National Asset Delivery

Technical Surveys and Testing

565232 M5 J22-J33 River Brue and Huntspill River Bridges

Concrete Testing & Delamination Survey

Works Information

CONTENTS AMENDMENT SHEET

Amend. No.	Revision No.	Amendments	Initials	Date
0	0	Original version	ET	30/04/20

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1 DESCRIPTION OF THE WORKS

1.1 Project Objectives

1.1.1 The principle objective of this project is to undertake a concrete testing and delamination survey of River Brue and Huntspill River Bridges. The concrete testing and delamination survey will help to assess the current condition of the tops of the reinforced concrete piers, precast beam ends, diaphragms, abutments and bearing plinths at both structures. The testing survey will be carried out in accordance with the requirements detailed in the specification.

1.1.2 The specification that applies to the *works* is included in Section 6

1.2 Scope of *Services*

1.2.1 The *works* to be provided under this contract are:

(1) Concrete testing and delamination survey to be carried out the tops of the reinforced concrete piers, precast beam ends, diaphragms, abutments and bearing plinths at both structures, in accordance with section 6.0. The testing survey shall be carried out under traffic management provided by the *Client* (Highways England).

1.3 Deliverables

1.3.1 The *Contractor* is required to produce the following deliverables:

(1) A copy of the *contractors* testing report along with elevational drawings of the visual and delamination survey carried out on site. These are to be provided four weeks after completion of the testing survey.

2 EXISTING INFORMATION

2.1.1 Location

River Brue and Huntspill River Bridges carry the M5 northbound and southbound carriageway over the River Brue (North) and Huntspill River (South) between Junction 22 and 23, between MP 182.80 and MP 185.00.

2.1.2 The Drawings listed (Table 1) below apply to this contract. Refer to the site information for details of existing site conditions including ground conditions, limitation on access, position of existing structures etc.

Drawing Numbers		Titles	Revision/ Date
	HE565232-M5_ML_BR_1812	Location Plan – River Brue	-
	HE565232-M5_ML_BR_1818	Location Plan – River Huntspill	-
River Brue Original As-built Drawings (1973)	405/201/811/2/C	General Arrangement	Rev C 09/07/1978
	405/201/811/7/B	Details of Central Piers	Rev B 10/07/1978
	405/201/811/8/B	Pier Reinforcement	Rev B 10/07/1978
	405/201/811/9/C	Concrete Beam Details	Rev C 19/07/1978
	405/201/811/10/D	Deck Layout	Rev D July 1978
	405/201/811/11/B	Deck Reinforcement	Rev D 10/07/1978
	405/201/811/14/B	Details of Invert Slab to River Bed and Banks	Rev B 04/09/1974
	405/201/811/16/A	Approach Span Reinforcement	Rev A July 1972
	405/201	Sequence of Placing Concrete at Expansion Joints	January 1975
Huntspill Original As-built Drawings (1973)	405/201/807/2/D	General Arrangement	Rev D 23/08/1974
	405/201/807/7/B	Details of Central Piers	Rev B Sept 1975
	405/201/807/8/B	Pier Reinforcement	Rev B 23/08/1974
	405/201/807/9/C	Concrete Beam Details	Rev B Aug 1974
	405/201/807/10/0	Deck Layout	Rev D Sept 1973
	405/201/807/11/0	Deck Reinforcement	Rev D Sept 1973
	405/201/807/14/C	Details of Invert Slab to River Bed and Banks	Rev C July 1975
	405/201/807/16/A	Approach Span Reinforcement	Rev A 03/09/1973

Table 1: Contract Drawings

Drawing Numbers		Titles	Revision/ Date
River Brue Bearing Replacement Drawings (1999)	BP 1035.015 – 0102A	Deck Strengthening Details & Partial Demolition	Rev B March 1999
	BP 1035.015 – 0103A	Pier Partial Demolition	Rev B March 1999
	BP 1035.015 – 0104A	Pier Bearing Details	Rev B March 1999
	BP 1035.015 – 0111A	Abutment Bearing Details	Rev B March 1999
Huntspill Bearing Replacement Drawings (1999)	BP 1035.016 – 0202A	Deck Strengthening Details & Partial Demolition	Rev C March 1999
	BP 1035.016 – 0203A	Pier Partial Demolition Details	Rev B March 1999
	BP 1035.016 – 0204A	Pier Bearing Details	Rev B March 1999
	BP 1035.016 – 0211A	Abutment Bearing Details	Rev B March 1999

