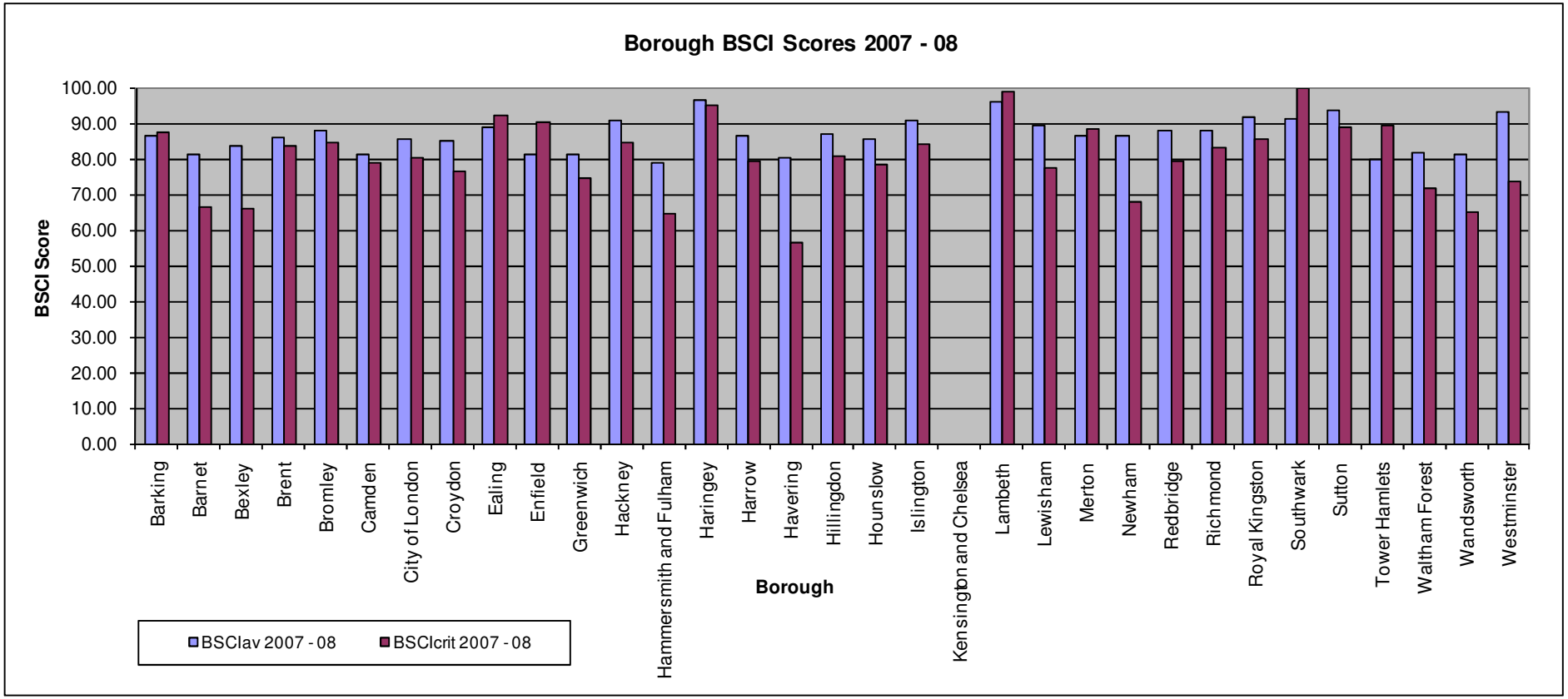


Figure 11: Borough BSCI Scores 2007 – 08

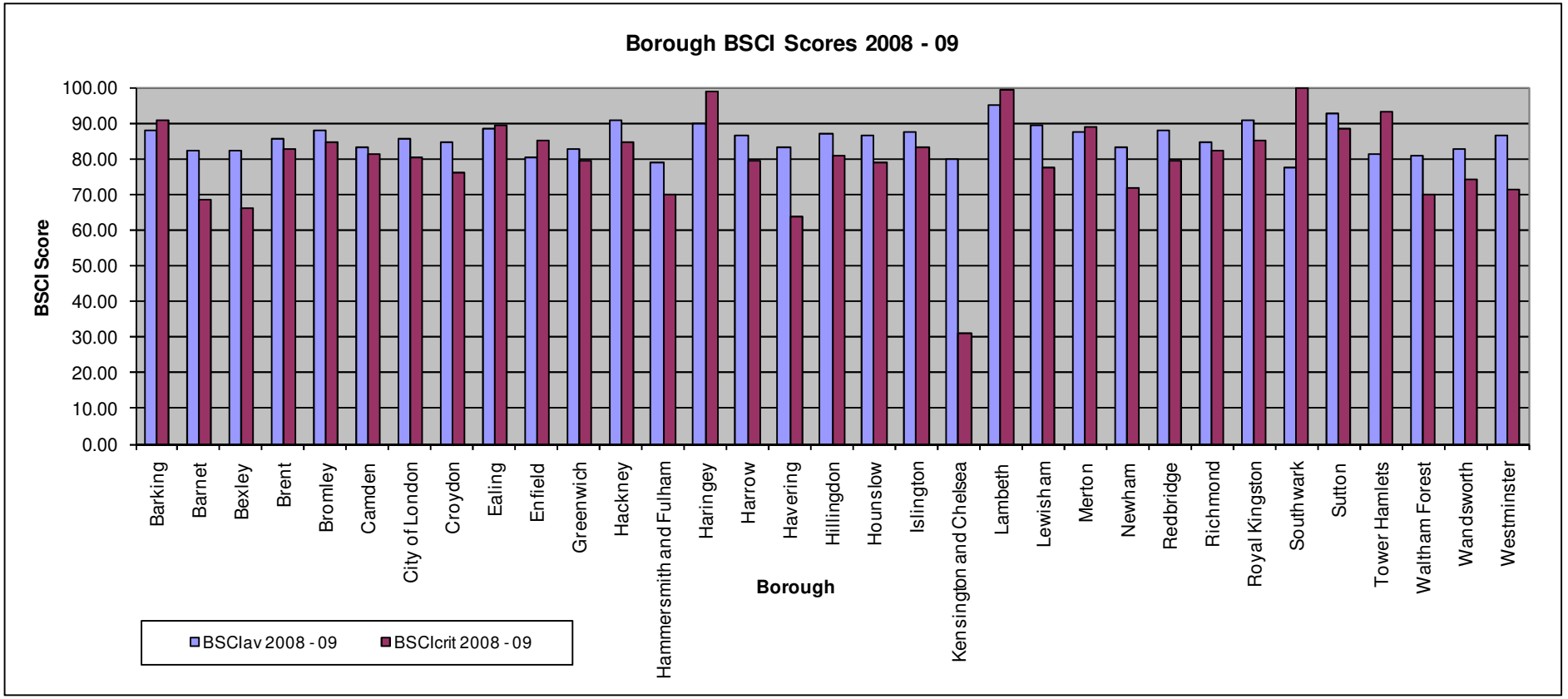


Figure 12: Borough BSCI Scores 2008 – 09

6.4 BCI values for the BPRN stock

Table 8 presents the Stock Condition Indicator values for the BPRN stock and Figure 13 presents the change in the Stock Condition Indicator values over the six year period. Figure 13 indicates that the Average Stock Condition Indicator, over the six year period, has been above 85 and the Critical Stock Condition Indicator has been above 75. An interpretation of these results is presented in section 6.5.

Table 8: BSCI values for the stock

BSCI	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09
BSCIav	85.55	86.09	87.99	86.71	86.28	85.03
BSCIcrit	77.80	80.14	82.87	78.15	76.68	76.73

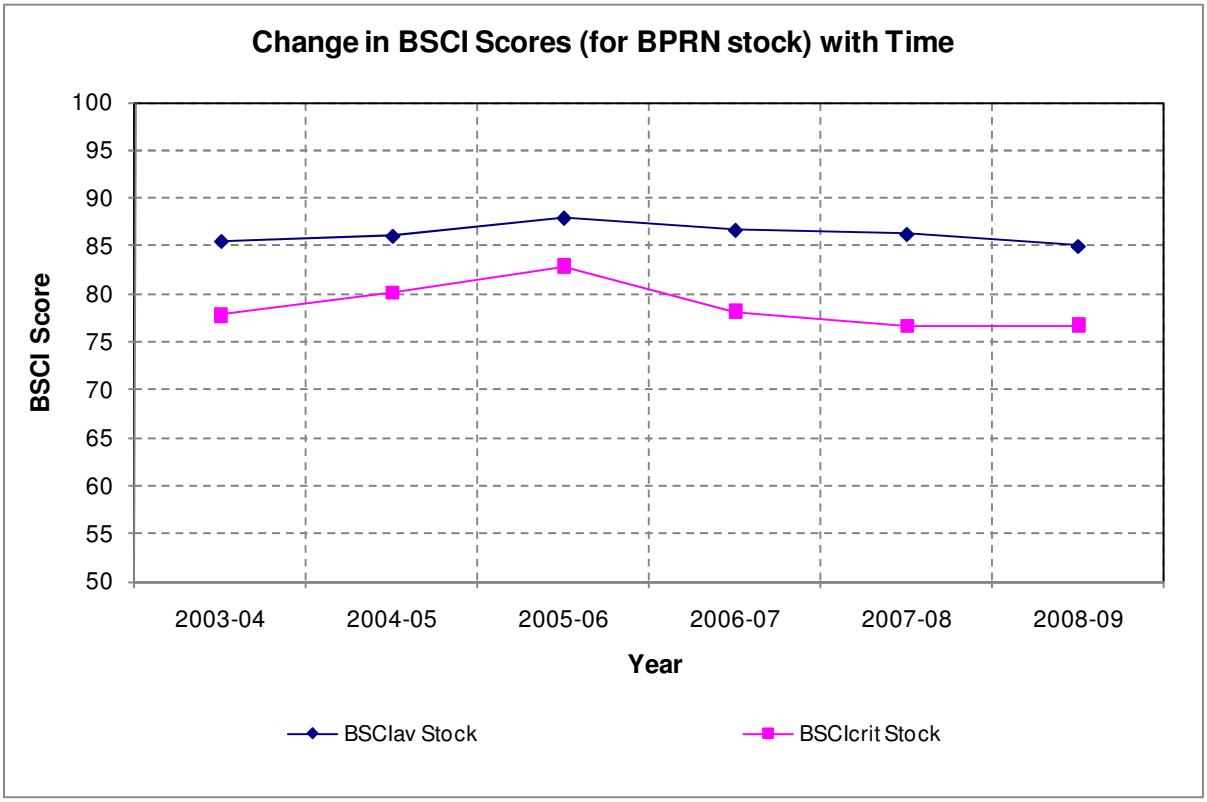


Figure 13: Trend of BSCI scores for the BPRN structure stock over the 6 year Period

6.5 Interpretation of Scores

Table 9 provides the interpretation of the Condition Indicator Scores ranging on a scale of 0 to 100.

Table 9: Description of Structure Stock Condition Indicator

Condition Range	Rating	Structure Stock Condition Description
90 ≤ BCI ≤ 100	Very Good	Structure stock is in a **very good** condition. Very few structures may be in a moderate to severe condition.
80 ≤ BCI < 90	Good	Structure stock is in a **good** condition. A few structures may be in a severe condition.
65 ≤ BCI < 80	Fair	Structure stock is in a **fair** condition. A number of structures may be in a severe condition.
40 ≤ BCI < 65	Poor	Structure stock is in a **poor** condition. Many structures may be in a severe condition.
0 ≤ BCI < 40	Very Poor	Structure stock is in a **very poor** condition. Many Structures may be unserviceable or close to it.

Condition Rating for Structure Types

Based on the interpretation of the condition indicator scores provided in Table 9 the rating for each of the structure type, over the six year period, is presented in Table 10.

Table 10: Structure Type Condition Rating

	Structure Type	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09
BCI Average	Basement (Ave)					V. Good	V. Good
	Bridge (Ave)	Good	Good	Good	Good	Good	Good
	Culvert (Ave)	Good	V. Good	Good	Good	Good	Good
	Footbridge (Ave)	V. Good	V. Good	Good	Good	Good	Good
	Pedestrian Subway (Ave)	Good	Good	Good	Good	Good	Good
	Pipe Subway (Ave)	V. Good	V. Good	V. Good	V. Good	V. Good	Good
	Retaining Wall (Ave)	V. Good	Good	Good	Good	Good	Good
	Tunnel (Ave)	Good	Good	V. Good	V. Good	V. Good	Good
	Vault (Ave)				V. Good	V. Good	V. Good
BCI Critical	Basement (Crit)					V. Good	V. Good
	Bridge (Crit)	Fair	Fair	Fair	Fair	Fair	Fair
	Culvert (Crit)	V. Good	V. Good	Good	Good	Good	Good
	Footbridge (Crit)	Good	Good	Good	Good	Good	Good
	Pedestrian Subway (Crit)	Good	Good	Good	Good	Good	Good
	Pipe Subway (Crit)	V. Good	V. Good	V. Good	Good	Good	Good
	Retaining Wall (Crit)	V. Good	V. Good	V. Good	V. Good	V. Good	Good
	Tunnel (Crit)	Fair	Fair	V. Good	V. Good	V. Good	Good
	Vault (Crit)				V. Good	V. Good	V. Good

The table indicates that the average condition rating for all the structure types ranges from 'GOOD' to 'VERY GOOD' over the six year period indicating a moderate backlog of maintenance works. The critical condition rating ranges from 'FAIR' for Bridges to 'GOOD' and 'VERY GOOD' for other structure types. A critical rating of 'FAIR' for Bridges indicate the following:

- Load bearing elements on a number of bridges have not been maintained over time. Thus a moderate backlog of maintenance work exists on load bearing elements.
- Some bridges may represent moderate risk to the public if appropriate mitigation measures are not undertaken

Condition Rating for Boroughs

Table 11 presents the average and critical condition rating for each of the Borough structure stock and it can be observed that although the average condition of most of the Boroughs is 'GOOD' the critical rating for few Boroughs is 'POOR' and 'VERY POOR' indicating:

- A significant backlog of maintenance causing the load bearing elements to deteriorate to this level; and
- A significant risk to the public if essential mitigation measures are not undertaken.

Table 11: Condition Rating for Boroughs

Borough	BSClav Score						BSClcrit Score					
	2003 - 04	2004 - 05	2005 - 06	2006 - 07	2007 - 08	2008 - 09	2003 - 04	2004 - 05	2005 - 06	2006 - 07	2007 - 08	2008 - 09
Barking	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	V. Good
Barnet	Fair	Fair	Good	Fair	Good	Good	Poor	Poor	Poor	Poor	Fair	Fair
Bexley	Good	Good	Good	Good	Good	Good	Good	Good	Fair	Fair	Fair	Fair
Brent		Good	Good	Good	Good	Good		V. Good	Fair	Fair	Good	Good
Bromley	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good
Camden	Good	Good	Good	Good	Good	Good	V. Good	Good	Good	Fair	Fair	Good
City of London	Fair	Good	Good	Good	Good	Good	Fair	Fair	Fair	Fair	Good	Good
Croydon	Good	Good	Good	Good	Good	Good	Fair	Fair	Fair	Fair	Fair	Fair
Ealing	Fair	Fair	Fair	Good	Good	Good	V. Good	V. Good	Fair	V. Good	V. Good	Good
Enfield	V. Good	Good	Good	Good	Good	Good	V. Good	V. Good	V. Good	V. Good	V. Good	Good
Greenwich	Good	Good	Good	Good	Good	Good	Good	Good	Good	Fair	Fair	Fair
Hackney	V. Good	V. Good	V. Good	V. Good	V. Good	V. Good	V. Good	V. Good	Good	Good	Good	Good
Hammersmith and Fulham	Fair	Fair	Fair	Fair	Fair	Fair	Poor	Poor	Poor	Poor	Poor	Fair
Haringey	V. Good	V. Good	V. Good	V. Good	V. Good	Good	V. Good	V. Good	V. Good	V. Good	V. Good	V. Good
Harrow	Good	Good	Good	Good	Good	Good	Fair	Fair	Fair	Fair	Fair	Fair
Havering	Fair	Good	Good	Good	Good	Good	Poor	Fair	Fair	Poor	Poor	Poor
Hillingdon	Good	Good	Good	Good	Good	Good	Fair	Good	Fair	Good	Good	Good
Hounslow	V. Good	Good	Good	Good	Good	Good	V. Good	V. Good	Fair	Good	Fair	Fair
Islington		V. Good	V. Good	V. Good	V. Good	Good		V. Good	V. Good	Good	Good	Good
Kensington and Chelsea						Good						V. Poor
Lambeth			V. Good	V. Good	V. Good	V. Good			V. Good	V. Good	V. Good	V. Good
Lewisham	Good	Good	Good	Good	Good	Good	Poor	Poor	Poor	Fair	Fair	Fair
Merton	V. Good	V. Good	V. Good	Good	Good	Good	Good	Good	V. Good	Good	Good	Good
Newham	V. Good	V. Good	V. Good	Good	Good	Good	Good	Good	Good	Fair	Fair	Fair
Redbridge	Fair	Fair	Good	Good	Good	Good	Fair	Fair	Fair	Fair	Fair	Fair
Richmond	V. Good	Good	Good	Good	Good	Good	V. Good	V. Good	Good	Good	Good	Good
Royal Kingston		V. Good	V. Good	V. Good	V. Good	V. Good		Good	Good	Good	Good	Good
Southwark				V. Good	V. Good	Fair				V. Good	V. Good	V. Good
Sutton	V. Good	V. Good	V. Good	V. Good	V. Good	V. Good	V. Good	V. Good	Good	Good	Good	Good
Tower Hamlets		Good	Good	Good	Good	Good		Fair	Fair	Good	Good	V. Good
Waltham Forest	Good	Good	Good	Good	Good	Good	Good	Good	Fair	Fair	Fair	Fair
Wandsworth	Fair	Fair	Good	Good	Good	Good	Poor	Poor	Fair	Poor	Poor	Fair
Westminster	V. Good	V. Good	V. Good	V. Good	V. Good	Good	V. Good	V. Good	Good	Good	Fair	Fair

Condition Rating for the BPRN stock

Table 12 presents the average and critical condition rating for the structure stock over the six year period. The table indicates that the average condition rating for the structure stock has been 'GOOD', indicating that a moderate backlog of maintenance work exists. The critical condition rating ranges from 'FAIR' to 'GOOD' over the six year period. A critical rating of 'FAIR' indicates the following:

- Load bearing elements on a number of structures have not been maintained over time. Thus a moderate backlog of maintenance work exists on load bearing elements.
- Some structures may represent moderate risk to the public if appropriate mitigation measures are not undertaken

Table 12: Structure Stock Condition Rating

BSCI	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09
BSCIav	Good	Good	Good	Good	Good	Good
BSCIcrit	Fair	Fair	Good	Fair	Fair	Fair

The interpretations described in this section are generalisations, more specific statements can only be made if they are supported by appropriate additional data, procedures and analyses. However, reviewing the average and critical condition of the entire stock of structures over the six year period provides some additional insight.

