### NATIONAL STANDARD TECHNICAL SPECIFICATIONS FOR SURVEYING SERVICES

### STANDARD TECHNICAL SPECIFICATIONS

Version: 5.0  
Date: 1 March 2021

### SUMMARY OF REVISIONS

<table>
<thead>
<tr>
<th>Section</th>
<th>Date</th>
<th>Description of Amendment</th>
</tr>
</thead>
<tbody>
<tr>
<td>All sections</td>
<td></td>
<td>Extensive revision of all sections</td>
</tr>
</tbody>
</table>

Please send notification of errors and suggestions for improvements to this document to Richard Groom on Richard.groom@environment-agency.gov.uk
Throughout this document, where the term ‘Surveyor’ is used, this is equivalent to the term ‘Consultant’ as used in PSC contract documentation.
SECTION I – GENERAL REQUIREMENTS

APPLICABLE TO ALL SURVEYS

1.0 Responsibilities of the Client Survey Manager (CSM)

1.0.1 For all contracts the CSM shall provide:


(ii) Mapping showing the scope of work. CSM will authorise the Surveyor to download OS map data via the Defra Data Services Platform – see para 2.3.

(iii) After having validated the survey, the CSM is required to submit the survey to the terrestrial surveyor who covers the EA Area concerned. If there is any doubt about where to send the survey, it shall be sent to survey@environment-agency.gov.uk.

1.0.2 Where appropriate CSM may provide:

(i) Description cards for existing survey control stations and benchmarks

(ii) Details of conservation sites e.g. SSSIs

(iii) Information on any ‘hostile sites’ known to the Environment Agency.

(iv) Any relevant land ownership data known to the CSM

(v) Any other data necessary to the performance of the contract

The Surveyor will check that all relevant materials have been received from the CSM and request any missing information at least three working days before it is needed. Where materials are missing the Surveyor shall inform the CSM.

2.0 Duties of the Surveyor

2.1 Before contract commencement, the Surveyor shall provide the CSM with a copy of risk assessments for the work. These shall include a scoring system for assessing the likelihood and consequence components of the risk and the control measures which will be used to manage the risk. In addition, where the survey involves working within 2m of a watercourse, the Surveyor shall, as a minimum requirement, ensure that all members of the survey team hold a valid DEFRA (Module 2) Water and Flood First Responder training course certificate and that any recommendations for subsequent top-up training have been carried out.

The Surveyor shall ensure that any employee who operates a powered boat has a valid Royal Yacht Association (RYA) Powerboat Level 2 training course certificate.
The Surveyor shall check river levels and warnings before mobilising to site and shall monitor them whilst surveyors are on working on site. This information is available on: https://www.gov.uk/check-if-youre-at-risk-of-flooding.

2.2 If not informed in the tender documentation, the surveyor shall request survey job numbers and job titles from the CSM. The CSM can obtain new job numbers from the terrestrial surveyors. The principle is that surveys in different areas are given different job numbers and that the title includes the river name and extents of survey – eg River Mole – London Road Horley to Guildford Road, Leatherhead. A survey contract can comprise one or more jobs.

2.3 The Surveyor shall download the Ordnance Survey digital data that is required to perform the contract. This involves registering on the Defra Data Services Platform: https://environment.data.gov.uk/ and abide by the licensing requirements and conditions.

2.4 The Surveyor shall ensure that all staff working on Environment Agency projects have read Nat_Specs_V5.0_Guidance.doc and Sections I, II and the relevant technical sections III – X and relevant referenced documents of this document and demonstrate that they understand the content.

2.5 The surveyor shall ensure that field surveyors have read and understood the survey scope for each survey commission.

2.6 All documents and reports shall be digital wherever possible in DWG, PDF, Word, Excel format where appropriate. Only when digital documents and reports cannot be provided shall paper documents be produced. Paper shall be recycled containing at least 80% post-consumer waste and printed double-sided. Colour photography and plots of the data need not be printed on double-sided or recycled paper if this impairs their accuracy or clarity.

2.7 Field surveyors are to carry equipment (loppers, shears, secateurs) for light vegetation clearance to site and, subject to the agreement of the land owner, use it to clear sight lines.

2.8 The surveyor shall note any obviously defective assets in the survey report, ‘Comments’ section. In situations where a defect presents an immediate risk, they should notify either the EA Project Manager or the Environment Agency Incident Hotline: 0800 807060. It is not expected that the surveyor will identify all asset defects unless specifically requested in the Scope.