Table 1: Contract Drawings (Continued)

2.1.3 Photographs

Figure 1: River Brue Bridge, Southeast Elevation

Figure 2: River Brue South Pier below the Central Reservation and View of Precast Concrete Deck Beams, South Elevation.

Figure 3: River Brue Abutment Bearings and Bearing Plinths.

Figure 4: Huntspill River Bridge, Southeast Elevation.

Figure 5: Huntspill River Bridge South Pier, Bearings and Precast Concrete Beams, South Elevation.

Figure 6: Huntspill River Bridge Abutment Bearings and Bearing Plinths.

3 CONSTRAINTS ON HOW THE *CONTRACTOR* PROVIDES THE WORKS

3.1 General

3.1.1 The *Contractor* Provides the Services in such manner as to minimise the risk of damage or disturbance to or destruction of third party property.

3.1.2 The *Contractor* complies with the constraints and meets with the requirements outlined in Appendix 1.

3.1.3 The *Contractor* submits information detailing how the *Contractor* will provide the Works to the *Employer* prior to the *works* commencing. This information will include any lifting plans, risk assessments, method statements, the *Contractor's* staff training information and any other relevant Health and Safety requirements.

3.2 Working Hours & Site-Specific Constraints

3.2.1 The *Contractor's* working hours for site works shall be between the hours of 22:00 to 06:00, Monday to Friday. The working hours will vary subject to traffic flows and weather conditions and the stated hours include the time for the traffic management to be set out and picked up.

3.2.2 *The Consultant* to undertake works to the piers within the Traffic management provided by HE and shall remain within the highway's boundaries. The abutments are accessible from the river banks, although the owner of Brent Farm will need to be contacted in advance for access to the River Brue south abutment.

3.3 Health, Safety, Environment & Risk Management

Health and Safety requirements

3.3.1 In Providing the Works the *Contractor* meets the requirements of Annex 2 of the supplementary constraints relation to health and safety duties.

3.3.2 The *Contractor* shall comply with the requirements of Highways England's safety passport scheme and ensure that all employees, and any of his subcontractor's, are registered in accordance with the implementation of the scheme. Details on the scheme can be found here: http://www.highwayssafetyhub.com/safety-passport.html

3.3.3 For details of the CDM duty holders, refer to the pre-construction information which can be found here (565232 River Brue and Huntspill Designer's PCI for TST signed.pdf)

3.3.4 Before commencing the construction phase of the *works*, the *Contractor* confirms to the *Employer* that adequate welfare facilities are in place. Where

the facilities detailed in section 5 are not deemed adequate, the *Contractor* provides all necessary facilities to provide the Works and to comply with the minimum requirements set out in HSE guidance document L153.

Environmental requirements

3.3.5 In Providing the Works the *Contractor* meets the requirements of Annex 2 of the supplementary constraints in relation to environmental duties.

Risk Management

3.3.6 The *Contractor* identifies, manages and mitigates risks in accordance with the principles of ISO31000.

3.3.7 The *Contractor* submits a risk register, which captures all risks associated with the delivery of the *works* including those identified by the *Employer*, with his tender and maintains it for the contract period.

4 REQUIREMENTS FOR THE PROGRAMME

4.1.1 The *Contractor* submits programme to the *Employer* with his tender.

4.1.2 The *Contractor* Provides the Works taking into account the following programme constraints:

(i) the *starting date* and *completion date* and any post site works, reporting and review period

(ii) The services and other things provided by *Employer* (see Section 5)

4.1.3 The programme can be in the form of an activity and time related bar chart produced as a result of a critical path analysis.

