List of key amendments included in Version MA 3.1 (19/07/2019)

1) Fixed bug resulting in occasional difficulties signing Form BA0(1) and BA0(2).

List of key amendments included in Version MA 3.0 (12/04/2019)

1) Updated Tool to run in Microsoft Excel 2016.

2) Updated Tool to run in Windows 10 while also remaining compatible with Windows 7.

3) Comments may now be included on the results sheets. Comments are compiled onto a new results comments sheet.

4) Comment, warning and error registers no longer limit entries to 5 lines of text.

5) The CRE must now select whether the Tracking Tables have been populated and checked, before Form BA0(1) can be signed.

6) Amendments to Guidance Notes and Justification Reports to capture updates.

List of key amendments included in Version MA 2.3 (22/09/2017)

1) Assessment Scenario and Permissible Road Speed information (where applicable) is now exported to CSAMS XML file for populating the CSAMS database.

2) Added error checking to the CSAMS XML exporting procedure, to ensure all required fields have been correctly populated by the user.

List of key amendments included in Version MA 2.2 (23/05/2017)

1) Input added to qualitative assessment pages to allow the identification of the leading minor element with the most significant defects causing the qualitative assessment result. These entries are required for populating the CSAMS database.

List of key amendments included in Version MA 2.1 (30/03/2016)

1) New functionality has been added to produce an XML, which can be uploaded to the CSAMS database.

2) When assessing underline bridge types details for up to four tracks can now be recorded. Track 1 will be used during all assessment calculations, Track 2, Track 3 and Track 4 are for information purposes only.

3) Recording of track IDs is now possible through new input fields (up to four tracks can be entered).

4) If the form code on the Form AA0 does not fully describe the deck it is mandatory to provide the correct form code for the deck. A limited number of fields on the FormAA0 will be open after import to allow the assessor to input the required information for this new question. Once the information for the new fields is entered, the FormAA0 will lock all remaining cells.

5) Additional fields to allow for correct BCMI references to be entered if an element is not correctly defined in sheets "Deck" and "Subdeck".

6) It is now possible to record a Defect ID where applicable.

7) Information sources have been split into a Date and By field. On import the information from older assessments will be placed in the "By" field, the assessor should manually split the information into the newly created "Date" and "By" fields.

8) New input has been added to the general sheet to record the loading requirement for footbridges; this does not affect the calculations or results.

9) Added popup window to display import/calculation progress.

List of key amendments included in Version MA 2.0 (14/08/2015)

1) Transfer from Excel 2003 to Excel 2010.

2) A new Assessment Menu has been added to fit with Excel 2010.

3) The Form AA0 and Form BA0 no longer contain an approved list of CREs. It is the responsibility of the Assessor to ensure each form is signed by a competent and approved person taking note that once signed the Form AA0 cannot be amended. Forms are signed using "Sign Forms" from the Assessment menu. The signatures will now be checked and approved by Network Rail Structures Managers.

4) Name and Title are now mandatory inputs on the Form AA0 and Form BA0 to facilitate approval by Network Rail Structure Managers.

5) During Data Transfer results from the original file are compared to the updated file with any changes being flagged within the Tool on an additional tab which will become visible if changes have occurred. If no changes occur the Form BA0 signatures will be carried forward.

6) A log file will be produced during Bulk Data Transfer which will show for each file if they contained Errors, Changes to the Results or Transferred without Change. This file will be saved in the output folder.

7) During signing of the Form BA0 forms, the inputs will be automatically checked to ensure no changes have been made since the calculation was run. If changes have been made, the calculation must be re-run before signing the forms.

8) Improvements to the efficiency of the Tool have been made throughout.

List of key amendments included in Version MA 1.6 (13/04/2015)

A number of minor bugs (identified by the Help Desk Queries) have been resolved.

List of key amendments included in Version MA 1.5 (24/01/2014)

The key update within this version of the Tool is within the 'engine' used to determine the assessed capacity for masonry arches.

The Tool output is generated from the results of a parametric study, within which thousands of ARCHIE-M assessments have been undertaken for a representative range of single span arches. To maximise the scope of the Tool for Network Rail's arch stock, adjustment factors have been developed to apply to the single span results to account for multi span and pier slenderness effects.

Within this version of the Tool, a verification exercise has been undertaken to confirm the trends with the multi-span factors and their magnitude.

Further work has also been undertaken to refine the method of applying the adjustment factors (within the Tool 'engine'), and subsequently for a number of multi span arches, this may remove a level of conservatism from the previous assessed capacities determined.

The following changes have also been made as part of this update:

Sheet Name	Amendment	Description
Assmt Parameters	Pier height	Further guidance provided for use in the absence of record information.
Arch Assmt	Geometrical parameters	Additional warning advise provided for short span viaducts (e.g. less than 6m span).
Reference tables	Assessed capacities updated	Guidance provided for typical assessed capacities for example arches has been updated to reflect the current Tool.

List of key amendments included in Version MA 1.4 (26/07/2013)

Sheet Name	Amendment	Description
Form AA0	Question 8	Tool is not appropriate for arch profiles with a span to rise less than 2 or greater than 8 for railway <u>and</u> highway / footway loading.
Assmt Parameters	Brick counting exercises	Brick on end dimensions revised.
Assmt Parameters	Barrel thickness	Further guidance provided.
Assmt Parameters	Fill depth at crown	Lower bound fill depths revised to 0.360m for underbridges and 0.200m for overbridges / footbridges. Further guidance provided.
Bridge Condition	Additional definitions added for a range of defect severities	Additional drop down options available to differentiate between: • Severity B – the effect of water and spalled masonry • Severity F – bulging and displaced or missing bricks / blocks • Severity I / P – transverse cracks with or without a stepped displacement of the barrel
Bridge Condition		The BCMI data populated by the Assessor will generate a statement, stating the effect of the condition recorded on the arch barrel assessment, and how the Tool will provide an assessed capacity based on the current condition.
Bridge Condition	BCMI matrices	The effect of condition revised following a review with Network Rail. Further clarity provided on type of transverse cracks observed.
Effect of Condition	Guidance added	Clarification provided as to how the Tool considers the effect of condition.
Further Guidance on Arch Defects	Guidance added	Further guidance provided on the type and significance of arch defects.

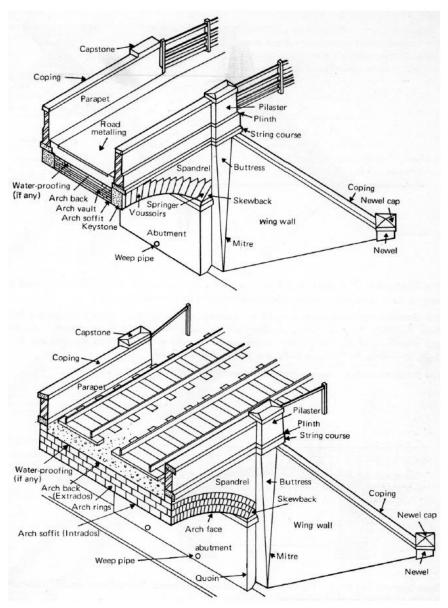| Sheet Name	Amendment	Description
Condition Qual	Question 1.0	Transverse crack question modified to align with revised matrices.
Condition Qual	Question 2.0	Question modified to align with revised matrices.
Condition Qual	Question 6.0	Question modified to align with revised matrices.
Condition Qual	Generated statements revised	
Arch Assmt	Provision of a current condition result	A current condition result is provided for all arches that are within the parametric range considered by the Tool. Where potentially significant defects are identified and not considered within the assessment result, warnings are provided stating the defects that have not been considered.
Arch Assmt	Image files	Further guidance provided on the insertion of the relevant image file.
Interim Guidance Note	Appended document removed	Interim guidance (dated May 2013) incorporated within the revised Guidance Notes (Version MA 1.4).

List of key amendments included in Version MA 1.3 (11/06/2013)

Sheet Name	Amendment	Description
Glossary of terms	"Header" added	Definition of "header" added.
General	Skew angle	Further guidance on skew angle provided within the Guidance Notes.
Condition_Qual	New sheet added	Where BCMI information is missing, a qualitative review of the arch condition can be made using the Tool functionality as described within the Guidance Notes.
Bridge_Condition	Uncracked defects	A bug has been resolved to ensure that bulging/ displacement/ missing bricks defects are accounted for within the assessment.
"Assessment Help" Menu	Guidance removed	Guidance on the use of this function removed from this document. The embedded Guidance Notes have been removed from the Tool.
Interim Guidance Notes	Interim Guidance Notes (dated May 2013) appended to Guidance Notes.	

Glossary of terms

Elements of a masonry arch rail overbridge (top) and underbridge (bottom)

Extract from CIRIA C656 Masonry arch bridges – condition, appraisal and remedial treatment

Arch barrel	The (vertical) load bearing part of the arch, which contains a single thickness of voussoir stones or several rings of brickwork.
ARCHIE-M	An engineering tool to assist with the analysis of masonry arch bridges and viaducts.
Arch extrados	The topside of the arch barrel.

Arch intrados	The underside / soffit of the arch barrel.
As built	The condition of the arch structure at its time of construction.
Brick	A masonry unit comprising a shaped and kiln-fired block of clay or shale which can be used as an element for the fabric of a bridge. *As a general guide, medium strength bricks can be scratched with a key. Soft bricks can be rubbed away with a finger.*
Bridge	A structure of one or more spans greater than or equal to 1.8m, whose prime purpose is usually to carry traffic or services over an obstruction or gap. For the purposes of this Tool, this term includes underline bridges, overline bridges, footbridges and intersection bridges.
Bridge drainage	The management of water on a structure, e.g. drainage channels, downpipes, weepholes etc.
Culvert	A structure with a span less than 1.8m whose prime purpose is to permit water or services to pass under or adjacent to Network Rail infrastructure.
Elliptical arch	Indicating a 'flattened' semi-circular arch, used to keep height reasonable, to reduce approach gradients, and to increase the width of gauge clearance below.
Engineering brick	A dense, strong and durable brick, often used for construction or facing of engineering structures. *As a general guide, such bricks cannot be scratched with a key.*
External support	BCMI reference for end supports such as abutments.
Fill depth at crown to underside sleeper	Fill depth (including ballast) measured from the extrados of the arch barrel at the crown to the underside of sleeper.
Haunching	Structural material used to provide support behind the structure (e.g. at the arch extrados interface).
Header	A masonry unit laid with its longer dimension normal to the face of a wall or arch barrel, used to interconnect adjacent rings of brickwork.
Internal spandrel walls (with voids)	Masonry wall that sits on the arch barrel (along the length of the barrel). The area between the internal spandrel walls is voided.
Internal support	BCMI reference for intermediate supports such as piers.
Major element	BCMI reference for major asset elements including the deck, intermediate and end supports.