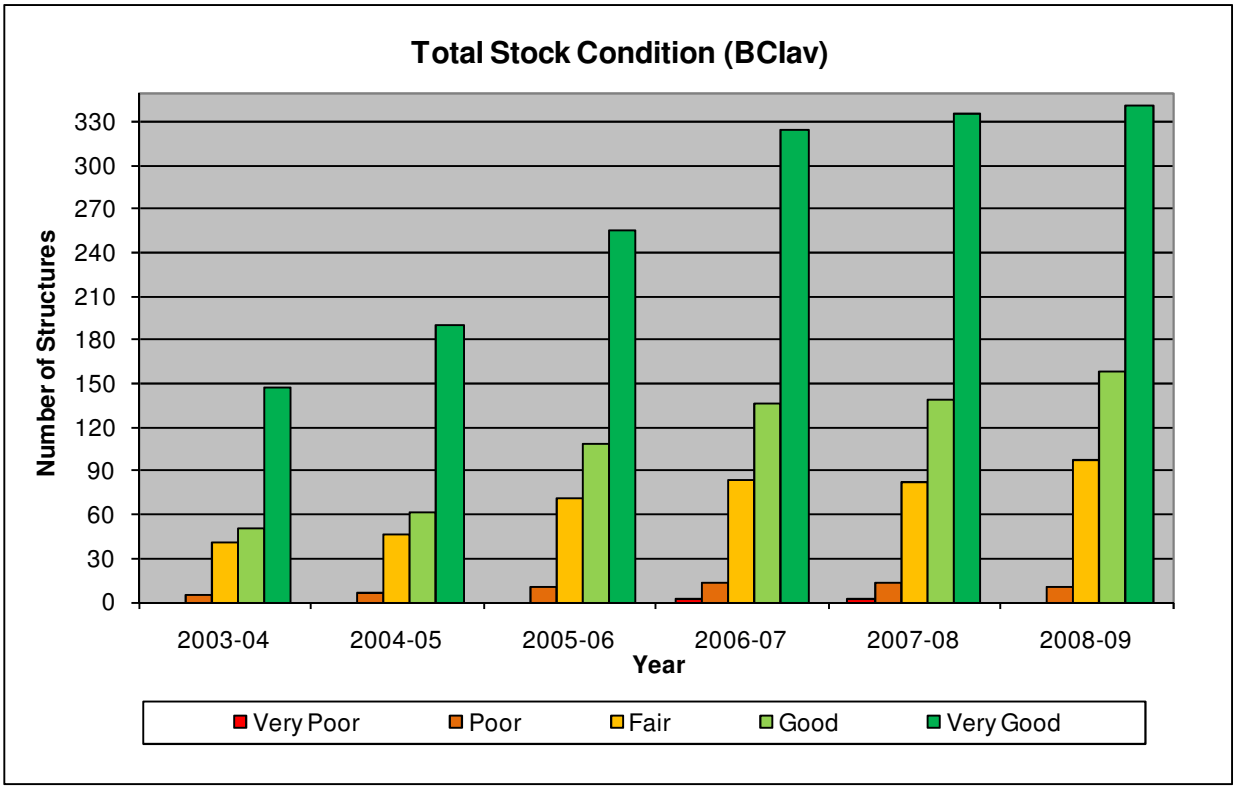


Figure 14: Average Condition Rating for the stock

Figure 14 above presents a histogram of the Average condition rating for the entire structure stock over the six year period. The following can be observed from the figure:

- The majority of the structures in the stock have an average condition rating of 'VERY GOOD' over the six year period.
- Some structures are in 'POOR' condition indicating maintenance backlog. These structures may pose risk to the public if appropriate mitigation measures are not undertaken.
- A few structures in 2006 and 2007 have an average condition rating of 'VERY POOR' posing significant risk to the public. These structures will require significant maintenance/repair expenditure to improve the overall condition to an acceptable level.

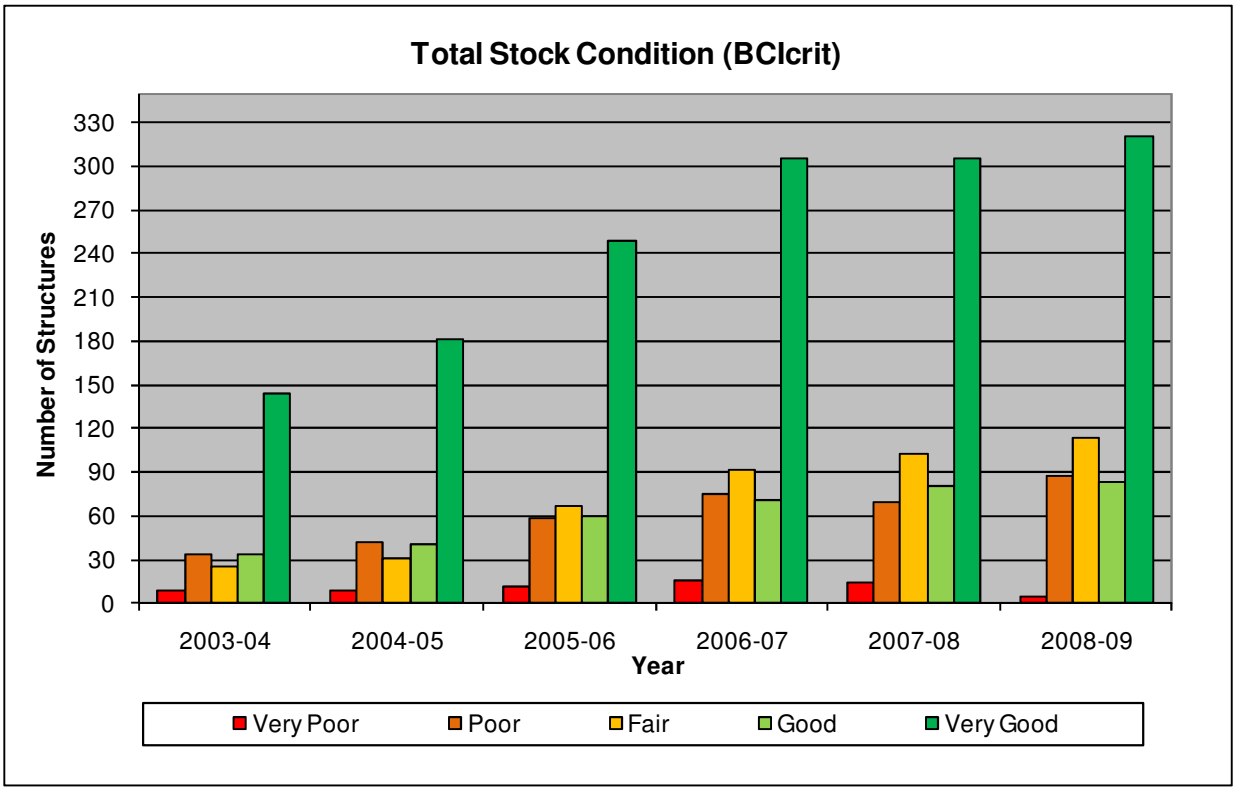


Figure 15: Critical Condition Rating for the stock

Figure 15 above presents a histogram of the Critical condition rating for the entire structure stock over the six year period. The following can be observed from the figure:

- The majority of the structures in the stock have a critical condition rating of 'VERY GOOD' over the six year period.
- Some structures are in 'POOR' condition indicating maintenance backlog of load bearing elements. These structures may pose risk to the public if appropriate mitigation measures are not undertaken.
- Throughout the six year period, a few structures have a critical condition rating of 'VERY POOR' posing significant risk to the public and indicating serious lack of maintenance of load bearing elements. These structures will require significant maintenance/repair expenditure to improve the overall condition to an acceptable level.

6.6 Conclusions

The survey of the BPRN structures provided an overview of the condition of the stock and enabled some inferences to be drawn about the adequacy of maintenance funding. The average condition of the overall stock, over the six year period, has been 'GOOD' with a critical rating of 'FAIR'.

A review of the individual structures in the stock indicated that some structures and load bearing elements have deteriorated to a level significantly below acceptable standards i.e. a condition rating of 'POOR'/'VERY POOR'. Structures/load bearing elements should not be allowed to deteriorate to this level because this:

- Increases risk to the public;
- Requires risk to be mitigated by temporary measures or essential reactive maintenance in order to maintain safety and serviceability;
- Necessitates funding to be spent on temporary measures or essential reactive maintenance at the expense of preventative maintenance in other areas, thus perpetuating a cycle of deterioration if not arrested by appropriate funding;
- Increases Whole Life Costs when compared to an optimal preventative maintenance approach.

The condition of load bearing elements, and the associated implications on safety and functionality of the BPRN stock, must be monitored closely. Improving the condition of these elements will dominate maintenance expenditure and the implications of this on the remainder of the stock condition must be carefully considered.

Structures currently classified as being in Good and Very Good condition still require appropriate maintenance and should be managed to retain high condition scores.

7 Maintenance Management and Planning

It was acknowledged by LoBEG and TfL that the evaluation of Condition Indicators alone does not identify, or provide justification for appropriate levels of maintenance funding for the BPRN structures. Therefore LoBEG/TfL have developed various tools/processes, described in Figure 16, to:

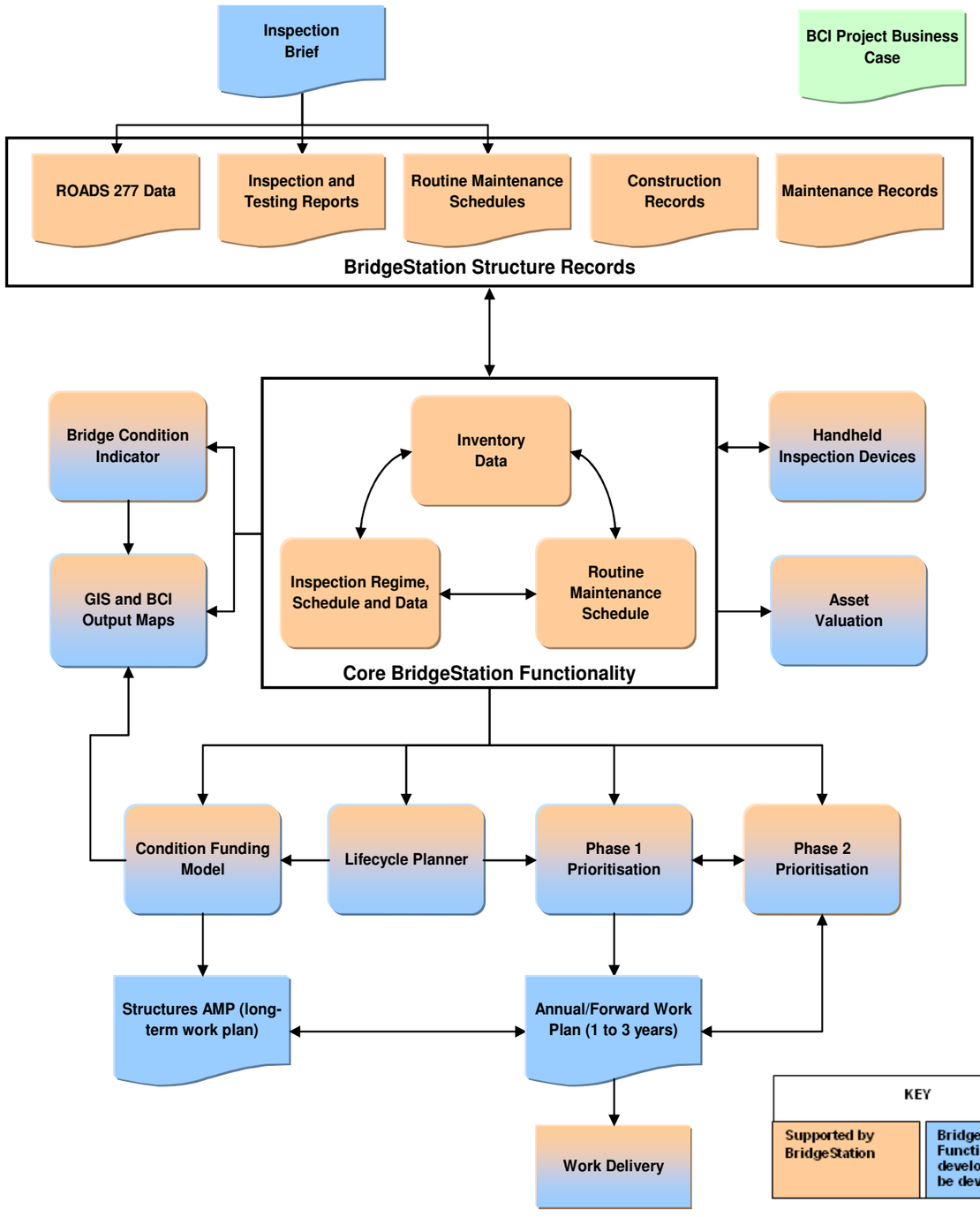
- Enable best use of the inspection data;
- Assist Bridge Managers to determine and justify appropriate levels of maintenance funding.
- Support effective management of highway structures, i.e. maintenance management and planning processes.

In addition to the tools/processes, LoBEG and TfL have developed a Bridge Management System, 'BridgeStation', which is used by all 33 London Boroughs and TfL. This provides a central database to assist all Boroughs in carrying out their maintenance management functions. In addition, BridgeStation is used for the bidding and allocation of Capital funding from TfL to the Boroughs.

Initially, BridgeStation was used as a data depository, however with time; the functionality of BridgeStation has been extended to include a range of additional modules, such as the BCI module, and LoBEG and TfL intend to extend it further to provide additional tools to assist managers in respect of Asset Management., e.g. Lifecycle Planning, Maintenance Prioritisation, etc.

However, it is crucial to understand that all the aforementioned systems, tools/processes are underpinned by consistent and good quality inventory and condition data, i.e. up-to-date and consistent inventory, inspection and assessment data is imperative to support the application of a robust Maintenance Management and Planning Process.

NOTE: The tools/processes that are currently supported by BridgeStation have been colour coded in tan in Figure 16 and those which are currently under development, or will be developed, have been colour coded in blue in Figure 16. The contents of this figure are regularly reviewed and updated; new items are added or removed as appropriate.