4.1.4 The programme should preferably be provided in either a PDF or MS Project or MS Excel format and cover the full contract period including post site activities. Activities should be clearly defined and named and the programme should detail the following:

(i) the *starting date*, *completion date* & *Contractor's* planned completion
(ii) for each activity, the proposed resources (plant & labour) expected to deliver each activity should be shown on the programme
(iii) review periods for any reporting requirements
(iv) key dates for the *Employer* to provide '*services* and other things'
(v) key dates for co-ordination with Others

4.1.5 The *Contractor* updates the programme every week. The *Contractor* submits an updated programme to the *Employer* upon request.

5 SERVICES AND OTHER THINGS PROVIDED BY THE *EMPLOYER*

The *Employer* will provide the temporary traffic management (TM).

5.1.1 The following temporary traffic management will be provided by the *Employer* to allow the *Contractor* to Provide the Works:

(1) Testing survey at both bridge (pier) locations will be carried out within lane closures (hard shoulder and Lane 1) and a reduced speed limit on the M5. The details of the layout and type of TM will be provided to the successful CWF contractor.

(2) The *Employer* will provide the access equipment such as scaffolding and underbridge unit for the specified works. All other equipment for the testing survey will be provided by the C*ontractor*.

5.1.2 Not used.

6 SPECIFICATION FOR THE *WORKS*

6.1.1 The *Contractor* shall undertake the works in accordance with.

6.1.2 The following works proposed to the *Employer* comprise undertaking of various tests to investigate potential deterioration in both reinforced concrete structures (River Brue Bridge and Huntspill River Bridge). No work shall begin until the work is consented to in writing by the *Employer*.

The following types of site survey/tests will be used:

I. Detailed visual and delamination survey,

II. Cover survey,

III. Half-cell potential survey,

IV. Depth of carbonation,

V. Exposing reinforcement,

VI. Concrete sampling, and

VII. Core sampling

The following types of chemical tests will be carried out to the concrete samples collected:

I. Chloride Ion Content,

II. Alkali content, and

III. Cement content

The following types of physical tests will be carried out to the concrete core samples collected:

I. Visual examination of the core(s), and

II. Petrographic examination

6.1.3 **Site Tests**

It is recommended that the detailed visual and delamination survey be carried out first to identify areas exhibiting leakage, leachates, rust staining, delamination and spalling. Test areas will then be targeted to these areas identified as exhibiting deterioration. The test areas will be 2m x 1m and can be extended as deemed necessary (refer to BA 35/90 for guidance).

Appendix 3 (General Arrangements with Test Locations) shows the general areas where the test locations are the be carried out.

6.1.3.1 Detailed Visual and Delamination Survey of Concrete Surfaces

I. The *Contractor* shall carry out a detailed visual and delamination survey of parts of the structure under consideration, as agreed with the *Employer*.

II. The detailed visual and delamination survey shall identify all areas of cracking, delamination, spalling, exposed reinforcement (noting the condition of exposed reinforcement), rust staining, efflorescence, dampness, honeycombing, etc. Dimensions shall be recorded for major defects, such as areas of delamination and spalling, including depth measurements where necessary. It is imperative off-set dimensions to fixed structure locations are noted in relation to the defect(s) identified, to ensure accurate developed elevational drawings can be produced. In addition, cracks with widths greater than 0.3mm shall be mapped and the width also recorded. Locations of previous concrete remedial works shall also be identified and recorded.

III. The results of the detailed visual and delamination survey including the defects identified in Sub-clause 6.3.1.1 (ii) above shall be presented on developed elevation drawings. All major defects shall be photographed and detailed accurate measurements shall be recorded on the developed elevation drawings to show the extent and location of the defects identified during the survey to the satisfaction of the *Client*. The locations of the defects identified in Sub-clause 6.3.1.1 (ii) above shall be clearly shown on the detailed visual and delamination survey drawings.

IV. The *Contractor* shall also identify any services or any other obstructions that impede the survey work at the areas under investigation.