Masonry	The work of a mason, commonly used to refer to work in stone or brick material.
Midspan	The clear distance between the support and a point at the position of span divided by 2.
Minor element	BCMI reference for asset sub elements including the arch barrel, face rings / voussoirs, spandrel walls etc. for masonry arch structures.
Multi span	A multi spanned bridge consisting of three or more spans.
Parapet	For the purposes of this Tool, a masonry wall that sits on top of the spandrel wall. The height of the parapet should be taken from the stringcourse level to the top of the masonry wall.
Permissible speed	The maximum speed allowed over a section of line that applies to trains (when not operating at an Enhanced Permissible Speed as shown within the Sectional Appendix).
Pier	An intermediate support between adjoining bridge spans.
Pier slenderness	The ratio of pier height divided by pier width.
Quarter span	The clear distance between the support and a point at the position of span divided by 4.
Ring	A layer of transverse masonry elements that form slender units to make up an arch barrel. In brickwork, multiple adjacent rings are commonly used to produce a multi ring arch.
Rise	Vertical height of arch intrados from the springing level.
Segmental arch	Arch whose intrados comprises a segment of a circle which is smaller than a semicircle.
Semi-circular arch	Arch with an intrados the shape of a semicircle (i.e. a 180º arc) so that the rise is half the span.
Skew arch	Arch where the longitudinal and transverse axes are not at right angles.
Span	The clear distance between supports of an individual arch along its longitudinal axis.
Span to rise ratio	The ratio of arch span divided by the rise of the arch at the crown.
Spandrel wall	Masonry wall that sits on the edge of the arch barrel and that limits the extent of, and retains, the backfill material.
Springing	Plane from which the arch springs, i.e. the junction between the

vertical face of the abutment / pier and the arch barrel.

Steady state	A stable condition that does not change over time.
Stocky piers	Piers with a slenderness ratio of 2 or below.
Stringcourse	A (decorative) section of masonry at the interface between the spandrel wall and the parapet.
Track / carriageway distance from wall	Distance between the nearest running rail / edge of carriageway and the inside face of the parapet / spandrel wall.
Voussoir	A wedged shape masonry unit used to make an arch or vault.

A number of the above definitions are taken from *CIRIA C656 Masonry arch bridges – condition, appraisal and remedial treatment.*

List of Abbreviations Used

CRE	Contractor's Responsible Engineer
Assmt	Assessment
Calcs	Calculations
RA	Route Availability
ELR	Engineers Line Reference
AC	Assessed Category
BSU	British Standard Unit
LL	Live load
HAWP	Heavy Axle Weight Permission
HGV	Heavy Goods Vehicle
CARRS	Civil Asset Register & Reporting system
BCMI	Bridge Condition Marking Index
S/Ex	Severity & Extent Rating of BCMI Index
DK	Deck
ES	External Support
IS	Internal Support
BAR	Arch Barrel
FRV	Face Rings / Voussoirs
SPW	Spandrel Wall
PPT	Parapet
ABT	Abutment
WWL	Wingwall
PRT	Pier / Trestle
PCL	Padstone / Cills
CSAMS	Civils Strategic Asset Management Solution

General Notes

No.	Topic	Note
1	Level 0 process	The Level 0 assessment process has been developed in order to give Network Rail more contemporary bridge strength information which can be readily updated as new information becomes available or if changes are proposed. The Level 0 Assessment Tool has been developed to deliver a brief Assessment Report; this will provide assessments in a common and familiar format which will greatly improve Network Rail's ability to manage their bridge stock.
2	Level 0 process	The Level 0 Assessment Tool has been developed on the basis of NR/GN/CIV/025 Issue 3 and BD 21/01.
3	Level 0 process	The Level 0 assessments are prepared using an Assessment Tool that introduces an agreed approach to the assessment method in order to reduce the time required to collect and process assessment data.
4	Level 0 process	The Assessor must determine the most reliable source of information. Generally the hierarchy of reliability for dimensional information will be: 1. Data confirmed on site 2. Data from record drawings 3. Data from drawings provided in Assessment Report 4. Data from assessment calculations 5. Data from Detailed Examination Reports The hierarchy of reliability for conditional information will be: 1. Data confirmed on site 2. Data from Detailed Examination Reports`
5	Use of the Tool	The Level 0 assessment process and this Assessment Tool are designed for use by experienced Assessment Engineers and must only be undertaken by persons with suitable competency. Each assessing organisation must have at least one person of suitable experience to be the CRE to oversee the delivery of Level 0 Assessments.
6	Use of the Tool	The Tool is created for Level 0 Assessment of masonry type arch bridges, using MS Excel 2016.
7	Use of the Tool	The Level 0 Tool should always be saved to and run from the C: drive of the user's PC. Running the Tool from a network location may impair functionality of Excel and the Level 0 Tool.

No.	Topic	Note
8	Use of the Tool	The Tool will attempt to identify whether Excel 2016's Autosave function is active, and if so, disable it to avoid any inteference with its operation.
		Autosave will automatically be disabled if the Tool is saved locally to the user's C: drive, as per above.
9	Scope of the Tool – General	Level 0 Assessment Tool is designed to assess one bridge span at a time. Structures with more than one span will require multiple files – one for each span. File names are standardised in the following format: MA_2_0_ELR-No-DKNo.xls
10	Scope of the Tool – Geometrical Limitations	Only bridge spans between 1.8m and 20m and skews up to 20 degrees can be assessed using the Level 0 Assessment Tool.
		Subsequent guidance from the Network Rail workshop states:
		"For bridges with skew > 20 degrees – assess based on skew span rather than square span taking account of any cracking patterns that may invalidate this approach. Assessor / CRE to record this throughout the assessment using the commenting facility and CRE notes."
		Refer to the "Assessment checklist" for further geometrical / arch form limitations.
11	Scope of the Tool – Qualitative Assessment	Elements of the structure which are not covered in the assessment calculations are assessed qualitatively. These include the spandrel walls, substructure and foundations.
12	Scope of the Tool – Loading Scenarios	The Level 0 Assessment Tool uses a pre-defined loading scenario for each available structure type - Underline (or Intersection), Overline or Footbridge.

No.	Topic	Note
13	Scope of the Tool – CSAMS Assessment Scenarios	The CSAMS database uses a pre-defined list of 'Assessment Scenarios' to classify the loading scenario assessed in the Level 0 Assessment Tool. For the assessment of 'Underline' or 'Intersection' structures, the corresponding 'Assessment Scenario' is pre-set to "Published RA @ Permissible Line Speed" and cannot be changed. For the assessment of 'Overline' structures, the corresponding 'Assessment Scenario' is pre-set to "Standard Highway Loads" and cannot be changed. For the assessment of 'Footbridge' structures, the corresponding 'Assessment Scenario' is pre-set to "Standard Requirement" and cannot be changed. For all qualitative assessment, the corresponding 'Assessment Scenario' is pre-set to "Qualitative" and cannot be changed.

GUIDANCE NOTES FOR MASONRY ARCHES		**Network Rail**
		Level 0 Assessment Tool
		Version MA 3.1

Using the Tool

No.	Topic	Note
1	Run macros	To use the Assessment Tool it is necessary for macros to be enabled. Go to "File/Options/Trust Centre/Trust Centre Settings/Macro Settings" and set "Disable all macros with notification". Re-open the Tool and choose "Enable Macros" from the "Security Warning" message box, which appears when you open file with macros.
2	Library of images	The library of ARCHIE-M images should be stored on a local computer or network within the Consulting organisation. These images will be required for the arch assessment output described later within this document (refer to sheet name "Arch assmt").
3	"Assessment"	Once macros are enabled and the Tool re-opened an additional "Assessment" menu is automatically added to your Excel menus. Use this menu to progress with assessment (following the assessment steps as described in the next item) and to navigate in the Tool.
4	Assessment steps	Assessor: 1. Review structure and fill all relevant information in sheets "General" and "FormAA0". Contractor's Responsible Engineer (CRE): 2. Contractor's Responsible Engineer (CRE) to review and sign "FormAA0". Note that changes to Form AA0 will not be allowed after the form is signed. Assessor: 3. Fill all relevant information on general input sheets "BCMI_Ref", "Assmt_Parameters", "Bridge_Condition" or "Condition_Qual", "SSI". 4. Run calculation (Assessment menu > Calculate > Run) 5. Correct all errors in the input data (if any). 6. Review and correct warning messages (if any). 7. Review results. Checker: 8. Steps 1 to 7 to be checked and initialled by checker. Contractor's Responsible Engineer (CRE): 9. Contractor's Responsible Engineer (CRE) to review assessment, write recommendations (sheet "CRE") and sign Form BA0 (Sheet "Form BA0(1)").

No.	Topic	Note
5	Input cells	There are two types of input cells in the Tool - "yellow" and "tan" coloured. "Yellow" coloured cells are *data value* input cells and "tan" coloured cells are either *data units* or *data source* input cells.
6	Units	"Units" must be assigned to each data input (if applicable). Select units from drop down menu: Four options (in, ft, m, mm) are available for all.
7	Source	"Source" must be assigned to each data input. Select information source from drop down menu - 16 options (refer to tab "General" for information sources). When "source" is assigned to a table of values and different sources are used for the input data in this table - specify the principal information source and use the comments facilities on the yellow input cell to record if any data in the table is taken from a different source. Offline supporting sources may be included in the Tool.
8	Comments	Add comments only to the data value input cells i.e. "yellow" coloured cells. These comments will be listed together with the data description in a separate sheet "Comments". All comments have to be entered using the standard Excel commenting facility. How to add "Comment" in Excel? 1. Go to "File/Options/General" and change "User name:" to your initials. 2. Select the "yellow" cell to which you want to add a comment. 3. Right click and choose "Insert Comment". How to change or delete "Comment" in Excel? 1. Select the "yellow" cell with the comment. 2. Right click and choose "Edit Comment" or "Delete Comment". Users are encouraged to make regular use of this facility explaining their decisions. Comments should be short, concise and meaningful.
9	Yes / No option	This option should be populated where requested for all fields.