BCI Project Business Case	Overall Business Case that provides justification of the continuation of the BCI Project.
Inspection brief	BCI Project; provides the specification to which inspections must be carried out, including details of the documents to be submitted.
BridgeStation Structure Records	BridgeStation - enables structure records (e.g. reports, drawings etc.) to be stored against each structure
Inventory Data	BridgeStation - holds the list of structures, subdivided to the appropriate span level where required.
Inspection Regime, Schedule and Data	BridgeStation - enables the inspection regime (i.e. type and timing) to be defined, the inspection schedule to be developed and the inspection data (e.g. severity, extent and priority) to be stored for each structure.
Routine Maintenance Schedule	BridgeStation - allows routine maintenance to be scheduled.
Handheld Inspection Devices	To support and streamline the collection and importing of inspection data from site
Bridge Condition Indicator	BridgeStation - calculates the Bridge Condition Indicator (BCI); BridgeStation calculation, and additional calculation functionality, being tested, checked and verified using an independent spreadsheet model.
GIS and BCI Output Maps	BCI Project - assessing methods of presenting BCI scores annually, i.e. UKPMS style.
Asset Valuation	BCI Project - technical note and spreadsheet for calculating Gross and Depreciated Asset Value (completed and circulated to LoBEG members).
Condition Funding Model	BCI Project - uses the condition data and lifecycle planning data to carry out the long-term condition/funding analysis, including "what-if" analysis for different levels of funding.
Lifecycle Planner	BCI Project - a tool to assist the development of structure specific lifecycle plans, including default information on Service Live, Deterioration Rates, Maintenance Options, Costs etc.
Phase 1 Prioritisation	BCI Project - look at reviewing existing BridgeStation procedure for prioritisation of maintenance needs (i.e. more than just condition) and support the packaging of works into cost effective schemes for Phase 2.
Phase 2 Prioritisation	BridgeStation - the strengthening/capital maintenance prioritisation carried out by BridgeStation. These schemes are taken into account when prioritising and planning maintenance works. To be revised in 2008/09.
Annual/Forward Work Plan (1 to 3 years)	BCI Project - the key outputs of the maintenance planning process are annual and forward work plans that describe in detail the maintenance activities, priorities and costs and are suitable prioritised. These are updated anually.
Structures AMP (long-term work plan)	BCI Project - the process provides the majority of the information required for the structures Asset Management Plan (AMP), including the long-term (10 year) work and financial plans
Work Delivery	BridgeStation (partial) - issuing of work orders and delivery of the physical work on the ground (where possible BridgeStatiion should be designed to assist delivery, e.g. monitoring work delivery, links to financial systems)

Figure 16: BCI Flowchart (April 2009)

Each component of the process, illustrated in Figure 16, represents an aspect of bridge management that makes use of inspection data. The components of this process that have been developed to date are:

- *Inspection Brief* – comprehensive inspection documentation and brief has been produced that seeks to ensure inspectors provide high quality and consistent data. This helped inform the content of the updated *Inspection Manual for Highway Structures*[2].
- *Bridge Condition Indicator* – inspection data is being used to calculate the Bridge Condition Indicator and monitor trends over time (at stock level and for structure groups). The essential input to this is up-to-date inspection data.
- *Asset Valuation** – a LoBEG Technical Note has been developed that explains how the CSS Asset Valuation guidance (including Depreciation and Gross Replacement Cost) has been interpreted and applied in London. The Depreciation approach described in the Technical Note is based on the Guidance Document for Highway Infrastructure Asset Valuation [14] published by the Roads Liaison Group and has now been superseded by the CIPFA code of practice [13]. However, the Gross Replacement Cost approach described in the technical note is still current. A MS Excel spreadsheet has been released which is intended to be used for evaluating the Gross Replacement Cost (GRC) only. This spreadsheet has been made available nationally through the CIPFA website.
- *Phase 1 Prioritisation** – a LoBEG Good Practice Guide has been developed that explains the maintenance prioritisation process; a MS Excel spreadsheet has been released and the process is currently being programmed into BridgeStation. The key input to this is up-to-date inspection data.
- *Condition/Funding Model* – a model has been produced that enables LoBEG to predict the long-term maintenance needs for bridges and the impact that different levels of spend have on the BCI. A key input to this model is up-to-date inspection data. The model is intended to form the basis of the toolkit that will be developed by DfT to support Asset Management Planning and Asset Valuation (Depreciation, GRC), in order to comply with the CIPFA code of practice [13].
- *Lifecycle Planner** – a LoBEG Good Practice Guide has been developed that explains the lifecycle planning process. A MS Excel spreadsheet has been released that supports detailed whole life cost analysis/comparison for individual bridges or group of bridges[3]. The inspection data (i.e. inventory and condition) provides the starting point for the WLC analysis.
- *Creating Structure Inventories** – Consistency is vital to current and developing Bridge Management Techniques and to ensure that these are suitably supported, it is essential that element inventories are created and maintained in a consistent manner. LoBEG have developed a Good Practice Guide (GPG) that describes the approach for creating consistent element inventories and provides guidance on consistent evaluation of Bridge Condition Indicators.

[3] It is considered that bridges with similar characteristics may typically behave in a similar manner and thus have similar maintenance needs and funding requirements. Therefore the lifecycle planner can be adopted for a group of bridges by developing and adopting a lifecycle plan for a representative bridge from the group.

The aforementioned illustrates the importance of up-to-date inspection data in developing, informing and adopting advanced Bridge Management Techniques and highlights the need for consistent good quality inspection data.

***NOTE:** The aforementioned documents and tools have been made available on the LoBEG website and can be obtained through LoBEG package co-ordinator Kevin Andrews. LoBEG members can obtain these directly by logging into the members' area.

8 Conclusions, Lessons Learned and Recommendations

8.1 Conclusions

The survey of the BPRN structures provided an overview of the condition of the stock and an indication of the maintenance backlog that enabled some inferences to be drawn about the adequacy of maintenance funding. The BPRN structures were found to have an Average Condition Indicator rating in the category of 'GOOD' and a Critical Indicator rating of 'FAIR', indicating that:

- A moderate backlog of maintenance work exists on the structure stock, in particular, the load bearing elements.
- Maintenance work has been historically underfunded which has allowed the structure stock to deteriorate to its current condition. If the maintenance work continues to receive insufficient funds it is likely to result in:
    - Continued deterioration of condition of highway structures, which may have an impact on the safety and functionality of these structures in the long-term;
    - A significant increase in the maintenance backlog;
    - A disproportionate increase in the level of maintenance funding required to arrest and rectify deterioration, i.e. increasing Whole Life Costs of the structures;

8.2 Lessons Learned

During the initial six year period of the BCI project, LoBEG and TfL recognised the need and importance of a robust maintenance management and planning process and started devising tools/processes to support effective management of highway structures. This led to the development of tools/processes described in Section 7, Figure 16.

However, it was recognised that these tools and processes are underpinned by consistent and good quality inventory and condition data. It was observed that a significant amount of inconsistencies exist within the inventory and condition data which have a considerable impact on the BCI values.

This led LoBEG to start developing a Good Practice Guide (GPG) on creating structure inventories in order to achieve consistent practices for creating element inventories, condition reporting and BCI evaluation.

Furthermore, LoBEG and TfL acknowledged that condition indicators provide a high-level overview of the structure stock and are effective when used to monitor trends over time. This would enable authorities to determine whether the stock condition is improving, remains constant or is progressively deteriorating with time. Based on these trends inferences can be made about the adequacy/appropriateness of current and historical maintenance funding levels. However, conclusive statements about the level of funding required to arrest deterioration or improve the condition score cannot be made. This can only be done if the Condition Indicator is linked to Maintenance Management and Planning. Therefore the following tasks were, or are currently being, undertaken:

1. Implementation of an inspection regime in accordance with national good practice [1, 2];
2. Formulation of a comprehensive Maintenance Management and Planning process that appropriately utilises the collated inspection/condition data, also taking account of the developments relating to the management of highway structures by other authorities;
3. Development of tools that will assist bridge managers to determine and justify appropriate levels of maintenance funding, e.g. Condition/Funding model, Lifecycle Planner, Maintenance Prioritisation (Phase 1)
4. Enhancement of the functionality of BridgeStation to support effective management of highway structures.

8.3 Recommendations

To support the continued and effective management of highway structures in London, it is recommended that LoBEG and TfL:

- **Appropriately utilise the collated condition information by:**
  - Reviewing/monitoring the stock condition trends, presented in this report, against historic levels of funding and identifying the adequacy/suitability of funding levels and maintenance requirements accordingly;
  - Establishing similar trends by capturing and maintaining quality inventory and inspection data in future;
  - Streamlining the inspection process to achieve greater efficiency, e.g. by introducing portable inspection devices;
  - Predicting future trends relating to the condition and maintenance requirements of the stock; e.g. application of condition/funding model to (i) identify the condition of the stock and hence the maintenance requirements in future and (ii) assess what-if scenarios to identify the impact of applying varying maintenance funding levels;
- **Continue to maintain and develop procedures/systems that underpin the Maintenance Management and Planning Process by:**
  - Undertaking the inspection regime in accordance with national good practice [1, 2] and/or evaluating the need of undertaking risk based inspections to target resources (efficiently) where they are most needed;
  - Developing a robust process for the implementation and adoption of the Good Practice Guide (GPG) on creating structure inventories to ensure consistency in the inventory data and the evaluation of Condition Indicators;
  - Developing robust processes for the implementation and application of the tools developed to date, e.g. Lifecycle Planner, Maintenance Prioritisation (Phase 1), etc.
  - Reviewing and updating the Maintenance Management and Planning tools/processes, taking account of relevant developments, relating to

management of highway structures, occurring outside LoBEG and/or London;

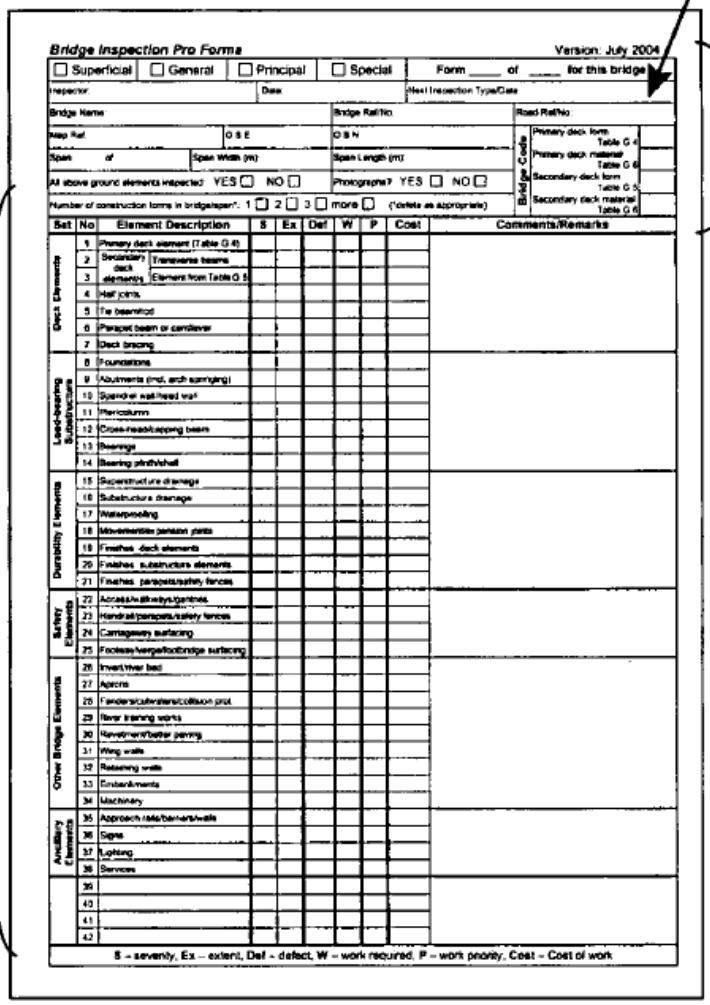
- **Enhance the performance/functionality of BridgeStation by:**
  - Updating the system to provide the desired functionality, e.g. updating existing modules to take account of recent developments and coding additional modules based on the tools/processes that are currently being developed;
  - Undertaking independent audits of BridgeStation to validate the functionality/outputs of existing and future modules that are intended to support the Maintenance Management and Planning Processes;
- **Provide formal training to the bridge engineers/managers, from the 33 boroughs and TfL, to assist them in adopting the tools/processes that underpin the Maintenance Management and Planning Process.**

9 References

1. Management of Highway Structures: A Code of Practice, Department for Transport, TSO, September 2005.
2. Inspection Manual for Highway Structures, TSO, May 2007
3. Maintaining a Vital Asset, Department for Transport, TSO, 2005
4. BSi PAS 55: Asset Management, BSi, 2008
5. CSS Framework for Highway Asset Management, CSS/TAG 2004
6. The Mayor of London's 'Transport Strategy for London' (TfL, 2001)
7. Bridge Condition Indicators Volume 3: Guidance Note on Evaluation of Bridge Condition Indicators, CSS, April 2002.
8. Addendum to Bridge Condition Indicators Volume 3: Guidance Note on Evaluation of Bridge Condition Indicators, CSS, August 2004.
9. Bridge Condition Indicators Volume 2: Guidance Note on Bridge Inspection Reporting, CSS, April 2002.
10. Guidance Document for Performance Measurement of Highway Structures, Part B1: Condition Performance Indicators, CSS Bridges Group and Highways Agency, 2007.
11. BD 63/94 - Inspection of Highway Structures, Design Manual for Roads and Bridges, Volume 3, 1994.
12. Road Network Performance & Research Team, Total Vehicle Delay for London, RNPR Technical Note 3, April 2003.
13. Code of Practice on Transport Infrastructure Assets: Guidance to Support Asset Management, Financial Management and Reporting, Chartered Institute of Public Finance & Accountancy (CIPFA), March 2010.
14. Guidance Document for Highway Infrastructure Asset Valuation, Roads Liaison Group, TSO, July 2005.

Appendix A: CSS Inspection Forms

Inspection Dates



Bridge Inspection Pro Forma Version: July 2004

☐ Superficial ☐ General ☐ Principal ☐ Special Form ____ of ____ for this bridge

Inspector | Date | Next Inspection Type/Date

Bridge Name | Bridge Ref/No. | Road Ref/No.