6.1.3.2 Cover Survey

I. Cover measurements shall be determined within each 500 mm x 500 mm grid established in proposed test areas.

II. Measurement of cover shall be carried out using equipment and procedures in accordance with BS 1881: Part 204[1] and Section 4.1 of the CBDG Technical Guide 2 to identify reinforcement size, position

[1] BS1881: Part 204: 1988, Testing concrete: Recommendations on the use of electromagnetic covermeters

and depth of cover. In addition, the lowest cover detected in each grid square shall be recorded.

III. Before the start of each day's work, the covermeter shall be calibrated against a standard block containing bars of known cover depth.

IV. A calibration check of the covermeter reading shall be made once in each test area by breaking back to expose a reinforcing bar and physically measuring the depth of cover with a calibrated Vernier or rule. Where only cover survey is to be carried out the standard reference block shall be used instead of having to break out concrete to calibrate the gauge. Breakout locations for half-cell measurement may be used for this purpose, where performed to double check the gauge.

V. Where the depth of cover by covermeter varies by more than 5mm from the measured value, a correction shall be applied to the readings within the test area.

6.1.3.3 Half-cell Potential Survey

Half-Cell Potential measurements shall be carried out and recorded in the following manner:

I. The tests shall be carried out in accordance with the American Society for Testing and Materials Standard Test Method C876-15[2].

II. The equipment shall comprise a reference electrode based on silver/silver chloride at 0.5M potassium chloride (Ag/AgCl/0.5M KCl)[3], calibrated against a standard, a sponge moistened with contact solution for making electrical contact with the concrete, and a digital voltmeter with input impedance of at least 100MΩ and electrical lead wires with compression-type clamps for bar attachment, as set out in ASTM C876-15.

III. Half-cell measurements shall be taken at a maximum of 500 mm x 500 mm grid centres in the test areas proposed. Locations of cracks, cold joints, delamination, spalling and areas of corrosion staining in particular may warrant closer grid centres to assess the half-cell potential over the feature.

IV. Before measurements are taken, two break-out exposures of reinforcement shall be made at diagonally opposite ends of each test

[2] ASTM C876-15: Standard Test Method for Corrosion Potentials of Uncoated Reinforcing Steel in Concrete

[3] ISO12696:2016: Cathodic protection of steel in concrete

area, having first located the bar with an electromagnetic covermeter (see 6.1.3.2). The electrical continuity between the two points shall be checked using a multimeter and electrical lead wires, after first preparing the exposed bar by scraping, scoring or wire brushing to expose a bright metal contact surface. If continuity is not confirmed, the test area shall be sub-divided until continuous areas are established.

V. Two half-cell readings shall be taken with the reference electrode and sponge at each node of the grid to the nearest 10 mV and the mean value used. Where the readings differ by more than 20 mV a third reading shall be taken and the mean of the two closest readings used. The result shall be corrected to an equivalent Cu/CuSO4 half-cell by subtracting 60mV from the mean reading[4].

VI. The *Contractor* shall ensure all recorded potential measurements are stable in line with the principles given in CBDG Technical Guide 2[5].

VII. Ambient conditions and concrete surface temperature shall be recorded together with details of the type of half-cell and its most recent calibration check.

VIII. Excavation to expose reinforcement for electrical connections shall be made good in accordance with the requirements of Series 1700.

IX. Where agreed, permanent electrical connections shall be made to the reinforcement by brazing or using a self-tapping screw into a drilled hole, to facilitate future monitoring of changes in potential at the location.

X. The results shall be presented as a map of equipotential contours marked on projected plans or elevations of the areas at a scale of 1:50.

XI. Potential contours shall be plotted with colour coding and a contour interval of 50 mV. Colour block diagrams are not an acceptable alternative to colour contours.