No.	Topic	Note
10	Results	Comments may be added on individual element results sheets by right-clicking in the blue cells adjacent to the 'Detailed Results' table and using the Excel commenting facility (see also Item No. 7 above). These comments can then be compiled into a formatted table (as per general input comments) by selecting the "Results_Comments" sheet and selecting "Yes" when prompted by the Tool to populate the table. The user will also be prompted to update this table during printing.
11	Printing	Note that the format of page numbering when printed is "Page 1 of N", where N is number of pages printed. Therefore one and the same page can have different page number when different printing options are used.

Form Codes

Sheet name – Form AA0

Input Data	Description	Suggested Sources
	The form code in the Tool is to be populated using the drop down list. This may be different than what is in the spreadsheet provided by Network Rail separately. Network Rail will capture the form code from the Tool which will form the definitive list.	
Structural form code – Ref1	Bridge Type (Ref1) A – Arches	
Structural form code – Ref2	Primary Longitudinal Elements (Ref2) M – Masonry/Brick	
Structural form code – Ref3	No. of Primary Elements (Ref3) - - not applicable for arch bridges	
Structural form code – Ref4	Floor Types (Ref4) - - not applicable for arch bridges	
Structural form code – Ref5	Track / Road Form (Ref5) B – Ballasted C – Carriageway - no footway D – Carriageway - with footway U – Carriageway - undefined F – Footway	

Sheet name – General

The Assessment Tool allows the assessor to record data for up to four tracks. Details of Track 1 are used in the calculations, while Track 2, Track 3 and Track 4 are for data collection purposes only.

Input Data	Description	Suggested Sources
Route	e.g. Midland, Southern etc.	TS Level Zero Task List
ELR	Engineers Line Reference.	TS Level Zero Task List
Number	Bridge number. Use "_" symbol instead of "/" symbol for structures with more than one identification number (e.g. use 46_47 instead of 46/47) as bridge number is used as part of the file name and therefore some symbols are not permitted. Leading zeros may now be included as necessary within the bridge number (e.g. 00127). This reference should align with the Level Zero Task List.	TS Level Zero Task List
Mileage	Format is "82.0022" which is 82 miles and 22 yards. This reference should align with the Level Zero Task List.	TS Level Zero Task List
OS Map Reference	Format is XY #### ####, e.g. TQ 1234 5678.	TS Level Zero Task List
Bridge name	Local name.	TS Level Zero Task List
Type of bridge	Select option from drop down menu – options "Underline" or "Overline" or "Footbridge" or "Intersection".	DE Detailed Examination Report
Number of spans	Number input.	DE Detailed Examination Report
Total number of decks	Number input. Deck is marked as DK within BCMI code. Refer to NR/L3/CIV/006/2C.	DE Detailed Examination Report
Status	Defaults to "Network Rail owned and maintained".	
Construction date	Date of construction. If unknown estimate date and add comment.	RD Record Drawings

Input Data	Description	Suggested Sources
CARRS Parent GUID	Number input required (32 alphanumeric characters required).	TS Level Zero Task List
CARRS Child GUID	Number input required (32 alphanumeric characters required).	TS Level Zero Task List
BCMI deck reference	Select option from drop down menu – options from "DK1" to "DK99".	DE Detailed Examination Report
Obstacle crossed: Type Name	Select option from drop down menu. Describe name of the obstacle, e.g. A321 public road.	DE Detailed Examination Report
Tracks / road carried	Name of lines, e.g. Up Fast Name of the road, e.g. A321 public road.	SA Sectional Appendices DE Detailed Examination Report
Track ID	The ID of the track, choose from dropdown.	
Published RA	Current RA of the line.	SA Sectional Appendices
Tonnage	Select option from drop down menu based on traffic tonnage data.	TTD Traffic Tonnage Data
Local permissible speed	Insert published speed (maximum of 125mph).	SA Sectional Appendices
Differential speed	Select option from drop down menu – options "Yes" or "No". A loco speed restriction published in Table D may be considered as a differential speed.	SA Sectional Appendices
Type	Select option from drop down menu.	SA Sectional Appendices
Speed	Insert published speed (maximum of 125mph).	SA Sectional Appendices
Heavy axle weight permission	Select option from drop down menu – options "Yes" or "No".	SA Sectional Appendices
RA value	Input RA value if "Yes" selected for HAWP.	SA Sectional Appendices

Input Data	Description	Suggested Sources
Speed	Input published speed if "Yes" selected for HAWP.	SA Sectional Appendices
Published weight restriction	Insert published weight restriction, e.g. 7.5 tonnes etc.	AR Assessment Report
Road speed	Insert speed.	DE Detailed Examination Report
Loading requirement to NR/L3/CIV/006/01C	Select the loading requirement of the footbridge from the dropdown. This does not affect the calculations and is collected for information only.	
Source type – Last Detailed Examination Report (Date)	Use the format "dd/mm/yyyy".	
Source type – Last Detailed Examination Report (By)	Name of organisation that wrote the Last Detailed Examination Report.	
Source type – Last Assessment Report (Date)	Use the format "dd/mm/yyyy".	
Source type – Last Assessment Report (By)	Name of organisation that wrote the Last Assessment Report	
Source type – Last Inspection for Assessment Report (Date)	Use the format "dd/mm/yyyy".	
Source type – Last Inspection for Assessment Report (By)	Name of organisation that wrote the Last Inspection for Assessment Report	
Source type – Last Visual Examination Report 1 (Date)	Use the format "dd/mm/yyyy".	
Source type – Last Visual Examination Report 1 (By)	Name of organisation that wrote the Last Visual Examination Report 1	

Input Data	Description	Suggested Sources
Source type – Last Visual Examination Report 2 (Date)	Use the format "dd/mm/yyyy".	
Source type – Last Visual Examination Report 2 (By)	Name of organisation that wrote the Last Visual Examination Report 2	
Source type – Additional Examination Reports (Date)	Use the format "dd/mm/yyyy".	
Source type – Additional Examination Reports (By)	Name of organisation that wrote additional Examination Reports	
Source type – BCMI Report (Date)	Use the format "dd/mm/yyyy".	
Source type – BCMI Report (By)	Name of organisation that wrote the BCMI Report	
Source type – Supplementary Site Inspection (Date)	Use the format "dd/mm/yyyy".	
Source type – Supplementary Site Inspection (By)	Name of organisation that undertook a supplementary site inspection	
Date of last inspection for assessment (Date)	Use the format "dd/mm/yyyy"	
Date of last inspection for assessment (By)	Name of organisation that undertook the last inspection for assessment.	
Source type – Record Drawings	Use the format "5E/1720/1, 3, 5-7 &21" etc.	
Source type – Five Mile Plans	Use the format "Dated …"	

Input Data	Description	Suggested Sources
Source type – Sectional Appendices	Use the format "Dated …"	
Source type – OMNICOM Information	Use the format "Dated …"	
Source type – Level 0 Task List	Use the format "Dated …"	
Source type – Internet	Use the format "Dated …, web address …"	
Source type – Traffic Tonnage	Use the format "Dated …"	
Source type – Gauging Train Surveys	Use the format "Dated …"	
Offline supporting calculations & sketches (OL1-OL10) (Source Type)	Title and/or brief description of the offline supporting document to be appended to the Level 0 Assessment	
Offline supporting calculations & sketches (OL1-OL10) (Date)	Use the format "dd/mm/yyyy"	
Offline supporting calculations & sketches (OL1-OL10) (By)	: Name of organisation that created the document.	

Sheet name – Form AA0

Input Data	Description	Suggested Sources
Assessment checklist	Select option from drop down menu for <u>all questions</u>. The Level 0 Tool has the following limitations: 1. The Tool is not appropriate for culverts (spans less than 1.8m) or long span (greater than 20m) arches. 2. The Tool is generally not appropriate for highly skewed (greater than 20º) arch structures. 3. For multi span viaducts, the Tool is limited to piers with a slenderness less than 6. Arches with more slender piers should be subject to an ARCHIE-M analysis. 4. For multi span arches with a pier slenderness greater than 2, the Tool assumes that adjacent spans are of a similar form, shape and span. 5. The Tool is not appropriate for arches with complex or unique features such as relieving holes or multi layer spans. 6. The Tool is not appropriate for highly skewed (greater than 20º) tracks / highway. 7. The Tool is not appropriate for arches that contain internal spandrel walls with voids. 8. The Tool is not appropriate for arch profiles with a span to rise less than 2 or greater than 8 (e.g. very flat). 9. Unusually shaped arches, such as triangular or gothic, should not be considered with this Tool. 10. The Tool will not consider the contribution of previous strengthening to an arch structure. As such, the use of the Tool for strengthened arches requires careful consideration as the behaviour of the arch may not be as constructed. <u>The type of strengthening and material used should be recorded using the commenting facility.</u> 11. The Tool will not consider the contribution of previous strengthening to the spandrel walls, such as pattress plates and tie bars. <u>The presence of strengthening should be</u>	

Input Data	Description	Suggested Sources
	recorded using the commenting facility. 12. If the bridge has not been fully defined by the structural form codes available in the Tool, the correct form code must be supplied.	
Structural form code	Reference should be made to page 14. Form code consists of 5 letters / numbers (Ref1 to Ref5) representing: • Bridge Type (Ref1) • Primary Longitudinal Elements (Ref2) – defines material for arch structures • Not applicable for arches (Ref3) • Not applicable for arches (Ref4) • Track/Road Form (Ref5) Drop down menus with valid combinations for the form codes included in the Tool are provided. The assessor must choose the form code combination that defines the bridge deck correctly and completely.	DE Detailed Examination Report
Correct structural form code	If the answer to Question 12 is "No", then the correct structural form code must be provided.	
Justification for adopting Level 0 assessment (if required)	If the answer to any of the questions in the Assessment Checklist is "No" the following statement will appear: "Bridge deck is NOT suitable for Level 0 assessment".	
Name / signing Form AA0	Name of the CRE from the Assessing Organisation.	
Title / signing Form AA0	Title of the CRE from the Assessing Organisation. To be filled by the CRE.	
Signing Form AA0	The Form AA0 should only be signed by the CRE. After filling the Name and the Title, go to Assessment menu and select "Sign Forms". It is the responsibility of the Assessor to ensure each form is signed by a competent and approved person. The signatures will be checked and approved by Network Rail Structures Managers. Completing the signing Procedure will lock all the information in Form AA0 sheet.	