Map Ref. O S E | O S N | Bridge Code: Primary deck form Table G 4; Primary deck material Table G 5; Secondary deck form Table G 5; Secondary deck material Table G 6

Span of | Span Width (m) | Span Length (m)

All above ground elements inspected: YES ☐ NO ☐ | Photographs? YES ☐ NO ☐

Number of construction forms in bridge/span*: 1 ☐ 2 ☐ 3 ☐ more ☐ (*delete as appropriate)

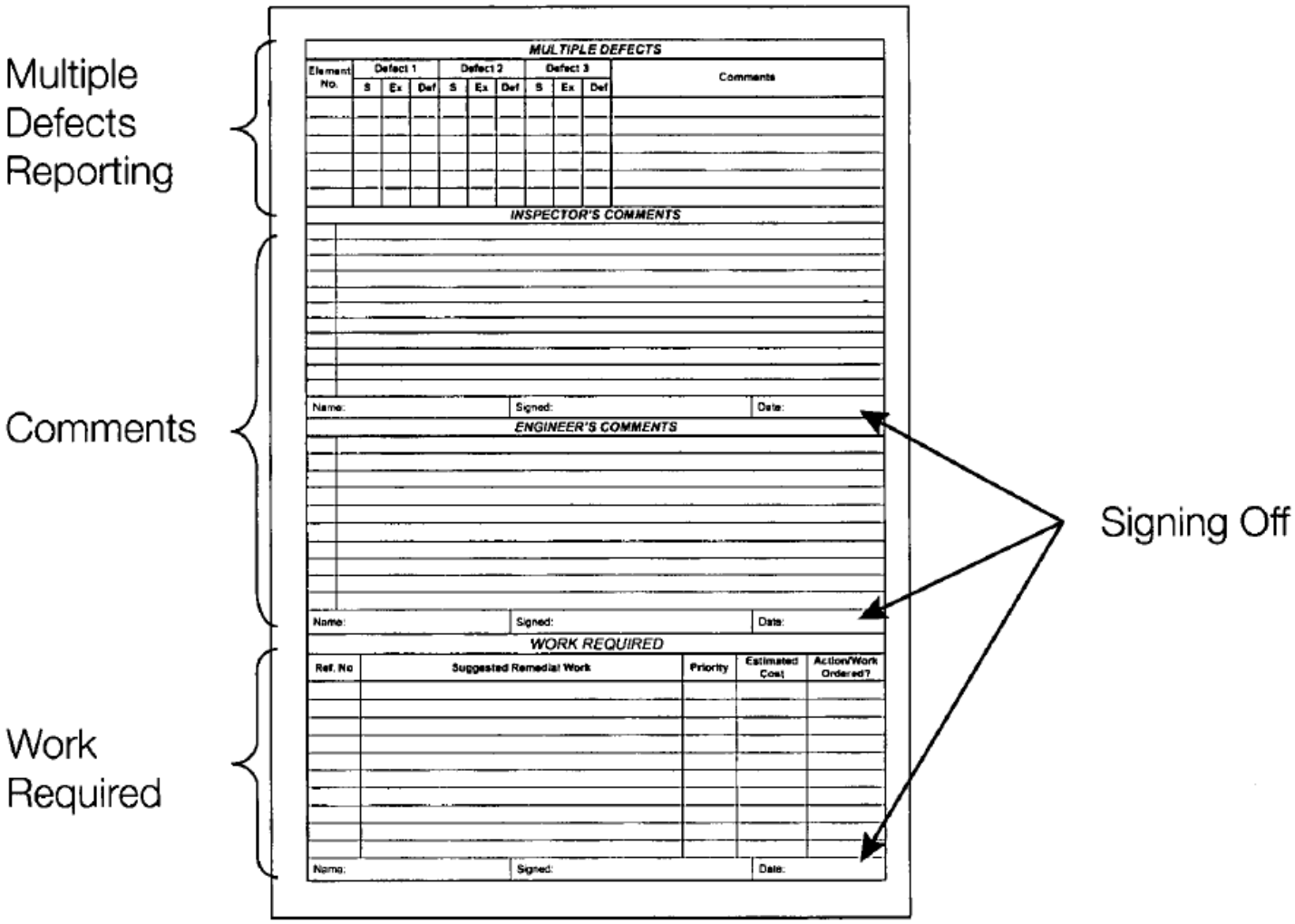
Set	No.	Element Description	S	Ex	Def	W	P	Cost	Comments/Remarks
Deck Elements	1	Primary deck element (Table G 4)							
	2	Secondary deck elements: Transverse beams							
	3	Secondary deck elements: Element from Table G 5							
	4	Half joints							
	5	Tie beam/cill							
	6	Parapet beam or cantilever							
	7	Deck bracing							
Load-bearing Substructure	8	Foundations							
	9	Abutments (incl. arch springing)							
	10	Spandrel wall/head wall							
	11	Pier/column							
	12	Cross-head/capping beam							
	13	Bearings							
	14	Bearing plinth/shelf							
Durability Elements	15	Superstructure drainage							
	16	Substructure drainage							
	17	Waterproofing							
	18	Movement/in-span joints							
	19	Finishes: deck elements							
	20	Finishes: substructure elements							
	21	Finishes: parapets/safety fences							
Safety Elements	22	Access/walkways/gantries							
	23	Handrail/parapets/safety fences							
	24	Carriageway surfacing							
	25	Footway/verge/footbridge surfacing							
Other Bridge Elements	26	Invert/river bed							
	27	Aprons							
	28	Fenders/cutwaters/collision prot.							
	29	River training works							
	30	Revetment/batter pitching							
	31	Wing walls							
	32	Retaining walls							
	33	Embankments							
	34	Machinery							
Ancillary Elements	35	Approach rails/barriers/walls							
	36	Signs							
	37	Lighting							
	38	Services							
	39								
	40								
	41								
	42								

S – severity, Ex – extent, Def – defect, W – work required, P – work priority, Cost – Cost of work

General Bridge Data

Bridge Elements & Element Condition Reporting

Front Page


Multiple Defects Reporting
Comments
Work Required
Signing Off
MULTIPLE DEFECTS
Element No.
Defect 1
Defect 2
Defect 3
S
Ex
Def
Comments
INSPECTOR'S COMMENTS
Name:
Signed:
Date:
ENGINEER'S COMMENTS
Name:
Signed:
Date:
WORK REQUIRED
Ref. No
Suggested Remedial Work
Priority
Estimated Cost
Action/Work Ordered?
Name:
Signed:
Date:

Back Page

Bridge Inspection Pro Forma Version: July 2004

☐ Superficial	☐ General	☐ Principal	☐ Special	**Form _____ of _____ for this bridge**
Inspector:		Date:		Next Inspection Type/Date:
Bridge Name:			Bridge Ref/No:	Road Ref/No:
Map Ref:	O.S.E		O.S.N	
Span of	Span Width (m):		Span Length (m):	
All above ground elements inspected: YES ☐ NO ☐			Photographs? YES ☐ NO ☐	
Number of construction forms in bridge/span*: 1 ☐ 2 ☐ 3 ☐ more ☐ (*delete as appropriate)				

Bridge Code		
	Primary deck form Table G.4	
	Primary deck material Table G.6	
	Secondary deck form Table G.5	
	Secondary deck material Table G.6	

Set	No	Element Description		S	Ex	Def	W	P	Cost	Comments/Remarks
Deck Elements	1	Primary deck element (Table 2)								
	2	Secondary deck element/s	Transverse beams							
	3		Element from Table 3							
	4	Half joints								
	5	Tie beam/rod								
	6	Parapet beam or cantilever								
	7	Deck bracing								
Load-bearing Substructure	8	Foundations								
	9	Abutments (incl. arch springing)								
	10	Spandrel wall/head wall								
	11	Pier/column								
	12	Cross-head/capping beam								
	13	Bearings								
	14	Bearing plinth/shelf								
Durability Elements	15	Superstructure drainage								
	16	Substructure drainage								
	17	Waterproofing								
	18	Movement/expansion joints								
	19	Finishes: deck elements								
	20	Finishes: substructure elements								
	21	Finishes: parapets/safety fences								
Safety Elements	22	Access/walkways/gantries								
	23	Handrail/parapets/safety fences								
	24	Carriageway surfacing								
	25	Footway/verge/footbridge surfacing								
Other Bridge Elements	26	Invert/river bed								
	27	Aprons								
	28	Fenders/cutwaters/collision prot.								
	29	River training works								
	30	Revetment/batter paving								
	31	Wing walls								
	32	Retaining walls								
	33	Embankments								
	34	Machinery								
Ancillary Elements	35	Approach rails/barriers/walls								
	36	Signs								
	37	Lighting								
	38	Services								
	39									
	40									
	41									
	42									

S – severity, **Ex** – extent, **Def** – defect, **W** – work required, **P** – work priority, **Cost** – Cost of work

MULTIPLE DEFECTS

Element No.	Defect 1			Defect 2			Defect 3			Comments
	S	Ex	Def	S	Ex	Def	S	Ex	Def	

INSPECTOR'S COMMENTS

Name:	Signed:	Date:

ENGINEER'S COMMENTS

Name:	Signed:	Date:

WORK REQUIRED

Ref. No	Suggested Remedial Work	Priority	Estimated Cost	Action/Work Ordered?

Name:	Signed:	Date:

Appendix B: ROADS 277 Form

Structure Name

ROADS 277

HA Structure No

HA ST key

National Grid Ref E N

RO File Reference

County/Borough

Date of Issue of form

Maintaining Region

Maintaining Agent:
For Structure

Date of Last Principal Inspection

For Road Surface

Structure Owner (if not TfL)

Maintaing Agent:
Strucure Ref:

Year Structure Commissioned

Design Office

Does the road go over /under
*Railway, Canal, River, Road

Railway Bridge Number

Is the River tidal? yes no

Is the River navigable? yes no

Name of Navigation /Drainage Authority

*Please delete as necessary

Is the structure Susceptible to scour? yes no

Is the structure on the High Load Route? yes no

Is the structure on the Heavy Load Route? yes no

Is the structure scheduled As an Ancient Monument? yes no

Name of statutory undertakers having Services on bridge

Min Headroom Clearance under/over

*Corporation of London Road Network

* N. Bound/W. Bound

* S. Bound/E. Bound

* Please delete as necessary

Design Load

Design standard version

* Special loading/restriction

Materials:

*Deck/Wall/Mast etc (eg in situ PSC)

Type of Construction (eg Solid Slab)

Form of Deck (eg Propped Cantilever)

End Supports (eg Skeleton Abutment)

Intermediate Supports (eg Slab Wall)

Nature of Foundations (eg Caissons)

Photograph(s)

PTO

Dimensional Elevation, Cross Section and Components of Structure.

Indicate all materials of construction, eg steel wrought iron, cast iron, concrete, brick, stone etc.

Indicate roadway and pavement widths of the reference road and also of the crossing road where appropriate (include spans).

Indicate type and position of bearings and joints.

	Manufacturer	*Type*
Pre stressing System		
Paint System: Parapet		
Internal		
External		

	Manufacturer	*Type*	*Position*
Bearings*			
Joints*			
Parapets			
Waterproofing			

* Indicate on sketch above

Appendix C

Trunk Road/Motorway Structure Inspection Report

BE11/94

Structure No. | Grid Ref

Agent Code | Agent Name

Structure Name | From Span | To Span

Date of Inspection (e.g. 0 1 J U N 2 0 0 6) | Inspected By

Type of Inspection* G ☐ P ☐ S ☐

Overall Assessment* G ☐ F ☐ P ☐

*Please tick

Defect Assessment

	Estimated Cost (£)	Extent	Severity	Work	Priority	PD	Comments
Foundations							
2. Inverts and Aprons							
3. Fenders							
4. Piers and Columns							
5. Abutments							
6. Wing Walls							
7. Retaining Walls and Revetments							
8. Approach Embankments							
9. Bearings							
10. Main Beams / Tunnel Portals / Mast							
11. Transverse Beams / Catenary Cables							
12. Diaphragms or Bracings							
13. Concrete Slab							
14. Metal Deck Plates / Tunnel Linings							
15. Jack Arches							
16. Arch Ring / Corrugated Metal							
17. Spandrels							
18. Tie Rods							
19. Drainage Systems							
20. Waterproofing							
21. Surfacing							
22. Service Ducts							
23. Expansion Joints							
24. Parapets / Handrails							
25. Access Gantries or Walkways							
26. Machinery							
32. Dry Stone Walls							
33. Troughing							

Was the remedial work recommended at previous inspection satisfactorily completed? Please tick. YES ☐ NO ☐

If ‘NO’ please comment and indicate any remedial work recommended and priority

Reasons for Priority Allocation

Signed | Name | Date

Appendix D: Inspection Briefs

LoBEG Structures Condition Survey

Bridge Condition Indicators Phase V Inspections (2007-2008)

Specification

The Royal Borough of Kingston upon Thames

LoBEG Structures Condition Survey

Bridge Condition Indicators Phase V Inspections (2007-2008)

Specification

SPECIFICATION

1. General

1.1. The Bridge Condition Indicator (BCI) project forms part of the strategy being developed by TfL jointly with LOTAG and LOBEG for asset management across TLRN and the Borough Principal Road Network (BPRN).

1.2. It is important that the highway structures on the BPRN are managed to accord with good practice, to:

- Enable bridge Managers from TfL and the Boroughs to demonstrate that the structures are safe for use and fit for purpose.
- Provide justification for funding on-going maintenance.
- Develop procedures and tools with a view to improving and streamlining management activities.

1.3. The purpose of the BCI Condition survey is to carry out an on-going regime of General and Principal Inspections in accordance with good practice, ie County Surveyor's Society Inspection procedures and the Code of Practice for Management of Highway Structures – September 2005 and due consideration should also be given to the Inspection Manual for Highway Structures, June 2007.

1.4. This project is the fifth year of the Condition Survey of the BPRN structures.

1.5. The party undertaking the inspections (be they a Borough or a Consultant) are referred to in this contract as the Contractor.

1.6. The Employer's Representative, Capita Symonds will undertake the project management of the condition survey contract.

2. Scope of the Works

2.1. The Condition Survey project comprises carrying out General and Principal Inspections of the highway structures on the Borough Principal Road Network (BPRN) listed in Appendix 1 and submission of draft and final reports in accordance with the specification herein.

2.2. Where information on the structures listed in Appendix 1 are available, eg inspection reports, assessment reports, Roads 277 forms and any drawings/sketches are included in the accompanying compact disc titled “Phase 5 – Available Information”.

3. Format of General and Principal Inspections

3.1. General and Principal Inspections shall be carried out in accordance with the following documents:

i) The Code of Practice for the Management of Highway Structures – September 2005, Section 6 ‘Inspection Testing and Monitoring.

Copies are available from:

Ivor Moses
Capita Symonds
Capita Symonds House
Wood Street
East Grinstead
West Sussex
RH19 1UU

Tel: 01342 327161
Fax: 01342 315927

E-mail address: ivor.moses@capita.co.uk

ii) Bridge Condition Indicators, Volume 2, Guidance Note on Bridge Inspection Reporting and August 2004 addendum to this document.

Copies are available from:

Richard Wills
CSS Honorary Secretary and Treasurer
Lincolnshire County Council
City Hall
Lincoln
LN1 1DN

Tel: 01522 553098
Fax: 01522 512335

E-mail address: css@linconshire.gov.uk

iii) Inspection Manual for Highway Structures, Volumes 1 & 2.

Copies are available from:

TSO Bookshop
E-mail address: http://www.tsoshop.co.uk/bookstore.asp

4. Undertaking Inspections

Public Safety

4.1. If the inspections identifies defects that are considered to have a safety implication and requires urgent attention, the Contractor shall report it to the Employer and Employers Representative immediately.

Access

4.2. The Contractor shall be responsible for liaising with relevant parties to arrange access and traffic management to carry out the inspection work.

4.3. The Contractor shall be responsible for procurement of all access plant and equipment necessary to complete the inspection.

Health and Safety

4.4. Works shall be carried out in compliance with all Statutory Requirements, Approved Codes of Practices and Guidance Notes relevant to Health and Safety at Work with regard to welfare of the operatives as well as the general safety of members of the public and properties.

4.5. The Contractor shall complete the Health and Safety forms and undertake a Risk Assessment using the template contained in Appendix II.

Element Condition Information

4.6. Element condition information shall be recorded during the inspection and reported as set out in Section 5.

4.7. If the inspector considers the elements on a structure to be different to those identified by the previous CSS style inspection, then the inspector shall record these differences on the new inspection pro forma for the particular structure.

5. General and Principal Inspection Reports

Front Cover

5.1. The front cover of all of the reports shall have the LoBEG logo in the top centre of the front page with the structure number, structure name, inspection type and the date located directly beneath as set out in Appendix II. The Contractor may place their logo in the bottom right hand corner of the front page of the report should they so wish.

Disclaimers

5.2. No disclaimers are to be placed on any part of the report without the prior permission of the Employer.

Access Arrangements

5.3. Where other than normal, access arrangements and traffic management are required to carry out the inspections. Information on these shall be included in section 1.3 of the General Inspection Report, and section 1.1 of the Principal Inspection Report for future reference.

Remedial Works

5.4. Advice on the remedial works required, together with cost estimates under the “Works Required” section of CSS Inspection Pro Forma shall be stated. For each defect where remedial work is recommended, a photograph or photographs shall be included in the report with cross reference to the particular defect in the pro forma.

Recommendations for Special Inspections

5.5. If a significant defect is found but the cause, extent and the nature of the remedial works is uncertain, the report shall make recommendations for future Special Inspection to be undertaken describing briefly the objectives and budget estimate for carrying out the special inspection.

5.6. If material testing and/or investigation is considered to be necessary the inspection report must make that recommendation as a further Special Inspection required, stating the type of investigation required, why testing is needed, what type or types of material testing

required, whereabouts on the structure does it apply, what would be the estimated costs and when it could be carried out. Proposals for such testing and/or investigation where deemed necessary shall be submitted to the Employers Representative for him/her to consult the Employer. As the proposal will be additional work, the Employer may instruct the work to be carried out and such additional work shall not be carried out without the prior instruction.

Headroom Restrictions

5.7. For structures with restricted headroom, comment on the following shall be included:

a) Evidence of any possible change in surfacing having occurred which has not been previously recorded/measured.

b) Evidence of any impact on the bridge. (In this regard it is important the highway authority is formally notified of any strikes on their bridges).

Routine Maintenance

5.8. The routine maintenance requirements for the structure and the intervals shall be provided listing them on the routine maintenance schedule Pro Forma given in Appendix III. A routine maintenance schedule is to be prepared where none exists and a pre-existing routine maintenance schedule is to be reviewed and updated as necessary.

Roads 277 Form

5.9. Existing Roads 277 forms shall be updated where Roads 277 forms do exist and new forms produced where no such forms exist. All forms shall accord with the Highways Agency Roads 277 Form, Rev 4/94 and include:

- The construction details of the structure, as far as is possible.
- Details of any signed width, headroom or weight restrictions.
- An up-to-date colour photograph of the structure that is titled.
- Clear sketches showing the plan, elevation and typical section indicating essential dimensions, photographs and OS maps in this section are not acceptable, all annotations are to be legible.
- Ordnance Survey plan showing the structures location clearly marked, titled and shown at a scale of 1:12500.