6.1.3.4 Carbonation Tests

I. Measurement of carbonation depth shall be made at the testing locations proposed.

[4] Concrete Society Report 73: Cathodic Protection of Steel in Concrete, 2011

[5] Concrete Bridge Development Group, Guide No 2, “Technical Guide to Testing and Monitoring the Durability of Concrete Structures”

II. The method of test is described in BS EN 14630:2006[6] shall be used. The test requires breaking the concrete to expose a freshly fractured surface and spraying the surface with phenolphthalein indicator solution within 30 seconds of fracturing. Within 2 minutes the carbonation depth shall be measured, being the distance from the surface of the sample to the start of the pink colouration.

III. Further guidance shall be obtained from Section 5.1 of the CBDG Technical Guide 2.

IV. Testing shall not be carried out on powder from drilled dust samples or the holes themselves, unless the concrete is broken out between two adjacent drill holes (e.g. for chloride ion content testing) to expose a freshly fractured surface.

V. Testing may be carried out on core samples, provided the side of the core or core hole is broken away with a chisel or light breaker to expose a fractured surface. Locations where concrete is broken out either to examine the bars (see 6.1.3.5) or to connect wires for half-cell potential testing (see 6.1.2) can also be used provided the exposure time requirement above is met.

6.1.3.5 Exposing Bars for Inspection

Reinforcing bars may be exposed for inspection when the results of the half-cell potential tests (see 6.1.3.3) are available and indicate possible corrosion activity.

I. In areas of high negative potential and/or where a significant difference in potential of more than 100mV exists between two adjacent readings, then the highest negative potential area shall be identified for exposure to inspect for bar condition.

II. The concrete cover shall be removed by coring to the depth of the bar, using a core barrel of not greater than 100 mm diameter (see 6.1.5.1) and breaking off the core.

III. The cover to the bar and its condition in terms of presence of active corrosion shall be recorded and a photograph of the condition shall be taken.

IV. The exposed bar shall be cleaned of corrosion product by chipping back to bright metal to allow section loss to be determined. A

[6] EN 14630:2003, Products and systems for the protection and repair of concrete structures – Test methods - Determination of carbonation depth in hardened concrete by the phenolphthalein method

calibrated calliper shall be used to measure the residual diameter, from which the remaining cross sectional area shall be calculated.

6.1.4 **Chemical Tests**

6.1.4.1 Chloride and Alkali (Na_2O equivalent) Content

The tests shall be carried out in accordance with BS 1881, Part 124. Guidance is provided in Section 7.1 of the CBDG Technical Guide 2.

The acid soluble test method shall be used to determine the chloride ion content at various depth increments, using concrete dust samples obtained by rotary percussive drilling. The normal depth increments shall be 5mm to 25mm, 25mm to 50mm, 50mm to 75mm and 75mm to 100mm.

I. The location for the drilled dust samples shall normally be selected as the highest negative half-cell potential determined from the potential contour maps, being the locations at greatest risk of corrosion. The exact position shall be determined to avoid reinforcing bars by using cover meter (see 6.1.3.2).

II. For each depth increment, dust samples shall be removed using a drill bit of at least 25mm diameter.

III. The minimum sample mass in each depth increment shall be 25g, which will normally require the collection of dust from two immediately adjacent drilled holes.

IV. The dust shall be collected and stored in sealable bags or containers, one for each depth range, clearly labelled with the location, depth range, date of sampling and the name of the operator.

V. The chloride ion content for each depth increment shall be determined by chemical analysis to determine the total acid soluble chloride ion content, expressed as a percentage of the sample mass.

VI. The test result by mass of sample shall be converted to the chloride ion content by mass of cement in the sample. The correction shall be based on either the known original cement content in the structure, or the calculated cement content from chemical analysis (see 6.1.4.2) or, in the absence of this information, an assumed cement content of 14% for insitu concrete and 21% for precast concrete.

VII. Where required, the sodium oxide and potassium oxide contents shall be determined following a similar approach, using the method of analysis given in BS1881: Part 124. The sodium oxide equivalent shall be reported by mass of cement in the sample.

6.1.4.2 Cement Content

The cement content shall be determined in accordance with BS 1881: Part 124 on concrete core samples; dust drillings shall not be used as the sample size will be inadequate.