2.9 The surveyor shall check that their work will not affect scheduled monuments, conservation areas SSSIs etc using www.magic.gov.uk (in England) or http://jura.rcahms.gov.uk/NMW/Map (in Wales) and ensure that permissions are obtained where necessary to work in these areas.
3.0 Surveyor’s environmental responsibilities

3.1 Any cut vegetation shall be deposited clear of the river banks, in a location where it will not be washed into the watercourse and subsequently cause a blockage. It should never be thrown into the watercourse. The Surveyor is to inform the CSM if any significant heaps of cut vegetation have been made and if vegetation has inadvertently entered the watercourse.

3.2 Any areas of invasive weed shall be shown on the drawings and brought to the attention of the Environment Agency as a comment in the survey report. Note that some invasive weeds are hazardous to health and that field surveyors should be made aware of them. See Invasive Plants_guidance.doc which is provided in NatSpecTemplates.zip

3.3 Surveyor is to ensure that staff are familiar with the requirement to identify and report non-native species. Information is available via an E-learning video at http://www.nonnativespecies.org/index.cfm?sectionid=123 This includes “Check, Clean, Dry” procedures.

3.4 Surveyor is to abide by seasonal access restrictions for the protection of wildlife (eg bird nesting and fish spawning periods).

3.5 Surveyor is report suspected pollution incidents or other irregularities to the Environment Agency Incident Hotline: 0800 807060. Incidents shall be noted in the survey report with their EA incident reference

4.0 Outputs

4.1 Grid

All coordinate data shall be presented on Ordnance Survey National Grid (EPSG::7953) with heights above Ordnance Datum (Newlyn) (EPSG::7711) using GNSS (Global Navigation Satellite System) transformation models current at the time of survey, unless otherwise specified in the survey scope. Coordinate reference system, height datum and transformation models used shall be stated in the survey report and on all drawings and data.

Only under exceptional circumstances is a local arbitrary grid to be used. If a local grid is used, the easting values shall not match the northing values anywhere on the site and the coordinate values shall be such that they cannot be confused with National Grid coordinates. The local grid shall be orientated approximately to north and have a scale factor of 1. The use of a local grid shall be clearly noted on any survey drawings and documented in the Survey report.

If the OS National Grid is modified so as to achieve a scale factor of 1 over the site, details of the modification shall be stated clearly in survey report and on drawings, so that it is possible to transform unambiguously between the modified grid and true National Grid.
4.2 The Survey is to be presented, where appropriate, as PDF format documents in the Environment Agency standard sheet format to include the Agency standard legend, which will be used with the title box and frame. The title box shall not be repositioned without the agreement of the CSM.

4.3 The Surveyor will provide the data defined in the Survey Scope at the delivery stage, for validation by the CSM and provide, in a timely fashion, any supplementary information, survey data or intermediate products (with or without a commercial value) as required by the validation surveyor to enable or assist in validating the survey. Intermediate products will not be retained or copied by the CSM. If any remedial action is required, the CSM will inform the Surveyor by email of remedial action which is required and provide feedback for future reference. Remedial action shall be carried out within a period of five working days, or other negotiated and agreed period. After validation and any necessary remedial action the Surveyor shall reissue the entire project unless otherwise agreed with the CSM.

4.4 The Surveyor shall request a link from the CSM to deliver digital data via FTP, or deliver by another method, as agreed with the CSM.

5.0 Photography

5.1 The standard resolution for photography shall be approx 3200 x 2400 pixels. Where batches of photography are required (eg channel survey cross-sections) these shall also be supplied at a resolution of approx 1600 x 1200 pixels by running a photo resizing program on the batch of photographs. The names for directories containing batch photographs shall be suffixed with 3200 or 1600 to indicate the resolution.

5.2 General photographs of the site shall be taken. Direction of view shall be stated.

5.3 Photographs are not to include identifiable people (including the Surveyor’s staff) unless those people have given their express written permission to be photographed and are aware that the data will be made available for download as Open Data. Records of permission shall be retained by the Contractor for six years. In public areas where photography including people is unavoidable, Surveyor shall ensure that people photographed are not in the foreground and that their privacy is respected as much as is possible.

6.0 Survey report

6.1 A survey report is required for all surveys carried out under this specification. This metadata is required to assist the Client survey manager in validating the survey. It also records essential information should the survey be required for another project at a later date. The report is not however intended to be burdensome. It should be confined to recording the information that any surveyor would need when reviewing the survey at a later date to confirm how the work was done and its quality. The report shall include details any defects of data coverage or quality.
6.2 The report shall be based upon template report.doc and presented as one file, including appendices. The report shall be submitted as a Word document and OCR compatible PDF.

6.3 All field notes and data sheets, reductions and computations shall be supplied as text files, 100dpi scanned jpg files and/or PDF files.