Format of General Inspection Report

5.10. The General Inspection report shall follow the sample General Inspection Report format given in Appendix II.

Format of Principal Inspection Report

5.11. The Principal Inspection report shall follow the sample Principal Inspection Report format given in Appendix II

Submission of Inspection Reports

5.12. Submission of reports to the Employers Representative shall be as follows:

- Initially, all reports shall be submitted as draft status in the following media/format:

  Microsoft Word - All Sections except as noted below.

Microsoft Excel	-	CSS Inspection Form H&S Risk Assessment Form Routine Maintenance Requirement Form Roads277 Form

Draft Reports shall be submitted via email. Reports shall be compressed into a 'zip' file, with one zip folder per report and labelled with the full LoBEG structure reference number.

- *Format of the structure code*

- Reports shall only be submitted as final status when draft reports have been accepted as complete. The final reports shall be submitted in the following media/format:

Microsoft Word	-	All Sections except as noted below.
Microsoft Excel	-	CSS Inspection Form H&S Risk Assessment Form Routine Maintenance Requirement Form Roads277 Form
Hard Copy	-	Full report – with signatures, at A4 size, 277 form at A3
PDF	-	Full report – with signatures, as per the Hard Copy

Final reports shall be submitted following the folder structure described in appendix V.

6. Programme

6.1. Prior to carrying out the inspection work, the Borough/Consultant shall submit to the Employer's Representative for his approval a programme of works in bar-chart form for the inspection. The programme should include separate activities for:

a) Inspections

b) Preparation of report

c) Submission of Draft Reports

d) Submission of Final Reports

6.2. The final reports for all the highway structures shall be submitted to the Employer by end of February 2008.

7. Invoicing

7.1. Invoices shall be submitted to the Employer once final reports are approved at the end of each month.

Appendix E: General Inspection Report Format

STRUCTURE NUMBER
BRIDGE

GENERAL INSPECTION REPORT

Date

Client

Consultant:

Structure Reference: STRUCTURE NUMBER

Document Title: General Inspection Report

Document Number:

Issue Number: 01

Date: date

Prepared By: Print

Sign .....

Authorised By: Print

Sign .....

Amendment List

Iss. / Rev.	Iss. / Rev Date	Remove		Insert	
		Page	Iss. / Rev.	Page	Iss. / Rev.

Filename: Document2

1. SUMMARY OF INSPECTION

1.1. The inspection was carried out by _____ on _____ . Weather conditions were_____ and the air temperature was_____.

1.2. Description of structure

1.3. Access arrangements

1.4. Conclusions and recommendations

NOTE TO REPORT WRITER

1.1 to 1.4 above not to exceed one page A4 total.

1.4 above to be set out as bullet points and refer to photographic evidence in section 2

2. PICTURES

NOTE TO REPORT WRITER

*Any pictures relevant to the inspection should be included here and shall be **two photos per page maximum**. Photos are to be titled.Photo 1, Photo 2 and so on.*

NOTE TO REPORT WRITER

Bridge inspection pro forma and inspection pro forma codes to be inserted here.

NOTE TO REPORT WRITER

Risk assessment pro forma to be inserted here.

NOTE TO REPORT WRITER

Roads 277 form in A3 format to be inserted here.

NOTE TO REPORT WRITER

Routine maintenance form to be inserted here.

Appendix F: Principal Inspection Report Format

STRUCTURE NUMBER
BRIDGE

PRINCIPAL INSPECTION REPORT

Date

Client

Consultant:

Structure Reference: *STRUCTURE NUMBER*

Document Title: Principal Inspection Report

Document Number:

Issue Number: 01

Date: date

Prepared By: Print

Sign .....

Authorised By: Print

Sign .....

Amendment List

Iss. / Rev.	Iss. / Rev Date	Remove		Insert	
		Page	Iss. / Rev.	Page	Iss. / Rev.

Filename: Document2

CONTENTS

1. INTRODUCTION 4

2. DESCRIPTION OF STRUCTURE 4

3. CONCLUSIONS AND RECOMMENDATIONS 4

4. DETAILED CONDITION REPORT

5. PHOTOGRAPHS

1. INTRODUCTION

1.1. The inspection was carried out by _____ on _____

1.2. Weather Conditions :

1.3. Inspections (other than routine) since last Principal Inspection

1.4. Maintenance since last Principal Inspection

2. DESCRIPTION OF STRUCTURE

3. CONCLUSIONS AND RECOMMENDATIONS

4. DETAILED CONDITION REPORT

4.1. Deck Elements

1. Primary deck element from Table 2
2. Secondary deck element/s Transverse beams
3. Element from Table 3
4. Half joints
5. Tie beam/rod
6. Parapet beam or cantilever
7. Deck bracing

4.2. Load-bearing Substructure

8. Foundations

9. Abutments (incl. arch springing)

10. Spandrel wall/head wall

11. Pier/column

12. Cross-head/capping beam

13. Bearings

14. Bearing plinth/shelf

4.3. Durability Elements

15. Superstructure drainage

16. Substructure drainage

17. Waterproofing

18. Movement/expansion joints

19. Painting: deck elements

20. Painting: substructure elements

21. Painting: parapets/safety fences

4.4. Safety Elements

22. Access/walkways/gantries

23. Handrail/parapets/safety fences

24. Carriageway surfacing

25. Footway/verge/footbridge surfacing

4.5. Other Bridge Elements

26. Invert/river bed

27. Aprons

28. Fenders/cutwaters/collision protection

29. River training works

30. Revetment/batter paving

31. Wing walls

32. Retaining walls

33. Embankments

34. Machinery

4.6. Ancilliary Elements

35. Approach rails/barriers/walls

36. Signs

37. Lighting

38. Services

5. photographs

NOTE TO REPORT WRITER

*Any pictures relevant to the inspection should be included here and shall be **two photos per page maximum**. Photos are to be titled.Photo 1, Photo 2 and so on.*

NOTE TO REPORT WRITER

Bridge inspection pro forma and Inspection pro forma codes to be inserted here.

NOTE TO REPORT WRITER

Risk assessment pro forma to be inserted here.

NOTE TO REPORT WRITER

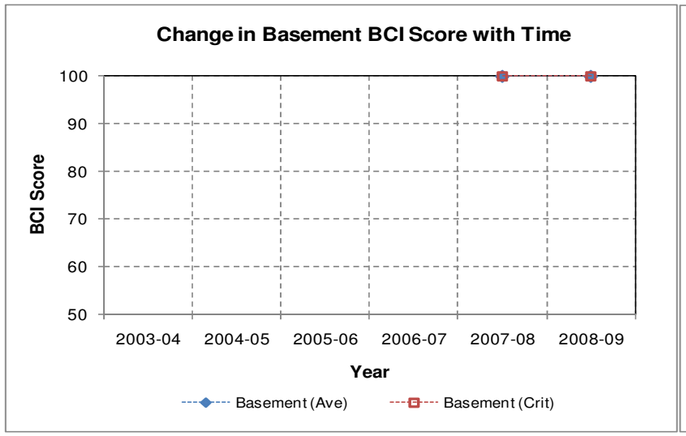
Roads 277 form in A3 format to be inserted here.

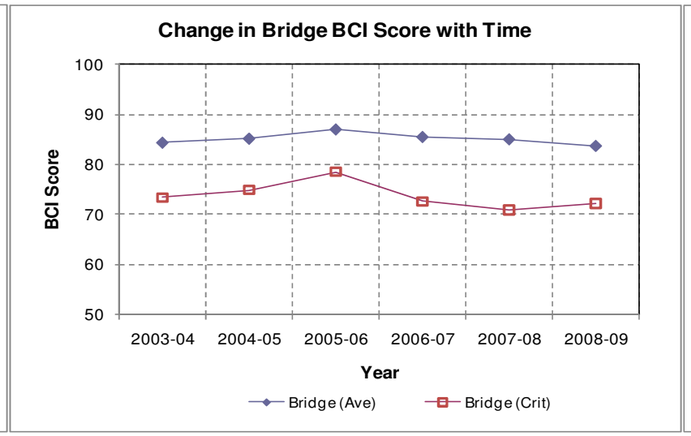
NOTE TO REPORT WRITER

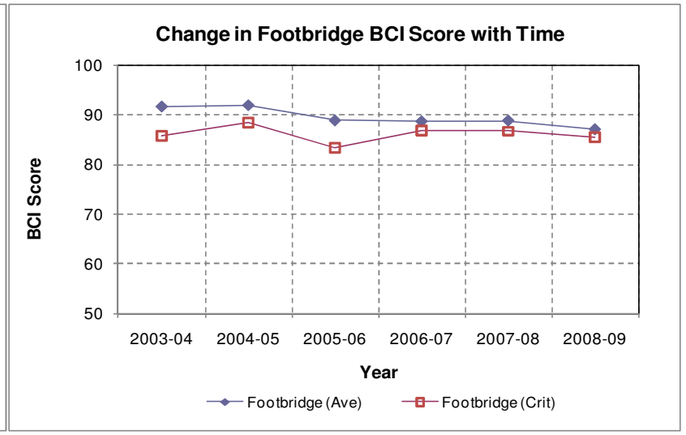
Routine maintenance form to be inserted here.

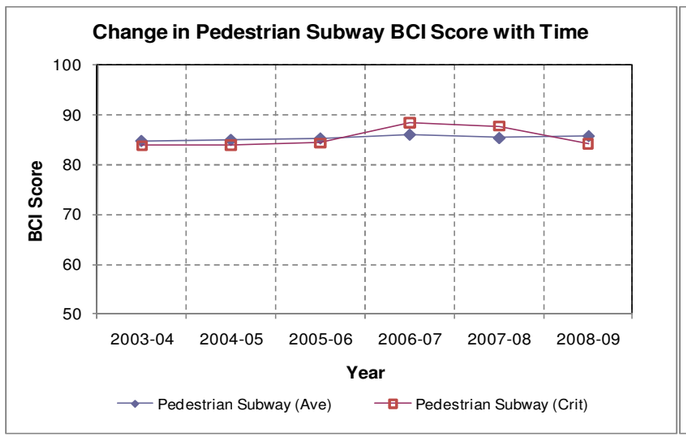
Appendix G: Condition Indicators

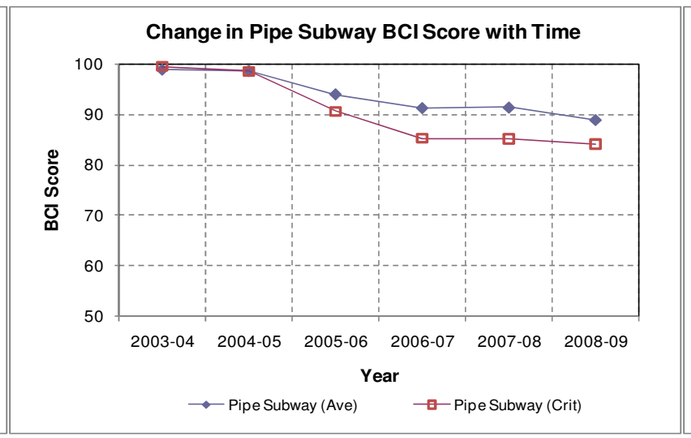
Appendix G1: Change in BCI scores per structure type

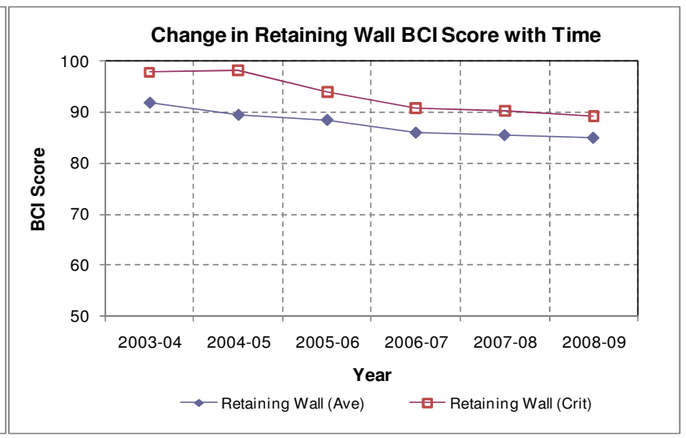


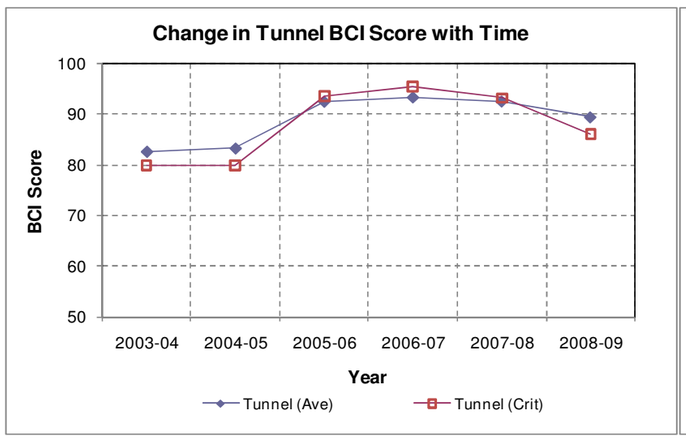


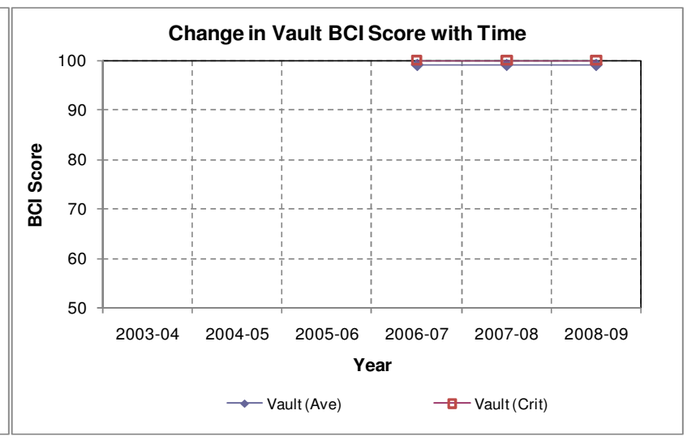








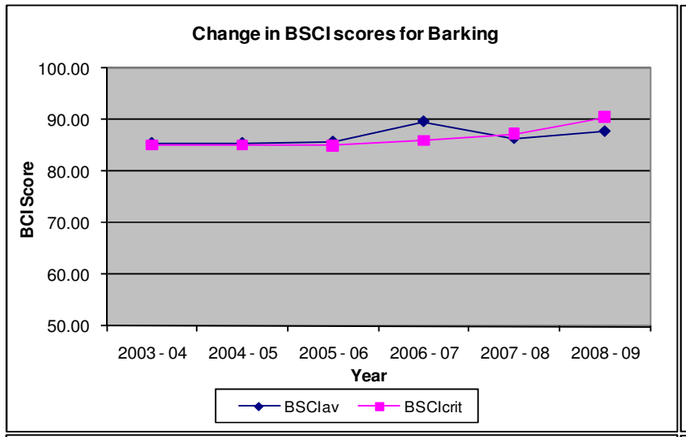


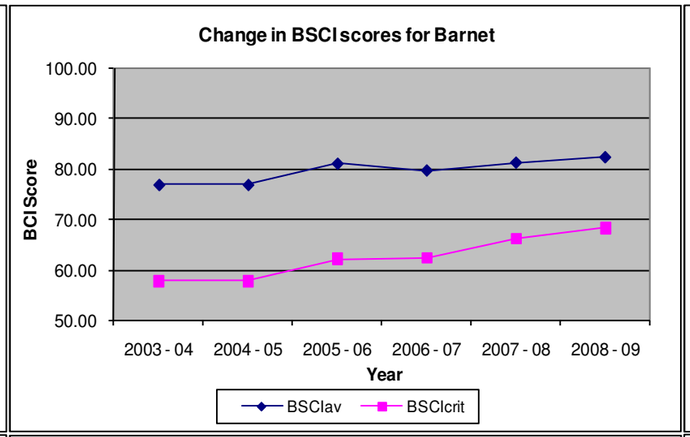


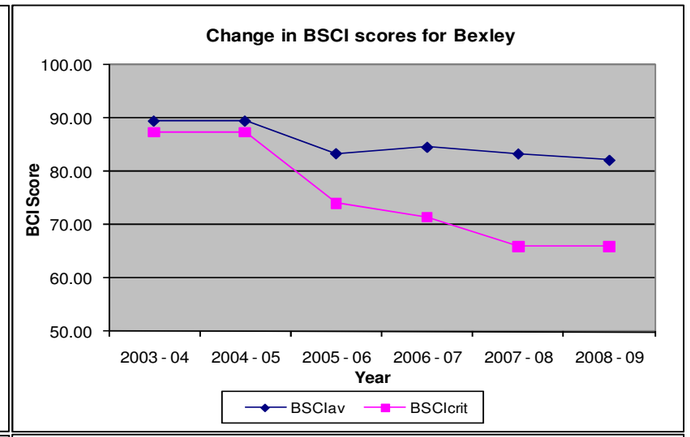
Appendix G2: BCI Values for each Borough