Sheet name – BCMI Ref

| Input Data	Description	Suggested Sources
BCMI deck reference	Automatically populated from "General" input sheet.	
Span number	Insert span number as per BCMI referencing.	BCMI BCMI Report (DE Detailed Examination Report)
Supports 1st	Select option from drop down menu, e.g. for external support "ES1" and for internal support "IS1" etc. Options from IS1-IS99.	BCMI BCMI Report (DE Detailed Examination Report)
Supports 2nd	Select option from drop down menu, e.g. for external support "ES1" and for internal support "IS1" etc.	BCMI BCMI Report (DE Detailed Examination Report)
Is a completed BCMI Examination Report Form available for the bridge?	Select option from drop down menu – options "Yes" or "No". If the answer is "Yes", the "Bridge Condition" tab will appear and will be populated using the BCMI information. If the answer is "No", the "Condition Qual" tab will appear. This considers a qualitative review of the bridge condition, and should be completed used available condition information.	DE Detailed Examination Report
Major element code	Select option from drop down menu to define deck reference and support references.	DE Detailed Examination Report
Minor elements (individually marked)	Insert number. If elements are not applicable insert a "0".	DE Detailed Examination Report
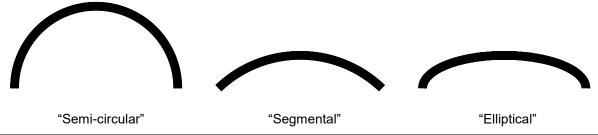
Sheet name – Assmt Parameters

The availability and quality of Record Information such as drawings will vary greatly across the arch population. It is envisaged that for many arch assets, geometrical and material parameters will need to be determined using Detailed Examination Reports. Where dimensions are not provided, photographs within the reports should be used to determine these parameters by:

- Brick counting exercises. In the absence of definitive information, the following dimensions can be considered for a brick – 215mm length x 65mm height (for brick on end 65mm x 102mm). This does not include a mortar joint (usually assumed as 10mm).
- Scaling from photographs.
- Any other evidence within the photographs / report.

The method of determining the dimensional information should be recorded using the comments.

Input Data	Description	Suggested Sources
Bridge span	Number input. Span is defined as the clear (skewed) span between abutments / piers.	RD Record Drawings DE Detailed Examination Report
Skew angle	Number input. Subsequent guidance from the Network Rail workshop states: *"For bridges with skew > 20 degrees – assess based on skew span rather than square span taking account of any cracking patterns that may invalidate this approach. Assessor / CRE to record this throughout the assessment using the commenting facility and CRE notes."*	RD Record Drawings
Shape of arch	Select option from drop down menu: • "Segmental" • "Elliptical" • "Semi-circular" Refer to the "Glossary of terms" for descriptions of the above arch shapes and the illustration below:	RD Record Drawings DE Detailed Examination Report

"Semi-circular"   "Segmental"   "Elliptical"

Input Data	Description	Suggested Sources
Rise at crown	Number input. Defined as the vertical distance between the springing level and the arch intrados level at the midspan location (assuming a symmetrical arch).	RD Record Drawings DE Detailed Examination Report
Barrel thickness	Number input. If the barrel thickness is unknown (e.g. hidden behind a stone voussoir), the table below provides typical barrel thicknesses for a range of spans: Note: *if values from this table are adopted, this must be stated as an assumption using the comment facility.* *The type of arch ring should also be commented upon, e.g. fully bonded, partially bonded etc.*	RD Record Drawings DE Detailed Examination Report

Span (m)	Typical barrel thickness (mm) **(blue denotes barrel thickness applicable to the Tool)**								
	200	300	400	500	600	700	800	900	1000
1.8	●	●							
3	●	●	●						
4	●	●	●	●					
5		●	●	●	●				
6		●	●	●	●	●			
7		●	●	●	●	●			
8		●	●	●	●	●	●		
10			●	●	●	●	●		
12			●	●	●	●	●	●	
14			●	●	●	●	●	●	
17				●	●	●	●	●	●
20				●	●	●	●	●	●

Equivalent Imperial barrel thickness		
No of Bricks	Barrel thickness (in)	Barrel thickness (mm)
2	9	225
3	13.5	335

table continued overleaf

Input Data	Description		Suggested Sources
No of Bricks	Barrel thickness (in)		Barrel thickness (mm)
4	18		450
5	22.5		560
6	27		675
7	31.5		785
8	36		900
9	40.5		1010

The 'engine' of the Tool interprets the results of a parametric study considering a range of representative barrel thicknesses across a population of arch spans. Therefore if the barrel thickness considered appropriate for an arch falls outside of the lower and upper bounds specified, the Tool does not consider the arch to be representative of the population and therefore will not provide an Assessment result.

Where the actual barrel thickness is greater than that specified within the table (for a specific arch span), the Assessor shall populate the Tool with the upper bound value from the table. Where this approach is adopted, the value from this table must be stated as an assumption using the comment facility, with the actual barrel thickness also included within the comment.

Within the CRE comments prior to Form BA0(1) sign off, the CRE shall also note the fact that a reduced barrel thickness has been used for the Assessment result reported and state value adopted / actual thickness.

There may also be a small number of arches within the Network Rail population that have a barrel thickness below the lower bound values specified within the table. In this scenario, adopting the lower bound value from the table would be considered unconservative. These arches shall be flagged as outside of the scope of the Level 0 Assessment Tool.

The table can also be used to provide a representative barrel thickness if this is unknown by the Assessor. If the lower bound barrel thickness is

Input Data	Description	Suggested Sources
	selected by the Assessor, the Tool may not provide a current condition Assessment result if a reduction in barrel thickness is required to take account of the condition of the arch. In these situations where the Tool seeks to reduce the barrel thickness to allow for the condition, the Tool is unable to produce a current condition assessment because the resultant barrel thickness is outside the scope of the Tool.	
Pier form	Free text input. Consider the following: • Basic Construction • Number of legs • Pier width (top and bottom if applicable) • Voided • Any unusual features	RD Record Drawings DE Detailed Examination Report
Pier height	Number input. In the absence of definitive record information, it is recommended that the pier height is taken from 0.5m below ground level to the springing level.	RD Record Drawings DE Detailed Examination Report
Pier thickness at top	Number input. Pier width to be taken at the springing level.	RD Record Drawings DE Detailed Examination Report
Pier thickness at bottom	Number input. Pier width to be taken at the ground level.	RD Record Drawings DE Detailed Examination Report
Fill depth at crown	Number input. For underbridges, this is defined as the depth of fill from the topside of the sleeper to the extrados of the arch at the midspan location. Fill depth range 0.360m – 1.660m. The Assessor should carefully consider the ballast level at the parapet wall interface, and take due account of ballast shoulders or uneven ballast profiles across the structure. For overbridges / footbridges, the depth of fill is defined as the depth from the top of the surfacing to the extrados of the arch at the midspan location. Fill	DE Detailed Examination Report (Omnicom)

Input Data	Description	Suggested Sources
	depth range 0.200m – 1.500m.	
	The parametric study undertaken to develop the 'engine' of the Tool, considered a representative range of fill depths as summarised previously. Therefore if the fill depth for an arch falls outside of the lower and upper bounds specified, the Tool does not consider the arch to be representative of the population and therefore will not provide an Assessment result.	
	For arches with <u>greater</u> fill depth than the Tool considers representative, the Assessor shall populate the Tool with the upper bound limit summarised below:	
	• For underbridges, fill depth 1660mm, defined as the depth of fill from the topside of the sleeper and extrados of the arch at the midspan location.	
	• For overbridges / footbridges, fill depth of 1500mm, defined as the depth of fill from the top of the surfacing to the extrados of the arch at the midspan location.	
	If the actual fill depth exceeds the maximum value adopted in the Tool range this must be stated using the comment facility including the fill depth assumed / actual fill depth for the arch.	
	Where the actual depth of fill is <u>less</u> than the minimum depth accommodated by the Tool it shall be stated that the arch is <u>outside</u> the scope of the Tool.	
	The CRE / Network Rail's Structure Manager attention is particularly drawn to arches where the fill depth is below 300mm, where different / more complex failure mechanisms may be considered more appropriate than those assumed within the Tool.	
	It is recommended that the CRE provides adequate commentary to highlight the above assumptions and warnings with such arch assessments.	
Track / carriageway distance from wall	Number input. Horizontal distance to inside face of masonry parapet wall.	DE Detailed Examination Report

Input Data	Description	Suggested Sources
Height of haunching	Select option from drop down menu: • "No haunching" • "Mid rise haunching" • "Full rise haunching" In the absence of Record Information, this parameter can be very difficult to determine. Clues to look for include: • Location of drainage pipes through the spandrel wall. • Change in brickwork type / coloration. • Variation in brickwork appearance due to water / moisture staining. • Degradation in brickwork condition due to presence of moisture.	RD Record Drawings DE Detailed Examination Report
Height of parapet	Number input. Height of masonry parapet (neglect metallic parapets or alike).	DE Detailed Examination Report
Track curvature	Select option from drop down menu: • "Straight" • "Radius greater than 1500m" • "Radius less than 1500m"	Scaled from mapping Five Mile Plans
Barrel material	Select option from drop down menu: • "Unknown" • "Soft Brick" • "Engineering Brick" • "Stone"	DE Detailed Examination Report
Voussoir material	Select option from drop down menu: • "Unknown" • "Soft Brick" • "Engineering Brick" • "Stone"	DE Detailed Examination Report

Input Data	Description	Suggested Sources
Ballasted / surfacing	Automated based on Form Code selection: • "Ballasted" • "Surfacing"	DE Detailed Examination Report
Minimum temperature	Select option from drop down menu (using Figure 7 from BS 5400 Part 2 and included with the toll for information).	
Maximum temperature	Select option from drop down menu (using Figure 8 from BS 5400 Part 2 and included with the toll for information).	
Location of bridge	Select option from drop down menu: • "Rural" • "Coastal / Estuary" • "Suburban" • "Inner City"	
Bridge drainage	Select option from drop down menu: • "No visible evidence of drainage" • "Poor drainage" • "Adequate drainage" • "Good drainage"	DE Detailed Examination Report
Classification of live loading	Select option from drop down menu: • "Railway (NR/GN/CIV/025)" • "Highway (BD 21/01)" • "Footway (BD 21/01)"	
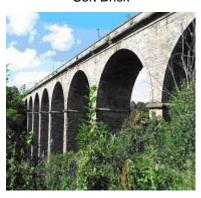
Sheet name – Bridge Condition

This table should be completed using the latest Detailed Examination Report and corresponding BCMI scoring (completed by the Examiner).