I. Samples shall be prepared from sections of 100mm diameter cores or freshly broken lumps and each shall have a minimum mass of 1kg. Where possible information on the original mix design used, including details of aggregate types, cement and other binders used should be forwarded to the testing laboratory.

II. Cement content shall be determined by chemical analysis in accordance with BS 1881: Part 124, section 5.

III. Where aggregate interference prevents an accurate assessment of cement content then the alternative method of petrography should be used.

IV. General guidance is given in Section 7 of CBDG Technical Guide 2.

6.1.5 **Physical Tests**

6.1.5.1 Core Samples

I. Core samples shall be 100mm in diameter and cut to at least 150mm depth, in locations that have been mapped to avoid cutting reinforcing bars (see 6.1.3.2). The core shall be broken off to provide a sample that is at least 120mm in length to permit proper preparation.

II. Examination of cores, preparation and measurement of density and compressive strength shall be carried out in accordance with BS EN 12504-1.

III. Visual examinations shall be carried out on all core samples before testing.

IV. Samples shall be immersed in water for at least 72 hours prior to testing.

V. The saturated density (water immersion method) shall be determined immediately before the cores are crushed to determine the compressive strength.

VI. The compressive strength shall be determined on specimens that have a length to diameter of between 1:1 and 1:1.2. Samples outside of this dimension range will be unsuitable for strength testing.

6.1.5.2 Petrographic Analysis

The cement content, entrained air content and confirmation of a range of deleterious reactions can be determined by a full petrographic analysis including point counting of constituents. Guidance on the use of petrography on reinforced concrete samples is contained in Concrete Society Technical Report 71[7].

I. Samples shall be prepared from sections of 100mm diameter cores trimmed to give an outer section that is 50mm in diameter, or other section within the core that merits detailed investigation. Where possible information on the original mix design used, including details of aggregate types, cement and other binders used should be forwarded to the testing laboratory.

II. Visual and reflected light examination shall be used to give basic information on the concrete including depth of carbonation, cracking, segregated aggregate and reinforcement condition, where the bar is included.

III. Full petrographic examination in accordance with ASTM C856[8] or APG-SR2[9] shall be used to identify the aggregate rock types present, alkali aggregate and sulfate reactions, use of additions such as PFA or GGBS, degree of cement hydration, cement and aggregate content by volumetric proportion analysis, entrained air content and estimation of the original water content and water/cement ratio.

IV. Further guidance is provided in Section 6.6 of the CBDG Technical Guide 2.

6.1.6 The information obtained and recorded from the testing survey shall be compiled into a testing survey report by the *Contractor*. The finalised testing survey report will then be issued to the *Client* with any areas of concern highlighted.

[7] TR71, Concrete Petrography, The Concrete Society, 2010

[8] AMERICAN SOCIETY FOR TESTING AND MATERIALS, ASTM C856, Standard practice for the petrographic examination of hardened concrete, 2018