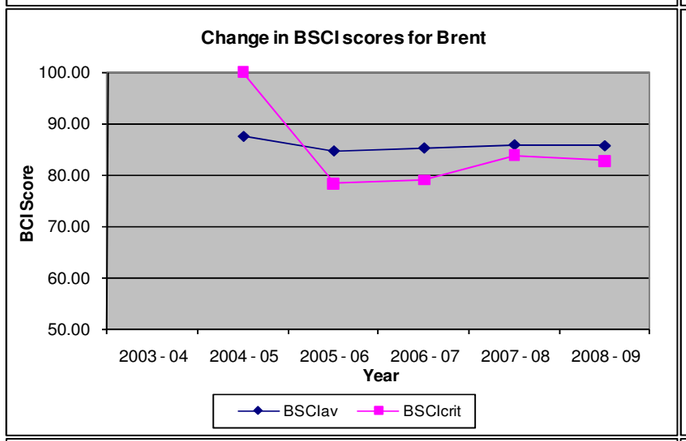
Borough	BSClav Score						BSClcrit Score					
	2003 - 04	2004 - 05	2005 - 06	2006 - 07	2007 - 08	2008 - 09	2003 - 04	2004 - 05	2005 - 06	2006 - 07	2007 - 08	2008 - 09
Barking	85.39	85.39	85.68	89.63	86.31	87.70	85.11	85.11	85.09	86.00	87.30	90.54
Barnet	76.91	76.91	81.09	79.76	81.32	82.39	57.84	57.84	62.15	62.36	66.26	68.34
Bexley	89.50	89.50	83.46	84.64	83.41	82.23	87.43	87.43	74.13	71.50	65.95	65.99
Brent		87.50	84.56	85.15	85.81	85.60		100.00	78.29	79.02	83.81	82.74
Bromley	88.06	88.18	87.69	87.99	88.02	87.87	87.53	87.34	87.77	87.63	84.68	84.64
Camden	85.57	88.45	85.53	80.70	81.03	82.99	90.96	87.91	82.50	78.08	78.89	81.49
City of London	79.75	81.09	81.09	83.53	85.42	85.42	74.14	76.41	76.41	79.53	80.16	80.16
Croydon	83.69	83.69	85.49	85.30	84.90	84.78	65.24	65.24	73.96	73.67	76.22	76.26
Ealing	71.00	71.00	70.36	87.71	88.67	88.21	100.00	100.00	79.75	90.58	92.14	89.14
Enfield	94.18	89.05	85.46	82.55	81.40	80.35	99.32	99.84	92.21	90.17	90.32	85.27
Greenwich	86.26	84.12	82.98	80.89	81.09	82.80	83.60	86.96	80.97	75.65	74.46	79.26
Hackney	91.55	91.55	90.77	92.06	90.86	90.75	91.14	91.14	87.09	85.78	84.72	84.72
Hammersmith and Fulham	77.12	78.80	78.61	78.61	78.61	78.78	60.39	59.62	64.71	64.71	64.71	69.99
Haringey	100.00	97.38	97.38	96.94	96.53	89.92	100.00	100.00	100.00	98.82	95.08	98.83
Harrow	88.25	88.25	87.28	86.95	86.48	86.37	79.15	79.15	78.91	79.49	79.41	79.36
Havering	78.48	80.81	85.21	80.79	80.32	83.28	64.41	66.18	75.50	62.51	56.36	63.87
Hillingdon	86.19	86.72	86.70	86.66	86.76	87.17	79.13	80.41	79.84	80.82	80.88	80.66
Hounslow	96.31	89.34	86.90	88.00	85.64	86.66	100.00	93.34	78.67	80.66	78.38	79.09
Islington		94.00	94.00	90.93	90.93	87.40		100.00	100.00	84.14	84.14	83.16
Kensington and Chelsea						80.00						31.00
Lambeth			96.93	96.13	96.16	95.10			99.56	98.65	98.65	99.14
Lewisham	84.29	84.29	85.09	89.20	89.20	89.20	50.71	50.71	56.88	75.36	77.41	77.41
Merton	90.34	91.98	95.24	87.97	86.66	87.43	81.48	85.54	94.45	87.61	88.23	88.72
Newham	92.19	92.21	91.85	87.01	86.53	83.33	88.70	89.94	86.94	71.68	67.84	71.79
Redbridge	75.01	75.09	81.76	85.61	87.71	87.79	65.35	66.04	65.48	74.84	79.50	79.36
Richmond	90.29	89.94	89.94	87.99	87.74	84.68	91.45	90.51	89.44	83.53	82.98	82.23
Royal Kingston		91.07	91.07	91.46	91.46	90.56		86.34	86.34	85.26	85.26	85.19
Southwark				91.00	91.00	77.50				100.00	100.00	100.00
Sutton	94.30	94.30	93.97	93.33	93.52	92.58	92.60	92.60	89.94	88.49	88.69	88.21
Tower Hamlets		80.00	80.00	80.00	80.00	81.33		79.00	79.00	89.50	89.50	93.00
Waltham Forest	88.97	88.97	83.56	82.42	81.70	80.80	81.56	81.56	73.78	73.17	71.71	69.91
Wandsworth	69.00	77.85	86.87	84.22	81.37	82.66	55.00	63.52	77.90	64.93	64.93	74.31
Westminster	100.00	93.16	93.87	93.21	93.12	86.35	100.00	91.82	85.78	85.78	73.62	71.49

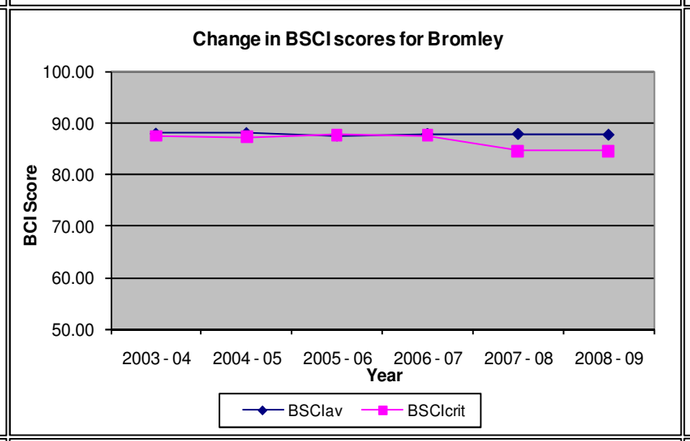
Appendix G3: Trend of BCI Scores for the Boroughs over the six year period