Input Data	Description	Suggested Sources
Source	Select option from drop down menu.	
Material	Select option from drop down menu: • "Unknown" • "Soft Brick" • "Engineering Brick" • "Stone" The material for the barrel and face rings / voussoirs is pre-populated from the input on sheet "Assmt_Parameters". Refer to the "Glossary of terms" and pictorial examples below:	DE Detailed Examination Report

Soft Brick

London Stock Brick

Engineering Brick

Fitted Stone

Sandstone

Limestone

Input Data	Description	Suggested Sources
Uncracked S/Ex 1	Define severity and extent of uncracked defects. Select option from drop down menu – based on matrix from NR/L3/CIV/006/2C.	BCMI BCMI Report (DE Detailed Examination Report)
Uncracked S/Ex 2	Define severity and extent of uncracked defects. Select option from drop down menu – based on matrix from NR/L3/CIV/006/2C.	BCMI BCMI Report (DE Detailed Examination Report)
Cracked S/Ex 1	Define severity and extent of cracked defects. Select option from drop down menu – based on matrix from NR/L3/CIV/006/2C.	BCMI BCMI Report (DE Detailed Examination Report)
Cracked S/Ex 2	Define severity and extent of cracked defects. Select option from drop down menu – based on matrix from NR/L3/CIV/006/2C.	BCMI BCMI Report (DE Detailed Examination Report)
Defect ID	The defect ID relating to the most sever defect; this is a 12 character ID.	DE Detailed Examination Report
	The BCMI data populated by the Assessor will then generate a statement, stating the effect of the condition recorded on the arch barrel assessment, and how the Tool will provide an assessed capacity based on the current condition. The statements generated are described later within this document (refer to page 37).	

Input Data	Description	Suggested Sources
Qualitative assessment of the substructure and foundations	"Based on the defect information for the current applied loads, the substructure and foundations are considered to be…" Select option from drop down menu: • "Adequate" • "Inadequate" In accordance with NR/GN/CIV/025, the Assessor shall undertake a qualitative assessment of the substructure and foundations based on its observed performance and condition. Reference should be made to the Detailed Examination Report and BCMI report / scoring recorded for the supports. The qualitative review should consider warning signs such as: • Movement (including loose or displaced masonry) • Settlement • Rotation • Bulging • Cracking	DE Detailed Examination Report BCMI BCMI Report

The matrices included within the following pages provide guidance as to when the condition is considered within the (Level 0) arch assessment.

Uncracked masonry defects for the arch barrel (based on NR/L3/CIV/006/2C Table 2C.16)

Note: the extent is defined as the percentage of the surface of the element that is occupied by the defect. Table continued overleaf.

Severity	Definition	Extent					
		1	2	3	4	5	6
		No visible defect	Localised	< 5%	5 to 10%	10 to 50%	> 50%
A	No visible defects to masonry						
B	Brickwork, where the depth of spalled or weakened / softened material < 10mm						
	Evidence of the presence or effect of water					🟧	🟧
C	Deterioration of pointing – 0 to 25mm depth						🟧
	Deterioration of pointing – 25 to 50mm depth						🟧
	Deterioration of pointing – 50 to 75mm depth				🟧	🟧	🟧
	Deterioration of pointing – 75 to 100mm depth				🟧	🟧	🟧
D	Brickwork, where the depth of spalled or weakened / softened material is ≥ 10mm but less than depth of header					🟧	🟧

Network Rail

Severity	Definition	Extent					
		1	2	3	4	5	6
		No visible defect	Localised	< 5%	5 to 10%	10 to 50%	> 50%
E	Hollowness or drumminess (not associated with B or D)						
Ex	Loose / wedged bricks / blocks – not displaced and not to the full depth of the element						
	Missing bricks / blocks – one or more, but not to full depth of the element						
F	Bulging or distortion						
	Displacement – loose and / or wedged displaced bricks / blocks to the full depth of the element						
	Missing brick / block to the full depth of the element						

Key to table

	Condition does not affect assessed capacity
	Condition affects assessed capacity – reduction is ring thickness considered
	Condition affects assessed capacity – defect(s) not considered within the Level 0 Assessment and warnings / flags provided

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Cracked masonry defects for the arch barrel (based on NR/L3/CIV/006/2C Table 2C.17)

Note: the extent is defined as the total length of all visible cracks of that severity rating as a % of principal dimension of the element in that orientation.

Severity	Definition (and maximum crack width)	Extent					
		1	7	8	9	10	11
		No visible cracks	< 20%	20 to 50%	50 to 100%	100 to 200%	> 200%
A	No visible cracks	(green)	(green)	(green)	(green)	(green)	(green)
G	Longitudinal hairline crack < 1mm	(green)	(green)	(green)	(green)	(green)	(green)
	Diagonal hairline crack < 1mm	(green)	(green)	(red)	(red)	(red)	(red)
I	Transverse hairline crack < 1mm (with no step / displacement within the arch barrel)	(green)	(green)	(green)	(green)	(green)	(green)
	Transverse hairline crack < 1mm (with stepped displacement within the arch barrel)	(green)	(green)	(green)	(green)	(red)	(red)
J	Longitudinal crack – 1 to 5mm	(green)	(green)	(green)	(green)	(green)	(green)
	Diagonal crack – 1 to 5mm	(green)	(red)	(red)	(red)	(red)	(red)
K	Longitudinal crack – 5 to 10mm	(green)	(green)	(green)	(green)	(green)	(red)
	Diagonal crack – 5 to 10mm	(green)	(red)	(red)	(red)	(red)	(red)
L	Longitudinal crack > 10mm	(green)	(green)	(green)	(green)	(green)	(red)
	Diagonal crack > 10mm	(green)	(red)	(red)	(red)	(red)	(red)
P	Transverse crack ≥ 1mm (with no step / displacement within the arch barrel)	(green)	(green)	(green)	(green)	(green)	(green)

Severity	Definition (and maximum crack width)	Extent					
		1	7	8	9	10	11
		No visible cracks	< 20%	20 to 50%	50 to 100%	100 to 200%	> 200%
P	Transverse crack ≥ 1mm (with stepped displacement within the arch barrel)						
	Island cracking						

Key to table

	Condition does not affect assessed capacity
	Condition affects assessed capacity – defect(s) not considered within the Level 0 Assessment and warnings / flags provided

Cracked masonry defects for the face rings / voussoirs (based on NR/L3/CIV/006/2C Table 2C.17)

Note: the extent is defined as the total length of all visible cracks of that severity rating as a % of principal dimension of the element in that orientation.

Severity	Definition (and maximum crack width)	Extent					
		1	7	8	9	10	11
		No visible cracks	< 20%	20 to 50%	50 to 100%	100 to 200%	> 200%
A	No visible cracks	🟩	🟩	🟩	🟩	🟩	🟩
H	Hairline ring separation < 1mm	🟩	🟩	🟩	🟩	🟩	🟩
M	Ring separation – 1 to 5mm	🟩	🟩	🟩	🟩	🟩	🟩
N	Ring separation – 5 to 10mm	🟩	🟩	🟥	🟥	🟥	🟥
0	Ring separation > 10mm	🟩	🟥	🟥	🟥	🟥	🟥

Key to table

🟩	Condition does not affect assessed capacity
🟥	Condition affects assessed capacity – defect(s) not considered within the Level 0 Assessment and warnings / flags provided

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The Effect of Condition

Based on the condition information provided by the Assessor, the Tool will consider the effect of any defects on the current condition assessment result.

The following scenarios are considered within the Tool:

Scenario	Type of defect and the effect on the assessment	As built result	Current condition result
A	Defects such that the condition is not considered to affect the assessed capacity	No defects considered	As built result
B	Defects such that the condition is considered to affect the assessed capacity, therefore a reduction in barrel thickness considered	No defects considered	As built result modified by a reduction in the barrel thickness
C	Defects such that the condition is not considered to affect the assessed capacity, and Defects such that the condition is considered to affect the assessed capacity, but outside of the scope of a Level 0 type assessment	No defects considered	As built result Warnings provided regarding the defects not considered within the assessment result
D	Defects such that the condition is considered to affect the assessed capacity, therefore a reduction in barrel thickness considered, and Defects such that the condition is considered to affect the assessed capacity, but outside of the scope of a Level 0 type assessment	No defects considered	As built result modified by a reduction in the barrel thickness Warnings provided regarding the defects not considered within the assessment result

The warnings generated within the Tool will identify the defects that have not been considered within the assessment. These warnings should be:

- Considered by the CRE in the recommendations made

- Considered by Network Rail in the recommendations made and possible actions required
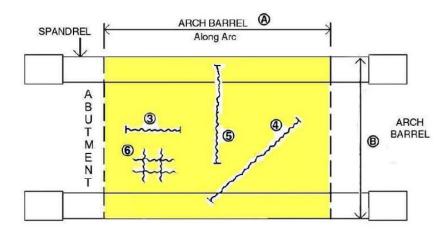
Further Guidance on Arch Defects

Where BCMI information is incomplete, the Assessor shall use engineering judgement to consider whether the defects identified in the last Visual Examination and Detailed Examination would affect the as built assessment. If not the assessor shall confirm in the commentary that the current condition assessment can be taken as the as built assessment. Where engineering judgements are made, the Assessor shall provide a commentary of the decisions made and justification using the comment facility.

Where BCMI information is missing, a qualitative review of the arch condition should be made using the Tool functionality as described later within this document (refer to page 42).

Cracking within the arch barrel

The extract below from the *Handbook for the examination of Structures* illustrates the types of cracking that may exist within an arch barrel.

3. Longitudinal crack

4. Diagonal crack

5. Transverse crack

6. Island cracking
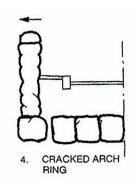
Extract from NR/L3/CIV/006/2C – Figure 2C.48

This terminology aligns with the defects included in the cracked masonry defect matrix presented within this document.

Longitudinal cracking within the arch barrel

The Tool will not consider the effect of longitudinal cracking when the crack width is greater than 5mm and with an extent of cracking greater than 200% (e.g. twice the arch span). It is recommended that the Assessor / CRE review the locations of this cracking, and consider reducing the extent to 200% if the cracks are primarily located at each of the interfaces between the spandrel wall and arch barrel (as per illustration below).