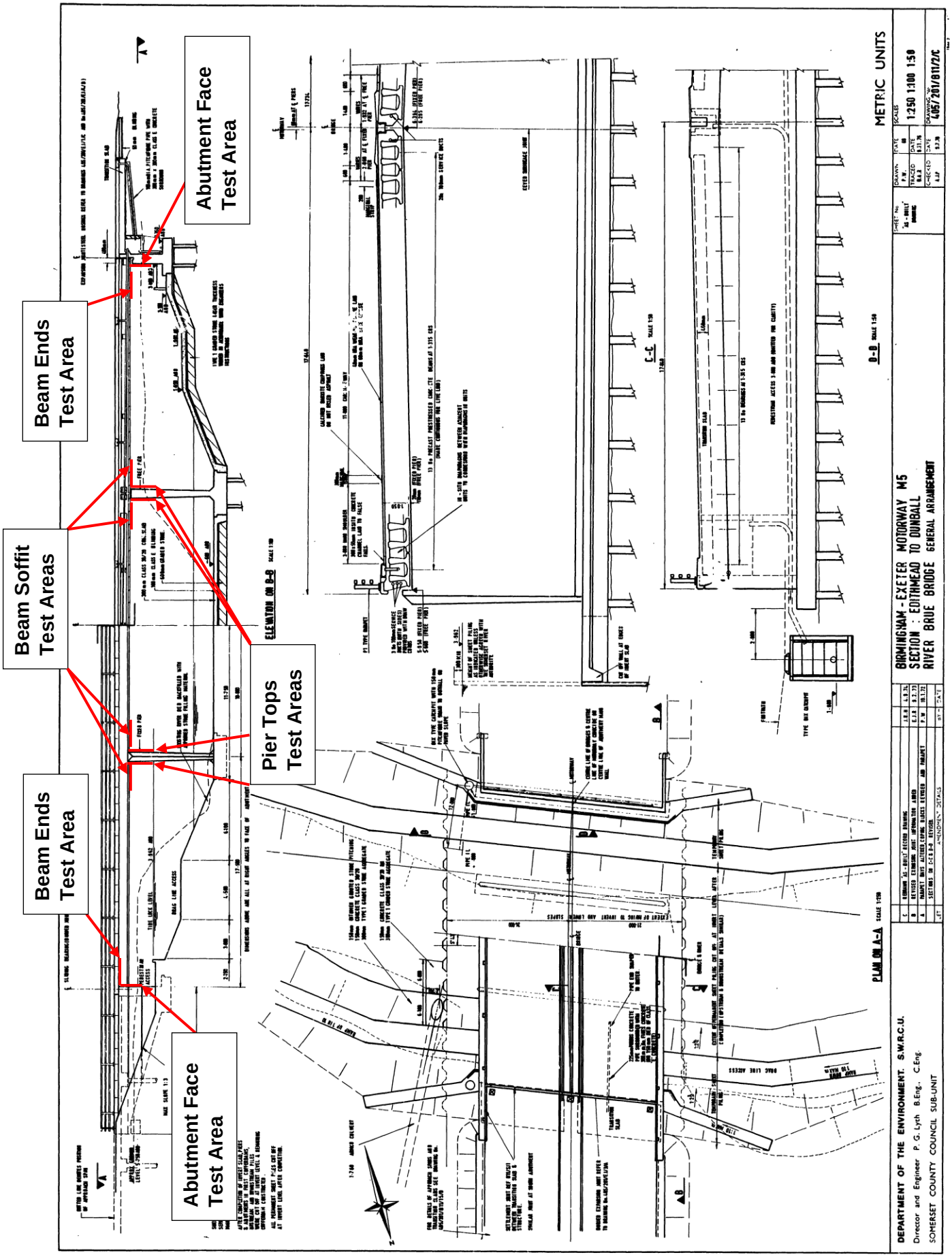
[9] APPLIED PETROGRAPHY GROUP. A code of practice for the petrographic examination of concrete (Author Eden, MA), The Geological Society of London, London, 2010. (http://www/appliedpetrographygroup.com/)