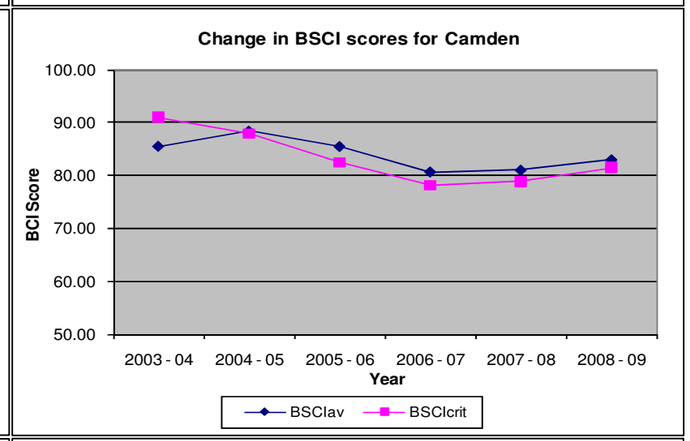


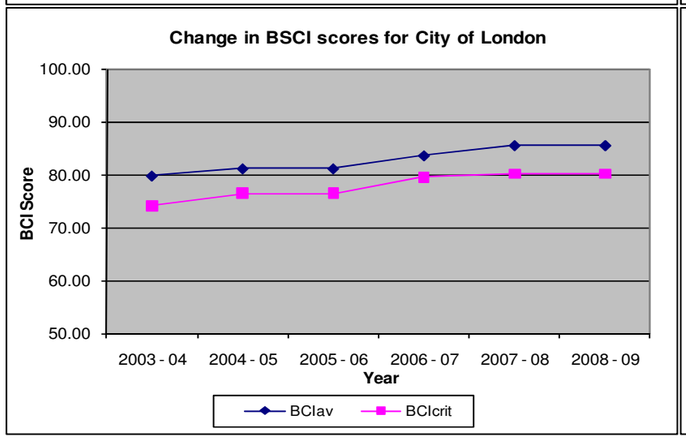


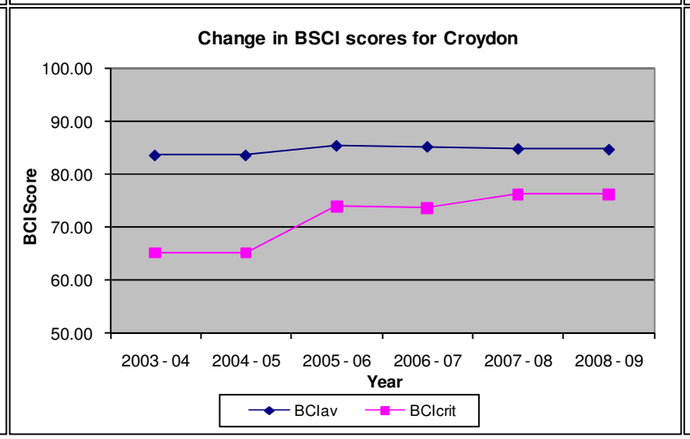


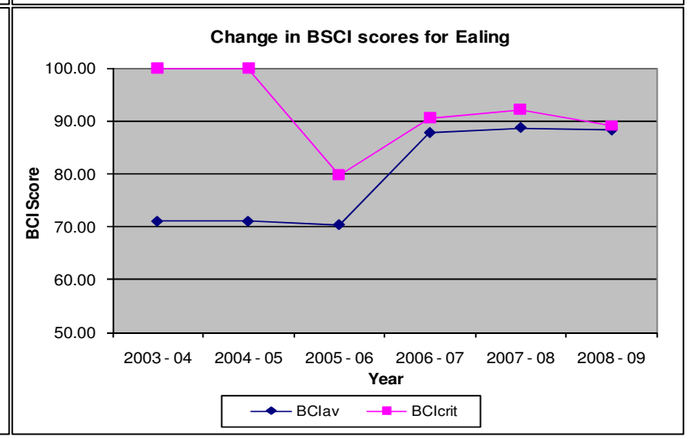


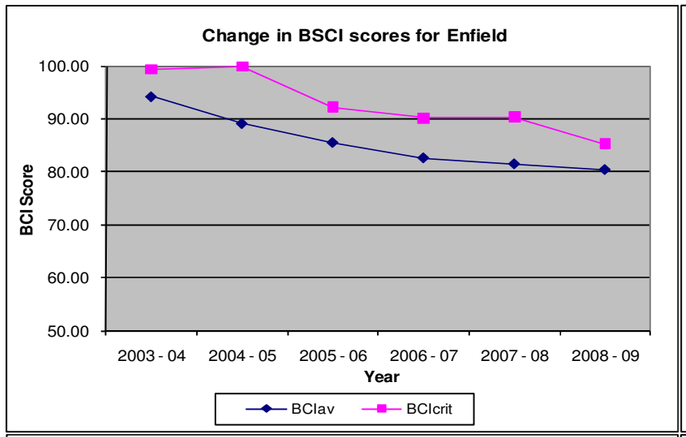








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80.00
70.00
60.00
50.00
BCI Score
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2004 - 05
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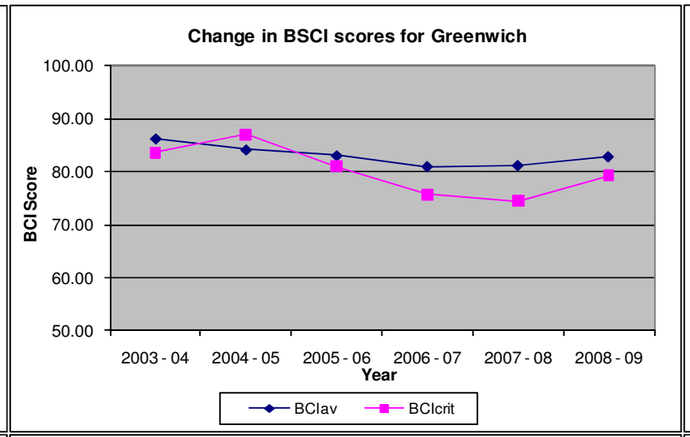
2006 - 07
2007 - 08
2008 - 09
Year
BCIav
BCIcrit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BCI Score
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2007 - 08
2008 - 09
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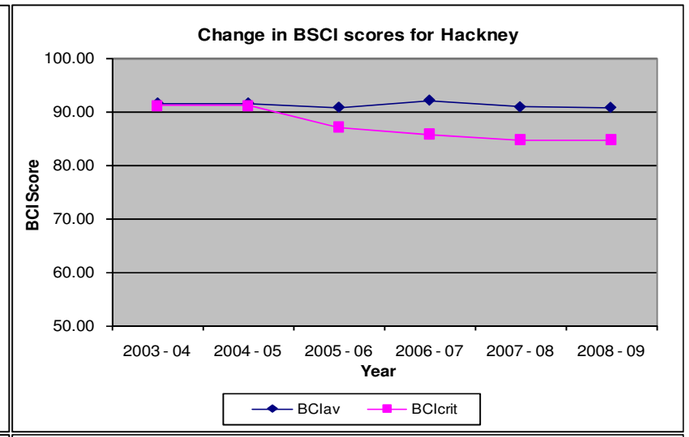
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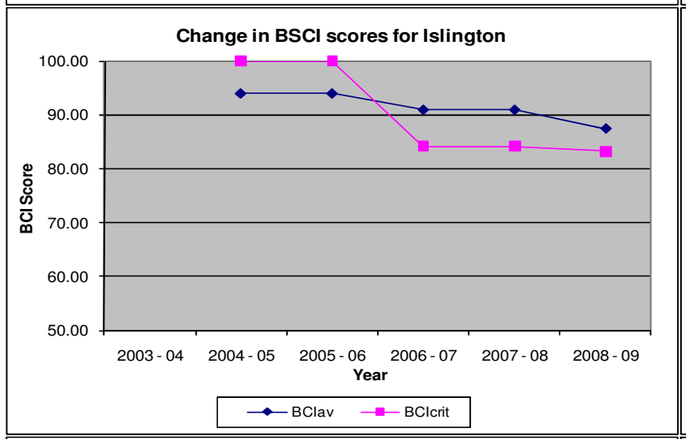
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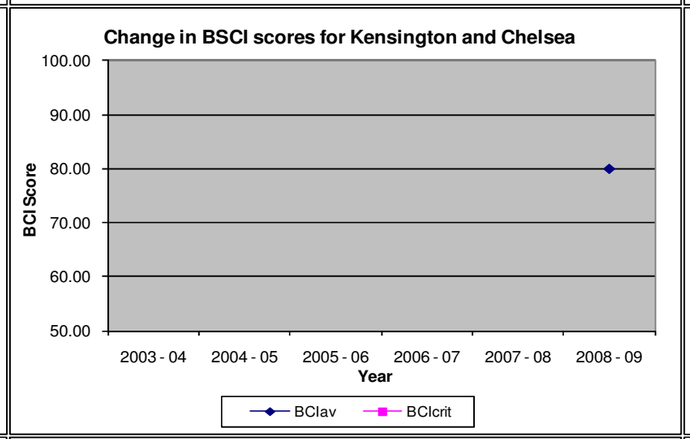
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BCI Score
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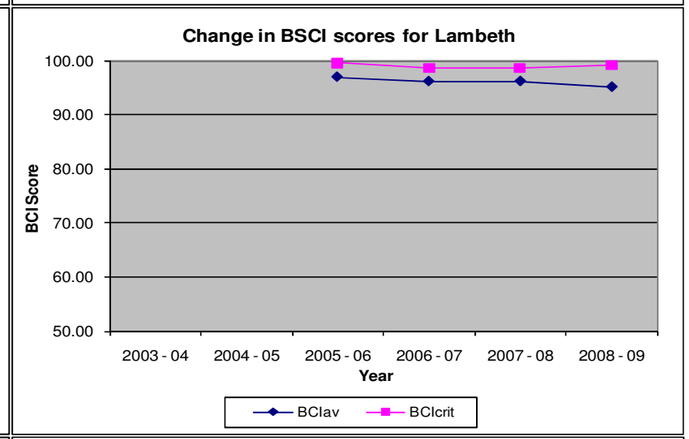
2006 - 07
2007 - 08
2008 - 09
Year
BCIav
BCIcrit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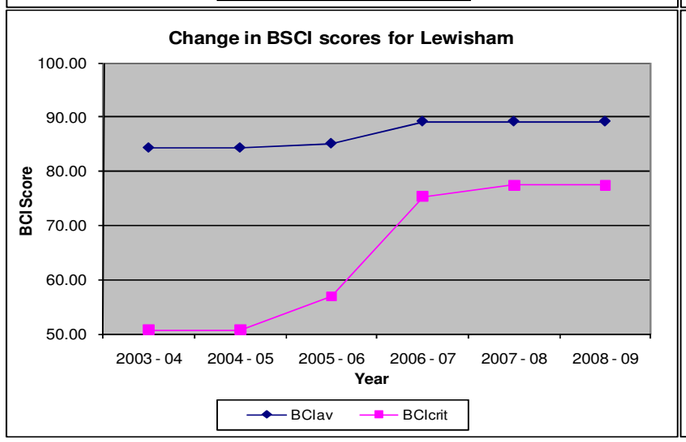
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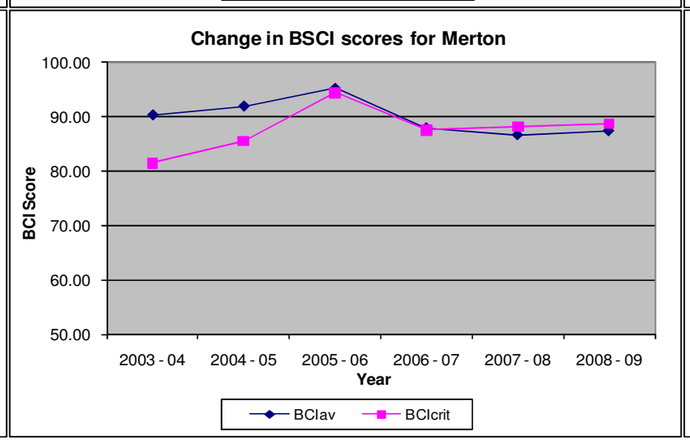
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Year
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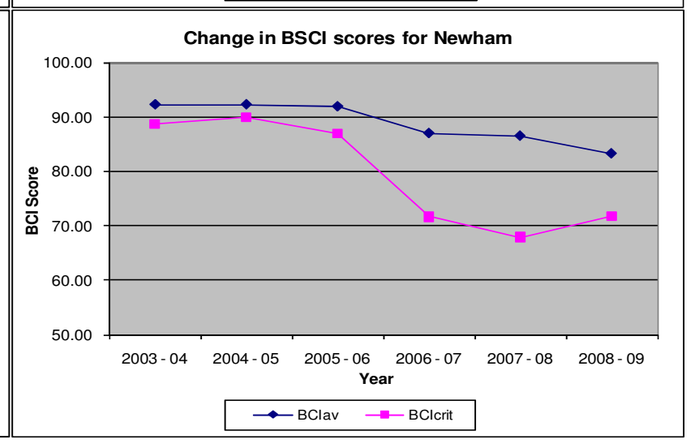
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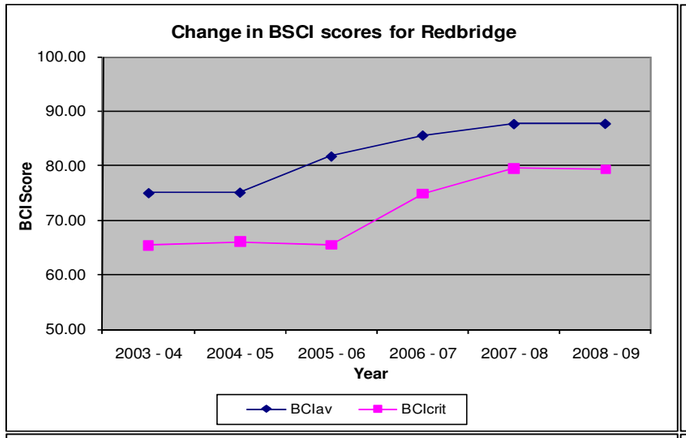
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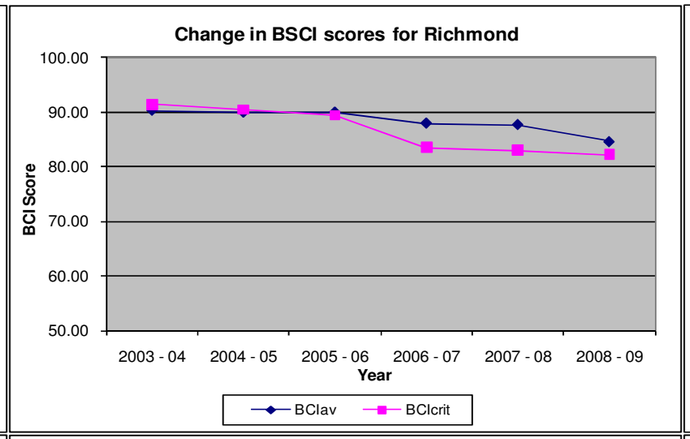
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BCI Score
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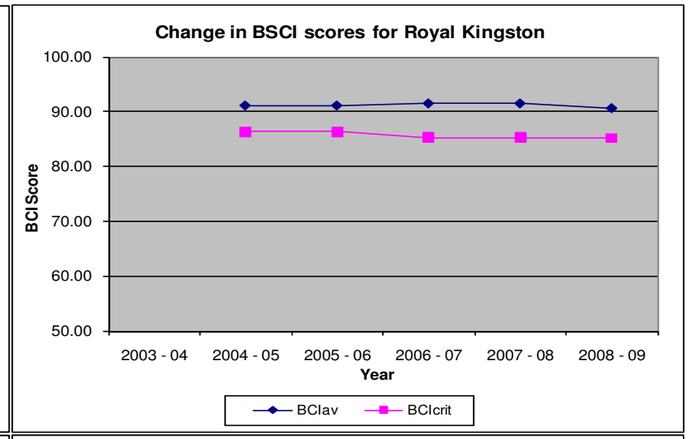
2004 - 05
2005 - 06
2006 - 07
2007 - 08
2008 - 09
Year
BCIav
BCIcrit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BCI Score
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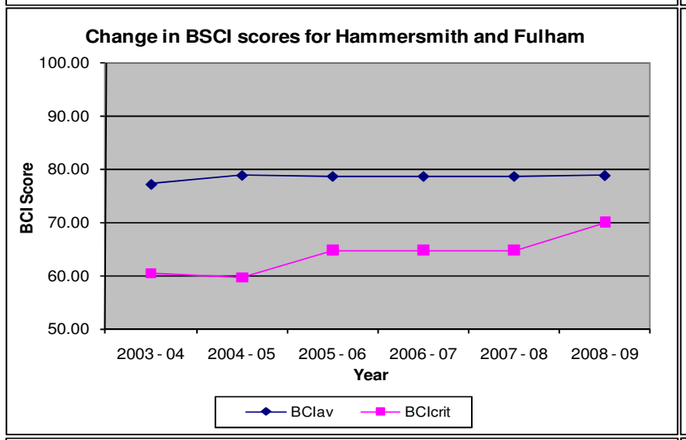
2004 - 05
2005 - 06
2006 - 07
2007 - 08
2008 - 09
Year
BCIav
BCIcrit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2007 - 08
2008 - 09
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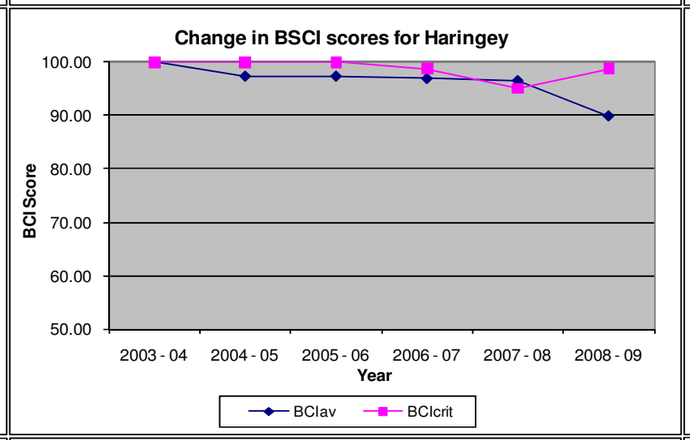
BCIcrit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2008 - 09
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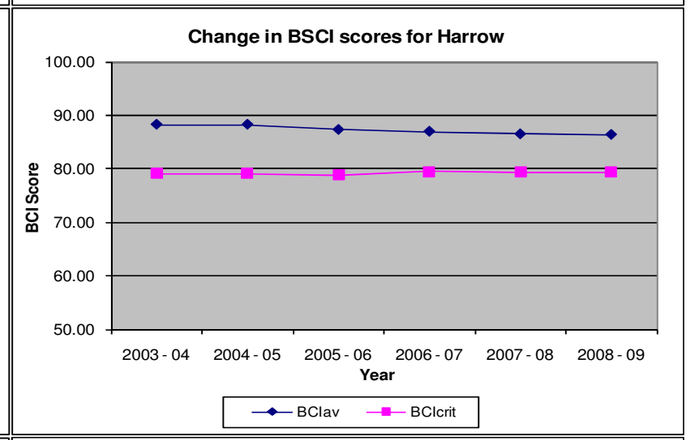
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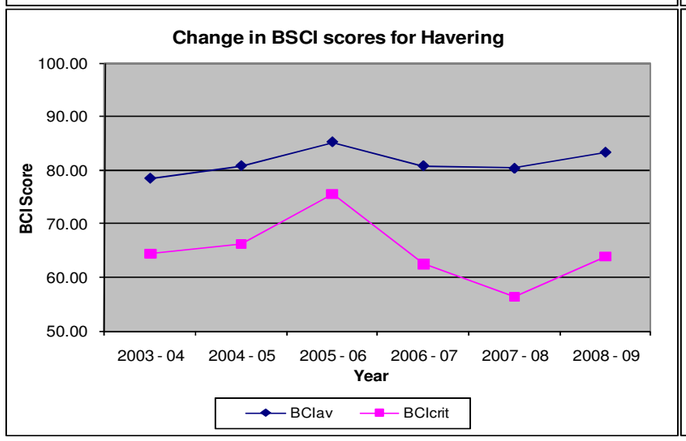
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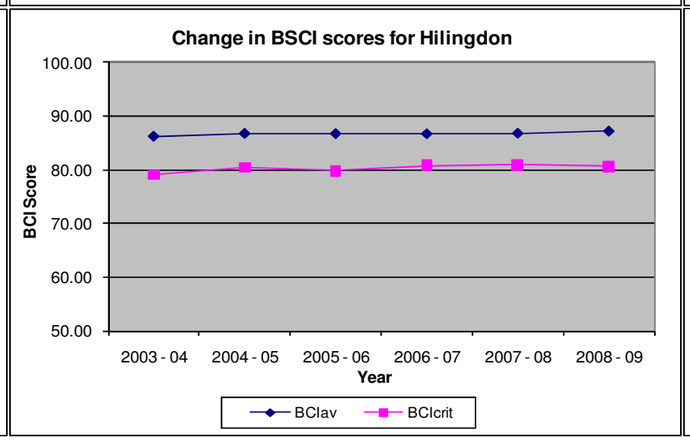
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2004 - 05
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2006 - 07
2007 - 08
2008 - 09
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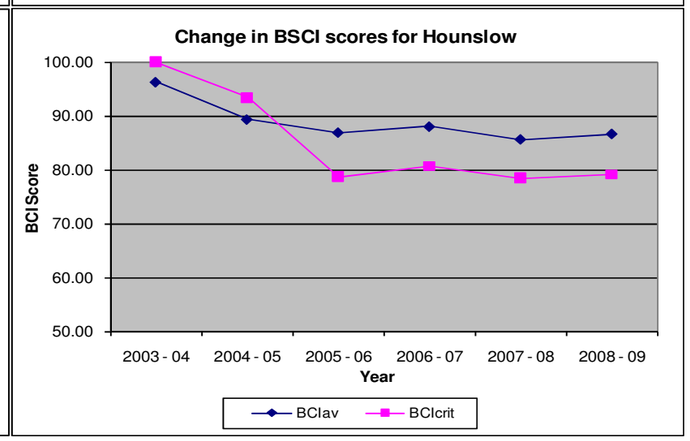
BCIcrit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2006 - 07
2007 - 08
2008 - 09
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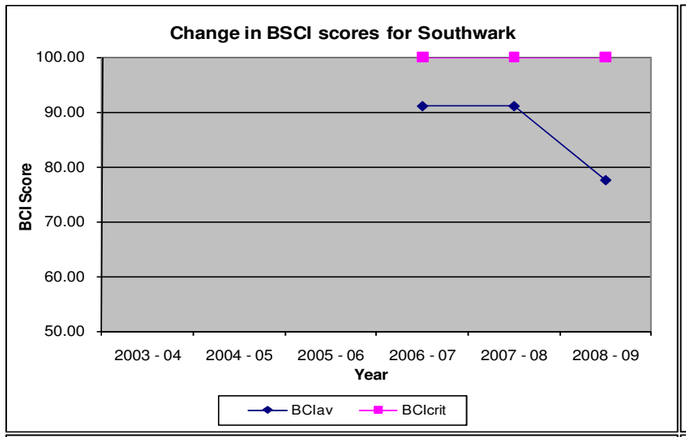
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2003 - 04
2004 - 05
2005 - 06
2006 - 07
2007 - 08
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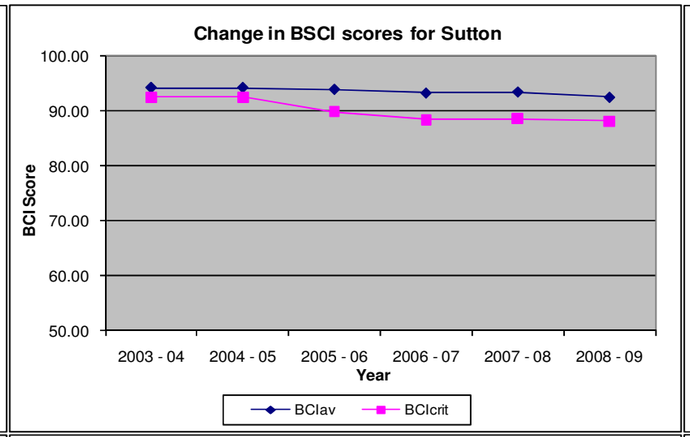
BCIcrit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2005 - 06
2006 - 07
2007 - 08
2008 - 09
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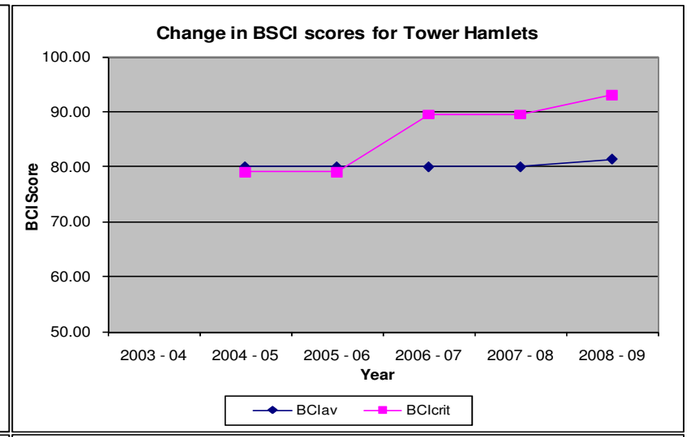
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BCI Score
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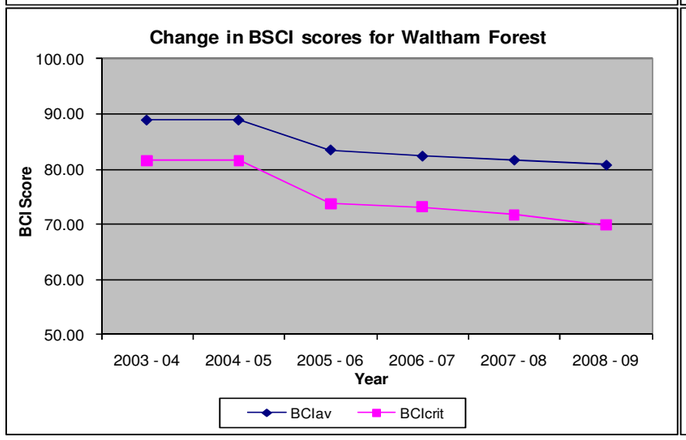
80.00
70.00
60.00
50.00
2003 - 04
2004 - 05
2005 - 06
2006 - 07
2007 - 08
2008 - 09
Year
BCIav
BCIcrit