4. CRACKED ARCH RING
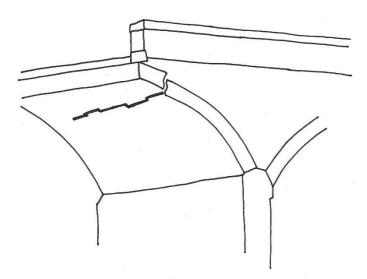
Transverse cracks within the arch barrel

The severity of a transverse crack within the arch barrel will be a function of the crack location, width, extent and any observed displacement of the barrel.

Within the scope of the Tool, these cracks have been characterised as below:

- Transverse crack(s) with no step / displacement within the arch barrel

- Transverse crack(s) with an associated stepped displacement (typically greater than 10mm) within the arch barrel (refer to illustration below)
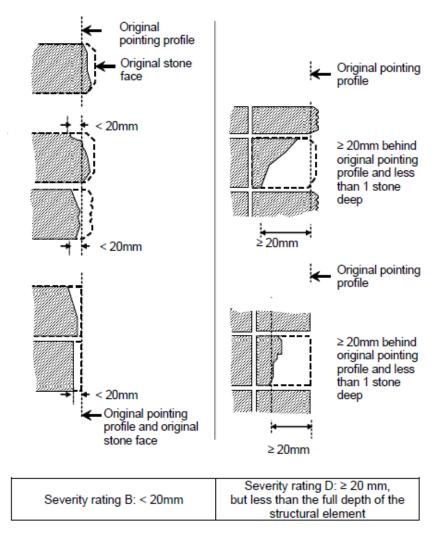
Transverse crack within the arch barrel with associated stepped displacement (exaggerated)

Spalled masonry and the deterioration of pointing

The extract below from the *Handbook for the examination of Structures* illustrates the deterioration of pointing and spalled masonry considered within the condition matrices presented within this document.

Extract from NR/L3/CIV/006/2C – Figure 2C.42 Severity ratings B & D (uncracked masonry defects)

Spandrel wall defects

A number of primary failure modes for spandrel walls have been identified, and these are considered within the qualitative assessment undertaken by the Tool for underbridges. These primary defects are summarised below:

Failure Mode	The Defect & Clues to Look For
1. TILTING	The forward rotation of the spandrel wall. Clues to look for include the leaning / mis-alignment of handrailing and / or the stringcourse. This defect can be relevant to all masonry arch bridges, but in particular those with significant cover levels.
2. BULGING	The bulging / distortion of the spandrel wall. Clues to look for include the mis-alignment of the stringcourse. This defect can be relevant to all masonry arch bridges, but in particular those with significant cover levels.
3. SLIDING	The lateral movement / oversailing of a spandrel wall. Clues to look for include the lateral displacement of brickwork above the arch barrel. The defect can also occur by the lateral displacement of brickwork within the arch face ring. This defect can be relevant to all masonry arch bridges.
4. CRACKED ARCH RING	A longitudinal crack within the arch barrel, located below the spandrel wall. Clues to look for include any evidence of cracking, e.g. leachate staining, sheared brickwork etc. This defect can be relevant to all masonry arch bridges, in particular structures with a material change between the arch barrel and voussoir.

GUIDANCE NOTES FOR MASONRY ARCHES	**Network Rail**	
	Level 0 Assessment Tool	
	Version MA 3.0	

<u>**Sheet name – Condition Qual**</u>

This considers a qualitative review of the arch condition in the absence of BCMI information.

This table should be completed using the latest Detailed Examination Report or other available condition data.

Input Data	Description	Suggested Sources
Source	Select option from drop down menu.	
Questions	The Assessor shall answer the questions below using available condition data. Question specific options should be selected from the drop-down menu: • "Yes" – *there is definitive evidence of the defect* • "No" – *there is definitive evidence of no defect present* • "Yes, unquantifiable" – *there is evidence of the defect, but the extent / severity is unquantifiable from the information available* All questions should be answered. The questions and terminology are consistent with a BCMI examination, and relate to the matrices provided within the previous pages.	DE Detailed Examination Report Any other source of condition information
Question 1.0	**Is there visible cracking to the arch barrel?** Are there diagonal cracks with a crack width >1mm? Is there evidence of island cracking? Are there transverse cracks with an associated stepped displacement within the arch barrel? Is there longitudinal cracking in areas away from the barrel/spandrel wall interface? For the longitudinal cracks, is the crack width >1mm and of total extent greater than twice the span?	
Question 2.0	**Is there evidence of bulging or distortion to the arch barrel?** Is the bulging or distortion over a surface area greater than 5%?	
Question 3.0	**Are there missing bricks / blocks to the full depth of the barrel?** **Are there loose and / or wedged / displaced bricks / blocks to the full depth of the barrel?** Are there loose / wedged / missing bricks / blocks	

Input Data	Description	Suggested Sources
	within the arch barrel (but not to full depth) and over a surface area of >10%?	
Question 4.0	**Is there barrel material spalled / weakened / softened to a depth ≥10mm and over a surface area greater than 10%?** **Is there deterioration to the pointing in the barrel to a depth >50mm and over a surface area >5%?** Is there deterioration to the pointing in the barrel to a depth >25mm and over a surface area >10%? Is there deterioration to the pointing in the barrel to a depth <25mm and over a surface area >50%?	
Question 5.0	**Is there evidence of water or the effect of water to the arch barrel over a surface area greater than 10%?**	
Question 6.0	**Is there evidence of ring separation (>10mm) to the face rings / voussoirs?** Is there evidence of ring separation (>5mm) to the face rings / voussoirs over an area greater than 20%?	
Question 7.0	**Is there evidence of tilting, bulging or lateral displacement of the spandrel wall, or longitudinal cracking between the spandrel wall and the arch barrel?**	
	The answers provided by the Assessor will then generate a statement, stating the effect of the condition recorded on the arch barrel assessment, and how the Tool will provide an assessed capacity based on the current condition. The statements generated are summarised below, and correlate with the matrices provided within the previous pages. • *Scenario A* "Based on the information above, the condition is not considered to affect the assessed capacity." • *Scenario B* "Based on the information above, the condition is considered to affect the assessed capacity and a reduction in the barrel thickness has been considered." • *Scenario C* "Based on the information above, the condition is considered to affect the	

Input Data	Description	Suggested Sources
	assessed capacity, and this has not been considered within this Level 0 Assessment." • *Scenario D* "Based on the information above, the condition is considered to affect the assessed capacity and a reduction in the barrel thickness has been considered. Defects have also been identified that are outside the scope of a Level 0 Assessment, and therefore have not been considered within the assessed capacity provided"	
Qualitative assessment of the substructure and foundations	"Based on the defect information for the current applied loads, the substructure and foundations are considered to be…" Select option from drop down menu: • "Adequate" • "Inadequate" In accordance with NR/GN/CIV/025, the Assessor shall undertake a qualitative assessment of the substructure and foundations based on its observed performance and condition.	DE Detailed Examination Report
Qualitative Result based on Minor Element	Choose the leading minor element (with the most significant defect) that the qualitative result is based on. If no defects, select a relevant element code.	

Sheet name – PPT Qual

For masonry arch overbridges, a qualitative risk assessment of the bridge parapet will be undertaken.

Input Data	Description	Suggested Sources
Parapet material	Select option from drop-down menu: • "Metal" • "Masonry" • "Concrete" • "Timber" • "Unknown"	DE Detailed Examination Report
Parapet condition	Select option from drop-down menu – "Yes" or "No" for each type of defect listed (note: the defects listed are a function of the material specified previously): • Strike damage (e.g. from previous vehicle incursions) • Metallic corrosion • Tears, fractures, cracked welds (for metallic parapets) • Buckling, permanent distortion (for metallic parapets) • Spalling or hollowness (for masonry or concrete parapets) • Cracking (e.g. hairline etc.) • Bulging, distortion or tilting (of masonry or concrete parapets)	DE Detailed Examination Report
Parapet containment (as-built condition)	The Assessor shall define the level of containment provided in the as built condition (e.g. irrelevant of condition). Select option from drop-down menu (note: the options available are a function of the material specified previously): Metallic: • "H4a parapet or welded steel half through type structure" • "N1 / N2 parapet or riveted steel / wrought iron half through type structure" • "Less than N1 parapet / cast iron" Masonry: • "Minimum thickness of 450mm and a height greater than 800mm" • "Minimum thickness of 450mm and a height greater than 1000mm"	DE Detailed Examination Report

Input Data	Description	Suggested Sources
	• "Minimum thickness of 350mm and a height greater than 1000mm" • "Minimum thickness less than 350mm and / or height greater than 1000mm" Concrete: • "H4a parapet" • "N1 / N2 parapet" • "Less than N1 parapet"	
Containment provided (due to defects)	Based on the defects identified, the Assessor shall qualitatively assess whether the defects are considered to affect the performance of the parapet. Select option from drop-down menu: • "Observed defects do not adversely affect the containment provided" • "Observed defects may adversely affect the containment provided" • "Little or no containment level provided due to observed defects"	DE Detailed Examination Report
Highway environment	For the purposes of this Tool, the highway environment is defined by 7 parameters. These parameters are used to assess the probability of a Road Traffic Accident (RTA) occurring. The parameters and scoring are based on the *Guidance Note Road Vehicle Incursions: Risk Assessment of Bridge and Neighbouring Sites (NR/GN/CIV/00012)* Road alignment – horizontal Select option from drop-down menu: • "Straight road with at least 7.3m carriageway" • "Straight road with less than 7.3m carriageway, or curved road with at least 7.3m carriageway" • "Curved road less than 7.3m carriageway" • "Reverse curves with less than 7.3m carriageway" Road alignment – vertical Select option from drop-down menu: • "Level or constant grade road" • "Slight hump back road" • "Hump back road where vehicles are inter-visible"	DE Detailed Examination Report Digital mapping

Input Data	Description	Suggested Sources
	• "Hump back road where vehicles are not inter-visible"	
	<u>Actual speed of road traffic</u>	
	Select option from drop-down menu:	
	• "Less than 30mph" • "30mph or greater, but less than 50mph" • "50mph or greater, but less than 70mph" • "Greater than 70mph"	
	<u>Site specific hazards</u>	
	Site specific hazards increasing the likelihood of an RTA include the following features in proximity to the bridge: farm access, road junction, private driveway, lay-by, bus stop, school, hospital, etc.	
	Select option from drop-down menu:	
	• "No obvious hazards" • "Single site specific hazard" • "Multiple site specific hazards and / or railway infrastructure likely to increase severity of incident"	
	<u>Road verges and footpaths</u>	
	Select option from drop-down menu:	
	• "Verge or footpath of at least 2m width to both sides of the road" • "Verge or footpath of at least 1m width to both sides of the road" • "Verge or footpath less than 1m to one or both sides of the road" (including bridges with no verge or footpath)	
	<u>Road signage / carriageway markings</u>	
	Select option from drop-down menu:	
	• "Signage / marking fit for purpose and clearly visible, or not needed" • "Signage / markings are not fit for purpose, non-existent or obscured"	
	<u>Volume of road traffic</u>	
	Select option from drop-down menu:	
	• "Less than 200 vehicles per day (e.g. lane or farm track)" • "Less than 2,000 vehicles per day (e.g.	