Appendix 1 – Supplementary Constraints

Appendix 2 – Designers Hazard Checklist and Risk Reduction Schedule

Appendix 3 – General Arrangements with Test Locations

Drawing No.	Drawing Title
405/201/B11/2/C	River Brue General Arrangement
405/201/B07/2/D	Huntspill River Bridge General Arrangement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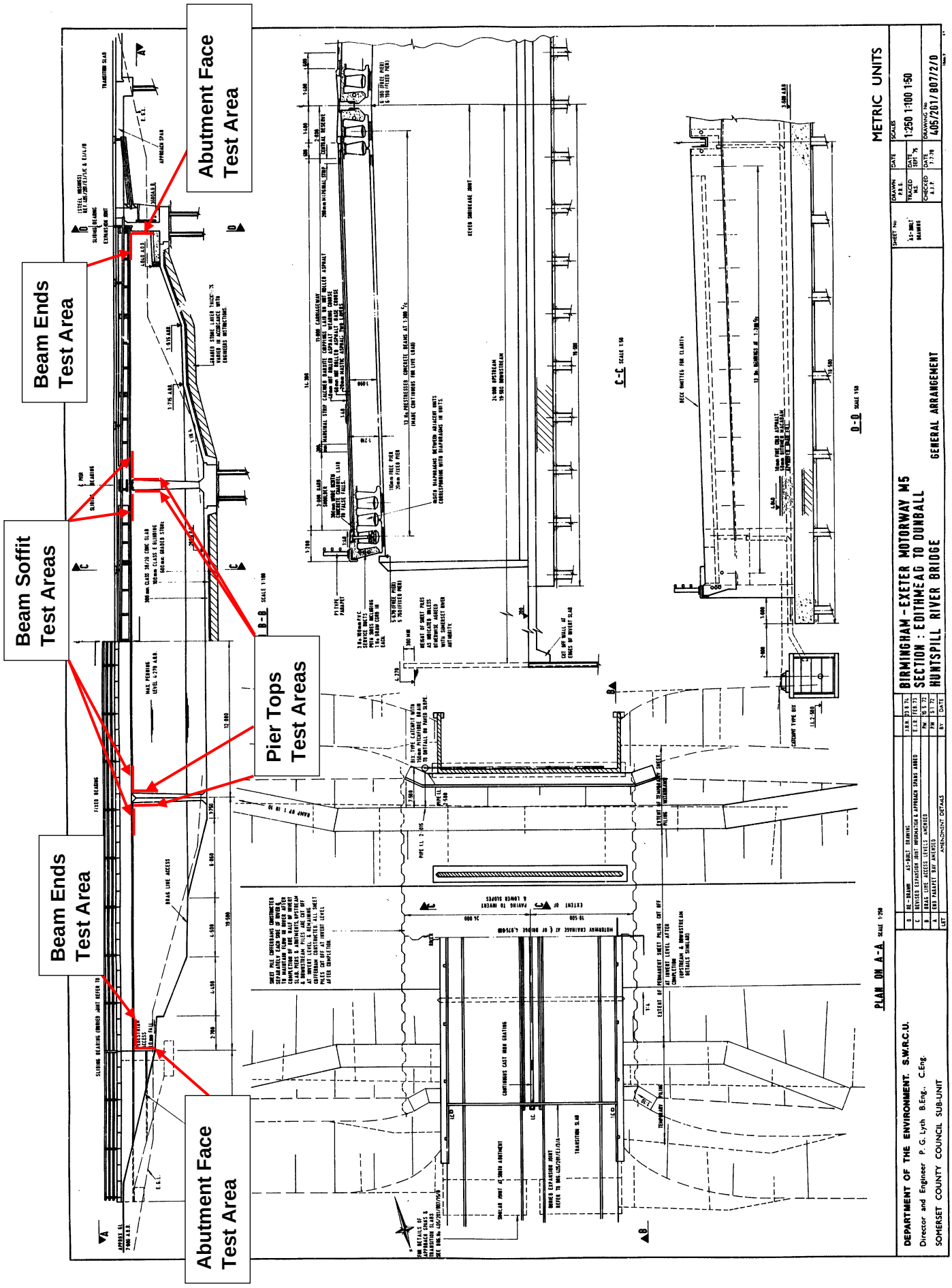
Beam Ends Test Area
Beam Soffit Test Areas
Pier Tops Test Areas
Beam Ends Test Area
Abutment Face Test Area
BIRMINGHAM - EXETER MOTORWAY M5
SECTION : EDITHMEAD TO DUNBALL
RIVER BRUE BRIDGE GENERAL ARRANGEMENT
METRIC UNITS
DEPARTMENT OF THE ENVIRONMENT S.W.R.C.U.
Director and Engineer P. G. Lyth B.Eng., C.Eng.
SOMERSET COUNTY COUNCIL SUB-UNIT
PLAN ON A-A
ELEVATION ON B-B
C-C
D-D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Beam Ends Test Area
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Director and Engineer P. G. Lyth B.Eng., C.Eng.
SOMERSET COUNTY COUNCIL SUB-UNIT
DRAWING No 405/201/807/2/0
SCALES 1:250 1:100 1:50