Change in BSCI scores for Waltham Forest
BCI Score
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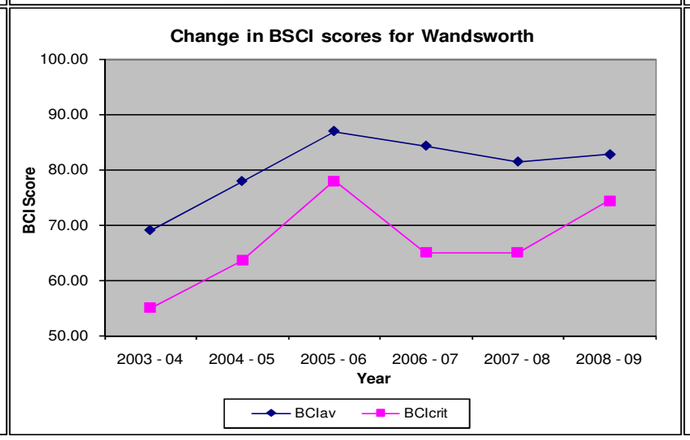
90.00
80.00
70.00
60.00
50.00
2003 - 04
2004 - 05
2005 - 06
2006 - 07
2007 - 08
2008 - 09
Year
BCIav
BCIcrit


Change in BSCI scores for Wandsworth
BCI Score
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2003 - 04
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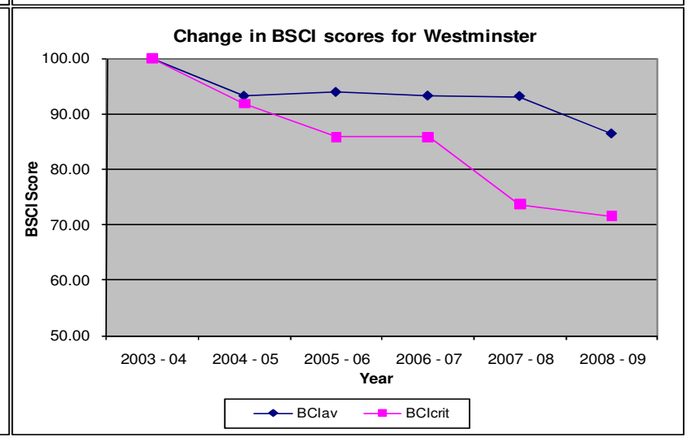
2007 - 08
2008 - 09
Year
BCIav
BCIcrit


Change in BSCI scores for Westminster
BSCI Score
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90.00
80.00
70.00
60.00
50.00
2003 - 04
2004 - 05
2005 - 06
2006 - 07
2007 - 08
2008 - 09
Year
BCIav
BCIcrit

Appendix G4: BCI Values for Boroughs per Structure Type

Borough	Structure Type	BClav						BClcrit					
		2003	2004	2005	2006	2007	2008	2003	2004	2005	2006	2007	2008
Barking	Bridge	84.79	84.79	87.18	90.88	91.03	91.67	81.10	81.10	83.72	72.17	71.98	78.49
	Footbridge			82.00	82.00	85.00	85.00			79.00	79.00	79.00	79.00
	Retaining Wall	90.71	90.71	90.71	92.36	92.36	91.84	85.52	85.52	85.52	92.76	92.76	95.17
	Tunnel	84.49	84.49	84.49	88.86	83.18	85.31	85.77	85.77	85.77	92.89	94.05	96.03
Barnet	Bridge	76.91	76.91	81.09	79.76	81.32	82.39	57.84	57.84	62.15	62.36	66.26	68.34
	Culvert	72.00	72.00	72.00	81.00	81.00	82.00	81.00	81.00	81.00	81.00	81.00	87.33
Bexley	Bridge	84.98	84.98	81.23	83.38	82.12	80.95	79.15	79.15	70.16	68.88	62.70	63.21
	Culvert			95.65	95.65	95.34	95.34			100.00	100.00	100.00	100.00
	Footbridge	95.49	95.49	86.11	83.00	83.00	83.13	85.09	85.09	67.94	71.55	71.55	71.96
	Pedestrian Subway	98.00	98.00	92.11	90.14	90.14	90.22	100.00	100.00	100.00	93.34	93.34	92.03
	Retaining Wall	95.66	95.66	95.38	94.56	93.46	92.21	99.23	99.23	97.17	91.71	90.06	87.03
Brent	Bridge		87.50	84.56	85.15	85.81	85.60		100.00	78.29	79.02	83.81	82.74
Bromley	Bridge	88.09	88.34	88.13	88.60	89.11	89.23	83.35	83.43	90.01	90.41	85.20	85.55
	Footbridge	88.00	88.00	88.15	88.36	88.36	88.36	55.00	55.00	58.49	58.64	58.64	58.64
	Pedestrian Subway	83.00	83.00	79.50	79.50	73.00	74.48	81.00	81.00	68.00	68.00	61.50	65.58
	Retaining Wall	88.04	88.04	86.83	86.81	85.99	85.31	98.71	98.71	90.32	89.19	89.59	88.80
Camden	Bridge	85.57	88.45	85.53	80.70	81.03	82.99	90.96	87.91	82.50	78.08	78.89	81.49
	Culvert			55.27	50.62	55.03	61.00			47.84	51.42	52.52	57.49
	Pedestrian Subway	73.45	73.45	74.14	74.14	71.70	71.70	80.70	80.70	81.42	81.42	81.65	81.65
	Pipe Subway			63.00	83.30	83.83	85.52			28.00	73.72	73.08	70.70
City of London	Bridge	79.75	79.75	79.75	79.75	82.14	82.14	74.14	74.14	74.14	74.14	74.94	74.94
	Footbridge		95.00	95.00	97.90	97.90	97.90		100.00	100.00	100.00	100.00	100.00
	Pedestrian Subway					80.00	80.00					100.00	100.00
	Pipe Subway	67.00	67.00	67.00	67.00	67.00	67.00	55.00	55.00	55.00	55.00	55.00	55.00
Croydon	Bridge	82.91	82.91	84.86	84.86	84.63	84.49	61.07	61.07	70.84	70.84	74.09	74.38
	Footbridge	92.00	92.00	92.00	92.00	86.80	85.91	100.00	100.00	100.00	100.00	100.00	94.56
	Pedestrian Subway	84.20	84.98	86.40	85.82	86.47	86.23	81.18	82.84	81.50	87.80	87.36	86.78
	Retaining Wall	90.17	90.17	90.67	88.87	87.05	87.16	100.00	100.00	100.00	97.21	92.01	89.98
Ealing	Basement					100.00	100.00					100.00	100.00
	Bridge	71.00	71.00	71.00	90.53	90.53	89.72	100.00	100.00	100.00	95.31	95.31	91.43
	Footbridge			63.00	63.00	71.50	71.50			55.00	55.00	55.00	55.00
	Pedestrian Subway			78.16	82.99	82.99	87.16			79.00	87.56	87.56	85.22
	Retaining Wall			71.00	67.60	75.51	75.34			55.00	56.02	70.86	70.86
Enfield	Bridge	98.18	98.18	84.91	84.94	81.89	79.57	95.67	95.67	86.48	87.13	86.47	76.87
	Culvert	90.11	90.68	92.18	92.08	91.16	90.63	98.40	98.54	92.33	88.37	83.78	83.46
	Footbridge			79.85	82.27	82.22	79.21			81.00	86.34	86.34	86.34
	Pedestrian Subway			85.96	85.96	82.18	82.18			100.00	100.00	100.00	100.00
	Retaining Wall	93.44	88.71	86.27	81.20	81.01	81.17	100.00	100.00	96.99	92.23	93.22	93.04
Greenwich	Bridge		90.00	81.42	74.24	74.30	80.02		81.00	57.95	51.90	51.90	68.61
	Culvert		98.44	98.44	95.98	95.98	94.57		100.00	100.00	96.65	96.65	97.77
	Footbridge	86.50	86.07	87.32	87.23	87.72	85.14	78.77	78.78	77.95	86.65	84.82	80.27
	Retaining Wall	89.44	81.33	81.64	82.30	82.39	82.01	99.46	99.70	98.12	94.70	91.58	89.43
	Tunnel	83.24	84.84	83.20	88.32	88.78	88.27	73.37	76.70	75.60	89.17	88.92	85.74
Hackney	Bridge	90.46	90.46	90.53	92.07	90.99	90.87	89.37	89.37	86.41	85.07	84.33	84.33
	Footbridge	97.00	97.00	92.00	92.00	90.00	90.00	100.00	100.00	90.50	90.50	87.33	87.33
Hammersmith and Fulham	Bridge			78.00	78.00	78.00	78.00			81.00	81.00	81.00	81.00
	Tunnel	77.12	78.80	78.80	78.80	78.80	79.02	60.39	59.62	59.62	59.62	59.62	66.54
Haringey	Bridge		88.00	88.00	91.35	92.92	88.69		100.00	100.00	96.68	89.95	98.69
	Footbridge	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
Harrow	Bridge	88.13	88.13	87.13	86.96	86.48	86.48	78.77	78.77	78.51	79.23	79.15	79.15
	Culvert	96.29	96.29	93.09	93.09	91.98	91.98	90.85	90.85	86.44	86.44	82.01	82.01
	Footbridge	93.00	93.00	93.00	87.00	87.00	87.00	79.00	79.00	79.00	80.00	80.00	80.00
	Pedestrian Subway	97.00	97.00	97.00	96.00	96.00	94.33	81.00	81.00	81.00	90.50	90.50	93.67
	Retaining Wall	90.00	90.00	90.00	86.33	86.33	79.75	100.00	100.00	100.00	93.00	93.00	90.00
Havering	Bridge	78.67	81.00	85.48	80.94	80.35	83.34	64.08	65.94	75.60	62.42	56.07	63.68
	Culvert	74.92	74.92	74.85	78.58	80.98	81.83	64.14	64.14	65.15	77.20	82.12	73.44
	Footbridge	69.00	69.00	69.00	69.00	78.33	78.33	81.00	81.00	69.50	69.50	79.67	79.67
	Pedestrian Subway		83.00	79.24	83.32	84.58	86.69		79.00	84.06	87.77	87.53	86.63
Hillingdon	Bridge	87.46	87.91	88.30	88.25	88.17	88.17	76.50	78.42	78.52	79.81	79.84	79.84
	Footbridge			66.00	66.00	66.00	66.00			55.00	55.00	55.00	55.00
	Retaining Wall	84.00	84.00	84.00	84.00	86.00	86.00	79.00	79.00	79.00	79.00	80.00	80.00
	Tunnel	82.14	82.81	82.81	82.81	82.81	85.44	89.41	89.41	89.41	89.41	89.41	88.00
Hounslow	Bridge	100.00	82.77	87.61	89.37	87.44	89.15	100.00	85.61	90.23	92.03	90.26	91.45
	Retaining Wall	95.00	95.00	86.00	86.00	83.00	83.00	100.00	100.00	64.00	64.00	61.00	61.00
Islington	Bridge		94.00	94.00	90.93	90.93	87.40		100.00	100.00	84.14	84.14	83.16
Kensington and Chelsea	Bridge						80.00						31.00
Lambeth	Pedestrian Subway			94.11	94.11	92.87	92.87			91.02	91.02	85.59	85.59
	Tunnel			96.93	96.13	96.16	95.10			99.56	98.65	98.65	99.14
Lewisham	Bridge	84.29	84.29	85.09	89.20	89.20	89.20	50.71	50.71	56.88	75.36	77.41	77.41
Merton	Bridge	88.80	91.07	95.10	88.00	86.56	87.53	77.75	83.37	94.18	87.90	87.73	88.58
	Culvert				100.00	100.00	100.00				100.00	100.00	100.00

Borough	Structure Type	BClav						BClcrit					
		2003	2004	2005	2006	2007	2008	2003	2004	2005	2006	2007	2008
	Retaining Wall	98.00	98.00	98.00	87.00	87.00	82.50	100.00	100.00	100.00	77.50	77.50	67.00
	Tunnel					88.00	88.00					100.00	100.00
Newham	Bridge	92.59	92.64	91.94	86.83	86.41	83.09	87.59	87.75	85.97	70.33	66.48	70.62
	Culvert			72.00	72.00	75.00	75.00			58.00	58.00	56.50	56.50
	Footbridge	90.65	90.65	92.30	92.30	92.14	92.14	94.02	94.02	97.01	97.01	98.01	98.01
	Pedestrian Subway	94.00	94.00	94.00	92.50	92.50	87.33	100.00	100.00	100.00	100.00	100.00	93.67
	Retaining Wall	87.86	90.44	89.35	89.11	88.77	86.98	100.00	100.00	97.74	97.74	96.99	96.99
	Tunnel			92.00	92.00	88.00	88.00			100.00	100.00	90.50	90.50
Redbridge	Bridge	74.75	74.75	81.69	82.45	85.43	86.29	64.65	64.65	64.07	66.35	72.90	73.98
	Culvert	87.46	87.46	86.01	90.77	90.67	91.51	85.47	85.47	85.47	89.90	89.90	91.01
	Retaining Wall	88.00	83.49	83.49	78.13	77.72	79.88	100.00	100.00	100.00	78.76	75.66	68.03
	Tunnel				96.11	96.11	94.47				100.00	100.00	100.00
Richmond	Bridge	90.29	89.94	89.94	87.99	87.74	84.68	91.45	90.51	89.44	83.53	82.98	82.23
	Pedestrian Subway	79.00	79.00	86.95	86.95	88.19	88.19	65.10	65.10	78.86	78.86	80.08	80.08
Royal Kingston	Bridge		90.87	90.87	91.38	91.38	91.40		81.50	81.50	81.03	81.03	81.11
	Culvert		97.45	97.45	91.18	91.18	89.57		85.27	85.27	75.19	75.19	83.46
	Footbridge		94.00	94.00	94.00	94.00	87.50		100.00	100.00	100.00	100.00	100.00
	Pedestrian Subway		86.11	86.11	87.89	87.89	88.17		81.86	81.86	81.86	81.86	81.86
	Retaining Wall		89.88	89.88	90.11	90.11	89.19		94.51	94.51	92.64	92.64	91.91
Southwark	Retaining Wall				91.00	91.00	77.50				100.00	100.00	100.00
Sutton	Bridge	96.82	96.82	95.59	95.59	95.87	95.87	100.00	100.00	93.85	93.85	94.14	94.14
	Culvert		98.57	92.55	88.63	91.98	91.88		100.00	66.97	59.38	75.89	77.00
	Footbridge	94.00	94.00	94.00	94.00	94.00	94.00	58.00	58.00	58.00	58.00	58.00	58.00
	Retaining Wall	88.32	88.32	88.32	84.97	84.97	80.08	100.00	100.00	100.00	92.45	92.45	89.94
Tower Hamlets	Bridge		80.00	80.00	80.00	80.00	81.33		79.00	79.00	89.50	89.50	93.00
	Pedestrian Subway				88.95	88.95	86.24				100.00	100.00	95.03
Waltham Forest	Bridge	88.97	88.97	83.56	82.42	81.70	80.80	81.56	81.56	73.78	73.17	71.71	69.91
	Culvert	90.00	90.00	90.00	90.00	93.00	93.00	100.00	100.00	100.00	100.00	100.00	100.00
Wandsworth	Bridge	69.00	77.85	86.87	84.22	81.28	83.00	55.00	63.52	77.90	65.15	65.15	74.88
	Tunnel				84.00	84.00	72.00				58.00	58.00	56.50
Westminster	Bridge	100.00	100.00	95.83	93.70	93.70	96.42	100.00	100.00	84.13	84.13	84.13	90.98
	Pedestrian Subway	100.00	100.00	91.81	91.81	91.61	91.23	100.00	100.00	87.03	87.03	85.37	71.32
	Pipe Subway	99.19	98.89	95.60	93.13	93.13	89.60	100.00	98.96	93.68	87.89	87.89	86.54
	Retaining Wall	100.00	90.06	92.99	92.99	92.03	91.96	100.00	88.11	86.53	86.53	86.53	86.13
	Tunnel					94.00	84.92					55.00	68.31
	Vault				99.00	99.00	99.00				100.00	100.00	100.00

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