Input Data	Description	Suggested Sources
	unclassified road)" • "Less than 7,150 vehicles per day (e.g. B classified road)" • "Less than 12,500 vehicles per day (e.g. A classified road)" • "More than 12,500 vehicles per day (e.g. primary / strategic routes)"	

GUIDANCE NOTES FOR MASONRY ARCHES	**Network Rail**
	Level 0 Assessment Tool **Version MA 3.0**

<u>**Sheet name – Assmt Status**</u>

Input Data	Description
Assessment status	Select status of the assessment from drop down menu: • "Provisional" – *first generation of assessment signed off by CRE* • "Provisional", "Updated" and "Revalidated"
Outstanding actions	<u>Review of record drawings:</u> Select option from drop down menu – options "Yes", "No" or "N/A". <u>Site measurement of key / missing dimensions:</u> Select option from drop down menu – options "Yes", "No" or "N/A". The CRE is responsible for the review of the comments inserted for outstanding actions and making recommendations regarding site attendance to confirm / collect data. <u>Confirmation of ballast depth:</u> Select option from drop down menu – options "Yes", "No" or "N/A". <u>Confirmation of current condition:</u> Select option from drop down menu – options "Yes", "No" or "N/A". <u>Other:</u> Select option from drop down menu – options "Yes", "No" or "N/A". If "Yes", insert a comment.
Reason / basis for revalidation	Select option from drop down menu: • "Reconfirmed at next Detailed Examination" • "Review of current condition" • "Review of current use" • "Other" If "Other" selected, insert a comment.

Sheet name – SSI

This free text space is provided to record the findings of a supplementary site inspection (SSI).
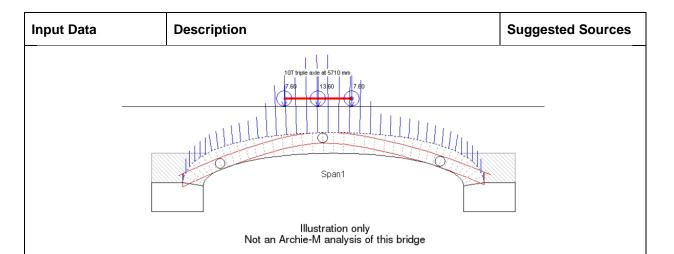
Sheet name – Arch Assmt

This is an output sheet from the Assessment Tool.

Input Data	Description	Suggested Sources
Assessment status	Pre-populated using input data	
Date and time of last calculations	Automatically generated	
Geometrical parameters	Pre-populated using input data *It should be noted that for spans under 4m there may be serviceability issues that are not considered within the Level 0 Assessment process. For spans under 4m, the appropriateness of the current examination regime for the structure shall be reviewed by Network Rail.* *For short span viaducts (less than 6m), the appropriateness of the span factor adopted shall be reviewed by Network Rail.*	
Live load type	Pre-populated using input data	
Assessment result	Pre-populated using input data An assessment result is provided by the Tool for the arch in an **as built** and **current** condition. Below the assessment results, a list is generated (if required) summarising the potentially significant defects that have not been considered within the current condition assessment result provided. The CRE shall consider this list within the recommendations made.	
Critical axle position and associated thrust lines		

Input Data	Description	Suggested Sources

10T triple axle at 5710 mm
7.60   13.60   7.60
Span1

Illustration only
Not an Archie-M analysis of this bridge

To insert the image:

1. Note automated image reference generated

2. Click button 'insert image file'

3. Select image with the matching reference to that automatically generated (the appropriate group number is also provided for information)

4. Click save or double click image file

An ARCHIE-M image taken from a parametric study is inserted. For the arch span considered within the assessment, the nearest span from the parametric study is selected with respect to providing an ARCHIE-M image. As such, the image result presented is representative, and not a definitive ARCHIE-M result for the arch under consideration.

The image illustrates the geometrical properties of the arch, critical axle load and position (for the assessed result provided) and associated thrust lines. The image provides the assessor with an indicative illustration of the arch behaviour, and the ability to understand the sensitivity of parametric variations if assumptions have been made.

Note: no image is provided for footbridge arch structures.

Qualitative assessment of substructure & foundation:

Pre-populated using input data

Sheet name – SPW Assmt

This is an output sheet from the Assessment Tool providing results for the qualitative assessment of the spandrel walls. The qualitative assessment of spandrel walls will only be provided for underline bridges and uses loading data from Track 1 as specified on the General sheet.

Input Data	Description				
Geometrical / parameters	Pre-populated using input data The table below provides guidance on the range of scoring adopted:				

Parameter	Value	Multi span		Single span	
		Min score	Max score	Min score	Max score
Bridge span	Less than 9m	62		44	
	Greater than 13m		83		58
Skew	No skew	0		0	
	Skew > 0 degrees		0		0
Pier geometry	Stocky	52			
	Slender		83		
Nearest rail to wall	Greater than 2.5m	35		24	
	Less than 1m		152		107
Fill depth at crown	Greater than 915mm	55		39	
	Less than 610mm		69		48
Parapet height	Less than 50mm	52		36	
	Greater than 600mm		76		53
Track curvature	Straight	0		0	
	Radius < 1500m		76		53
Haunching	Haunching evident	0		0	
	No haunching		42		29
Material parameters	Pre-populated using input data The table below provides guidance on the range of scoring adopted:				

Parameter	Value	Multi span		Single span	
		Min score	Max score	Min score	Max score
Spandrel / barrel material	Brick / brick	0		0	
	Stone / brick		152		107

Input Data	Description
Condition parameters	<u>Pre-populated using input data</u> The table overleaf provides guidance on the range of scoring adopted:

Parameter	Value	Multi span		Single span	
		Min score	Max score	Min score	Max score
Spandrel wall defects	No defects	0		0	
	Defects observed		152		107

Environmental factor	<u>Pre-populated using input data</u> The table below provides guidance on the range of scoring adopted:

Parameter	Value	Multi span		Single span	
		Min score	Max score	Min score	Max score
Environment	Beneficial	0		0	
	Adverse		114		80

Rail traffic factor	<u>Pre-populated using input data</u> The table below provides guidance on the range of scoring adopted:

Parameter	Value	Multi span		Single span	
		Min factor	Max factor	Min factor	Max factor
Type of traffic	EMU's etc.	0.5		0.5	
	HTA freight wagons		1.0		1.0
Tonnage	< 5m tonnes / annum	0.6		0.6	
	> 42m tonnes / annum		1.0		1.0

Steady state score	<u>Pre-populated using input data</u> A qualitative assessment status is provided by the Tool by way of a risk categorisation: • "Low" • "Medium" • "High" The risk bandings are summarised below:

Risk categorisation		Multi span		Single span	
		Min score	Max score	Min score	Max score
Low		0	599	0	399

Input Data	Description				
	Medium	600	750	400	500
	High	751	1000	501	700

Input Data	Description
Recommended actions	Pre-populated using input data Based on the steady state score, a number of recommended actions are given. The recommendations given are based on the score for "Freight Traffic (non HTA wagons)". A summary of all recommended actions based on the risk categorisation is summarised below: Low risk Management of structure as per established Network Rail asset management procedures (e.g. examination / assessment cycles). Medium risk Management of structure as per established Network Rail asset management procedures (e.g. examination / assessment cycles), but consider benefits of: • Further review of input data to ensure that the risk assessment assumptions are valid. • Understand the characteristics / condition / loading / environment of the structure that dictates a medium level of risk – may be critical if there is a change to the steady state. • Identify any requirement to "flag up" spandrel wall defects to Examiner, for particular attention during the routine examinations. • "Flag up" structure as potential for spandrel wall problems should there be a change in the steady state conditions. High risk For a high risk asset, it should be considered that the established Network Rail management procedures (e.g. examination / assessment cycles) may not be sufficient in managing the spandrel wall risks associated with the structure, therefore consider: • Review frequency of examinations, e.g. are special / sensitive examinations required to mitigate the risks to an acceptable level? • The value in undertaking structural monitoring of the structure for an established timeframe to understand if the spandrel wall defects are active under the steady state conditions. • Detailed assessment of the structure using the 3D linear finite element

Input Data	Description
	model tools.
	• Mitigation measures, including maintenance and / or strengthening works. Mitigation measures to be considered may include:
	• (Temporary) speed restriction over the structure.
	• (Temporary) weight restriction over the structure.
	• Maintenance activities (e.g. brick work / crack repairs)
	• Installation of pattress ties and plates.
	• Construction of concrete trough / saddle below permanent way.

Sheet name – PPT_Results

This page is generated if a qualitative assessment of the overbridge parapet has been undertaken.

Input Data	Description
ELR / Mileage	Pre-populated from sheet "General".
Assessment Status	Pre-populated from sheet "Assmt_Status".
Date & time of last calculations	Pre-populated date and time.
Highway Environment	For each highway parameter considered on sheet "PPT_Qual", a level of risk is provided by the Tool, as summarised below: • "Green" – *lowest risk with respect to an RTA occurring* • "Amber" – *medium risk with respect to an RTA occurring* • "Red" – *highest risk with respect to an RTA occurring*
Railway Environment	The route criticality is assessed within the Tool as a function of the ELR and mileage. Based upon the ELR and mileage input by the Assessor, the Tool will automatically look up the Strategic Route Section (SRS) applicable for this location. The SRS is then used by the Tool to assign a level of risk with respect to the consequence of an incident on the railway environment (e.g. cost of disruptions, unplanned possessions etc.)
Qualitative Assessment	An automated output is generated by the Tool as summarised below:
Output 1A	Provides the containment level (or comparative containment level) of the parapet in an <u>as-built condition.</u> The following outputs are available: • "H4a high containment" • "N2 normal containment (or comparative containment)" • "N1 normal containment (or comparative containment)" • "Less than N1 normal containment
Output 1B	Provides the containment level (or comparative containment level) of the parapet in its <u>current condition.</u> This is based on the qualitative assessment of the parapet defects and the following logic: • "Observed defects do not adversely affect the containment provided" *The containment level in the current condition will be that provided for the as built condition.* • "Observed defects may adversely affect the containment provided"

Input Data	Description
	The containment level in the current condition will be a downgrading (of one category) of that provided for the as built condition, e.g. H4a containment (as built) will be reported as N2 containment (for the current condition). • "Little or no containment level provided due to observed defects" *The containment level will be reported as less than N1 normal containment.*
Output 2	Provides the level of risk associated with the highway and railway environment. • Risk of an RTA is considered to be – "High" or "Low" • Consequence of an RTA on NR infrastructure is considered to be – "High" or "Low" If the mileage entered for the structure is outside the extents of the ELR, no result will be provided and a message stating this will appear in the results. The mileage should be checked and amended if necessary. This output will also provide a recommended action based on the current parapet condition (and therefore the level of containment provided) and the risk of an RTA occurring / consequence of an RTA / incursion occurring. "Parapet containment level is... • adequate • recommended for upgrade to H4a • considered to be a lower priority upgrade • recommended for upgrade to N2 or above ...based on the current condition"

Sheet name – CRE

This free text space is provided for the Contractor's Responsible Engineer recommendations to be recorded.

Sheet name – Form BA0(1)

Part 1 of the Certificate of Assessment and Checking – Assessment and Check Details

Input Data	Description	Suggested Sources
Address	Insert the address of the Company responsible for the assessment in Royal Mail standard format.	
Name (of person signing the Form BA0)	Name of the CRE from the assessing organisation.	
Title (of person signing the Form BA0)	Title of the CRE from the assessing organisation . To be completed by the CRE.	
Signing Form BA0	The Form BA0(1) should only be signed by the CRE. After filling in the Name and Title, the CRE must either verify that the Tracking Tables have been populated and checked by selecting "Yes" from the provided dropdown box, or otherwise select "No" but provide justification as to why this has not been carried out. The CRE may then go to the Assessment tab and select "Sign Forms" to complete Form BA0 sign-off. It is the responsibility of the Assessor to ensure each form is signed by a competent and approved person. The signatures will be checked and approved by Network Rail Structures Managers. Completing the signing procedure will lock all the information in Form BA0(1) sheet. Before signing the Form BA0(1) form the inputs will be checked to ensure no changes have been made since the calculation was run. If changes have been made, the calculation must be re-run before signing the forms. The Form BA0(1) cannot be signed unless Tracking Table status has been verified (with either a 'Yes' response, or a 'No' response with accompanying justification) and all scenarios have been calculated using the 'Calculate Scenarios' > 'Calculate All' button. This is even the case if only Scenario 1 (predefined) is being used.	

Sheet name – Form BA0(2)

Part 2 of the Certificate of Assessment and Checking – Review and Acceptance by Network Rail Structures Manager

Input Data	Description	Suggested Sources
Name (of person signing the Form BA0)	Name of the Structure Manager, Network Rail.	
Title (of person signing the Form BA0)	Title of the Structure Manager, Network Rail. To be filled by the Structure Manager.	
Key (of person signing the Form BA0)	The Form BA0(2) should only be signed by the Structure Manager. After filling in the Name and Title, go to Assessment menu and select "Sign Forms". Competing the signing procedure will lock the relevant information in Form BA0(2) sheet (i.e. "Structures Manager's comments on assessment") and change the Assessment Status to "Final". Before signing the Form BA0(2) form the inputs will be checked to ensure no changes have been made since the calculation was run. If changes have been made, the calculation must be re-run before signing the forms. On signing, two XML files will be created which are used for adding assessment information to the Level 0 database and CSAMS database respectively.	

Reference tables

These tables provide the Assessor / the CRE / Network Rail with an overview of assessed capacities for a selection of segmental arch configurations (in an as-built condition). These values are for guidance only, and will be subject to variation depending upon specific arch parameters.

UNDERBRIDGES									
2m single span									
Span to rise	Depth of fill at crown (mm)								
	300	500	1000	1500					
2	RA15+	RA15+	RA15+	RA15+					
4	RA15+	RA15+	RA15+	RA15+					
6	RA11	RA14	RA15+	RA15+					
8	RA6	RA8	RA15	RA15+					
4m single span					6m multi span with stocky piers				
Span to rise	Depth of fill at crown (mm)				Span to rise	Depth of fill at crown (mm)			
	300	500	1000	1500		300	500	1000	1500
2	RA15+	RA15+	RA15+	RA15+	2	RA13	RA14	RA15+	RA15+
4	RA15+	RA15+	RA15+	RA15+	4	RA10	RA10	RA11	RA13
6	RA11	RA12	RA15	RA15+	6	RA6	RA7	RA7	RA8
8	RA6	RA7	RA9	RA11	8	RA3	RA3	RA3	RA3

assuming a level of haunching to arch intrados at crown, soft brick construction and a typical barrel thickness for the span considered.

UNDERBRIDGES								
6m single span					8m multi span with stocky piers			
Span to rise	Depth of fill at crown (mm)				Span to rise	Depth of fill at crown (mm)			
	300	500	1000	1500		300	500	1000	1500
2	RA15+	RA15+	RA15+	RA15+	2	RA10	RA10	RA12	RA13
4	RA15+	RA15+	RA15+	RA15+	4	RA7	RA7	RA8	RA9
6	RA11	RA12	RA13	RA14	6	RA4	RA4	RA4	RA5
8	RA7	RA7	RA7	RA8	8	RA1	RA1	RA1	RA0
8m single span					10m multi span with stocky piers			
Span to rise	Depth of fill at crown (mm)				Span to rise	Depth of fill at crown (mm)			
	300	500	1000	1500		300	500	1000	1500
2	RA15+	RA15+	RA15+	RA15+	2	RA11	RA12	RA13	RA14
4	RA13	RA13	RA14	RA15	4	RA8	RA9	RA9	RA9
6	RA9	RA9	RA9	RA10	6	RA5	RA5	RA5	RA5
8	RA5	RA5	RA4	RA4	8	RA2	RA2	RA1	RA0

assuming a level of haunching to arch intrados at crown, soft brick construction and a typical barrel thickness for the span considered.

UNDERBRIDGES									
10m single span					**12m multi span with stocky piers**				
Span to rise	Depth of fill at crown (mm)				Span to rise	Depth of fill at crown (mm)			
	300	500	1000	1500		300	500	1000	1500
2	RA15+	RA15+	RA15+	RA15+	2	RA8	RA9	RA9	RA10
4	RA13	RA13	RA14	RA14	4	RA6	RA6	RA6	RA6
6	RA9	RA9	RA9	RA9	6	RA3	RA3	RA2	RA2
8	RA6	RA5	RA4	RA3	8	RA0	RA0	RA0	RA0
12m single span					**14m multi span with stocky piers**				
Span to rise	Depth of fill at crown (mm)				Span to rise	Depth of fill at crown (mm)			
	300	500	1000	1500		300	500	1000	1500
2	RA13	RA13	RA14	RA15	2	RA10	RA10	RA10	RA11
4	RA9	RA9	RA9	RA10	4	RA7	RA7	RA7	RA6
6	RA6	RA6	RA5	RA5	6	RA4	RA4	RA3	RA2
8	RA3	RA2	RA1	RA0	8	RA0	RA0	RA0	RA0

assuming a level of haunching to arch intrados at crown, soft brick construction and a typical barrel thickness for the span considered.

UNDERBRIDGES								
10m multi span with slender piers					**14m multi span with slender piers**			
Span to rise	Depth of fill at crown (mm)				Span to rise	Depth of fill at crown (mm)			
	300	500	1000	1500		300	500	1000	1500
2	RA4	RA4	RA5	RA6	2	RA3	RA4	RA4	RA4
4	RA2	RA2	RA2	RA3	4	RA1	RA1	RA1	RA1
6	RA0	RA0	RA0	RA0	6	RA0	RA0	RA0	RA0
8	RA0	RA0	RA0	RA0	8	RA0	RA0	RA0	RA0
12m multi span with slender piers					**17m multi span with slender piers**			
Span to rise	Depth of fill at crown (mm)				Span to rise	Depth of fill at crown (mm)			
	300	500	1000	1500		300	500	1000	1500
2	RA2	RA3	RA3	RA4	2	RA3	RA3	RA3	RA4
4	RA1	RA1	RA1	RA1	4	RA1	RA1	RA1	RA0
6	RA0	RA0	RA0	RA0	6	RA0	RA0	RA0	RA0
8	RA0	RA0	RA0	RA0	8	RA0	RA0	RA0	RA0

assuming a level of haunching to arch intrados at crown, soft brick construction and a typical barrel thickness for the span considered.

OVERBRIDGES								
8m single span					**12m single span**			
Span to rise	Depth of fill at crown (mm)				Span to rise	Depth of fill at crown (mm)			
	300	500	1000	1500		300	500	1000	1500
4	40t ALL	40t ALL	40t ALL	40t ALL	4	40t ALL	40t ALL	40t ALL	40t ALL
6	40t ALL	40t ALL	40t ALL	40t ALL	6	40t ALL	40t ALL	40t ALL	40t ALL
8	40t ALL	40t ALL	40t ALL	40t ALL	8	40t ALL	40t ALL	40t ALL	18t ALL
10m single span					**14m single span**			
Span to rise	Depth of fill at crown (mm)				Span to rise	Depth of fill at crown (mm)			
	300	500	1000	1500		300	500	1000	1500
4	40t ALL	40t ALL	40t ALL	40t ALL	4	40t ALL	40t ALL	40t ALL	40t ALL
6	40t ALL	40t ALL	40t ALL	40t ALL	6	40t ALL	40t ALL	40t ALL	40t ALL
8	40t ALL	40t ALL	40t ALL	40t ALL	8	26t ALL	40t ALL	18t ALL	18t ALL

assuming a level of haunching to arch intrados at crown, soft brick construction and a typical barrel thickness for the span considered.

Useful Reference Material

NR/GN/CIV/025 Issue 3   The Structural Assessment of Underbridges

NR/SP/CIV/035 Issue 2   Assessment of Structures

BD 21/01   The Assessment of Highway Bridges and Structures

CIRIA C656   Masonry arch bridges – condition, appraisal and remedial treatment

NR/L3/CIV/006/2C Issue 1   Handbook for the examination of structures

Part 2C: Condition marking of bridges