6.4 The survey report shall state the transformation used to calculate coordinates (e.g. OSTN15 and OSGM15)

7.0 Calibration and verification of instruments

7.1 All instruments shall be calibrated or verified (as appropriate) in accordance with RICS guidelines (e.g ISBN: 9781842193525). Where there is no published guideline, accepted industry practice shall be adopted – if necessary from text books. Copies of relevant certificates shall be included in each survey report.

For levelling instruments, a two-peg test shall be carried out at the beginning of each survey project, at weekly intervals thereafter and if the instrument receives a knock. Results are to be documented and submitted with the survey report.

8.0 Public Relations and Access

8.1 The Surveyor is responsible for finding out if the survey is affected by special regulations (e.g. Crown, Ministry of Defence lands), Listed Buildings, Scheduled Ancient Monuments, SSSIs etc., by searching using www.magic.gov.uk, or http://jura.rcahms.gov.uk/NMW/Map in Wales. The Surveyor shall comply with any legislation or special rules, which affect these sites.

8.2 The surveyor should request from the CSM an introduction letter based upon the template letter LandownerIntroLetter.doc and a ‘while you were out’ note (if required) based upon the template whileout.doc. For threshold surveys, template thresholdpermitletter.doc should be used.

8.3 Surveyor’s responsibilities regarding access to land
The Surveyor is to notify the CSM at least three working days prior to need that they require the letters specified in paragraph 8.2 above and any landowner and access information that the CSM has obtained from internal Environment Agency sources. The Surveyor shall duplicate sufficient copies of these documents. The Surveyor shall investigate land ownership through internet searches.

Verbal approval for access from the occupier is sufficient. There is no requirement for proof of title to be obtained or for Land Registry searches to be carried out unless ownership cannot be ascertained through enquiries on site.

For agricultural properties the introduction letter shall be delivered at least 24 hours before access is required. For residential properties, the letter shall be delivered at
least 7 days before access is required. When the Surveyors arrive on site to carry out the fieldwork, they shall call on the landowner to advise of their presence and, if there is no response, shall deliver a ‘we called while you were out’ note (if required).

Having been introduced by the CSM, the surveyor shall maintain contact with public volunteers groups, as necessary.

The convenience and feelings of each landowner are to be respected and a polite and professional attitude maintained. In cases of adamant refusal of access the Surveyor will immediately withdraw from the site without demur and report the refusal to the CSM who may take appropriate action to obtain access.

8.4 The Surveyor shall obtain permission from the reputed owner or tenant before establishing any permanent marks or before carrying out any damaging works, such as clearance of sight lines. The Environment Agency will not be responsible for any damage or distress caused by the Surveyor.

8.5 The Surveyor shall be responsible for obtaining all permissions that he/she might need for use of equipment associated with the work and for adhering to land owner requirements regarding permits to survey and for entry on to land to make measurements. In respect of authorities to be consulted, the Surveyor’s particular attention is drawn to the procedures to be adopted when obtaining permits for surveys undertaken on or where access is required over areas designated as SSSI, railway property, or involving MOD property (EA powers of entry are not applicable for Crown Estate land). The Surveyor shall make themselves aware of the limitations on access both in terms of the method of working and timing, which the relevant authorities might impose.

8.6 The Surveyor shall ensure that all site staff carry an identification card whilst they work on Environment Agency projects. The ID card shall include a photograph, employee name, company name and contact details. This information shall be clearly displayed at chest height at all times. Field surveyors shall carry copies of the ‘to whom it may concern’ letter and take care not to lose them. The letters shall be shredded on completion of fieldwork. These precautions are necessary to prevent the letters falling into the wrong hands. Surveyor is to record properties visited with date, time and response but not personal details.

8.7 If required by the CSM, the Surveyor shall insert notices in the local press and shall notify the local police of the survey.

9.0 Progress Reports and Early Warnings

9.1 A brief (one page) progress report shall be submitted each Friday (p.m.) by email throughout the contract against the programme presented with the Method Statement, using the template provided in templates.zip.

9.2 The Surveyor shall raise an early warning where changes to the Scope or the accepted Programme occur or where significant issues arise on a project. Reports are to be submitted to the Employer as soon as they are realised by the Surveyor to allow
informed decisions to be made by the project team. The early warning shall provide the Surveyor’s best indication of the effect on the forecast and the Programme at the time of it being raised.

10.0 Accuracy and completeness

10.1 Accuracy specifications quoted throughout this specification are for 1 sigma (σ). This is a measure of the error present in observed data and includes residual systematic errors remaining after they have been measured and removed. Residual systematic errors shall be minimised by removing as much systematic error as possible. For example, if the specified accuracy is stated as 0.09m, this means that there is a 68% probability that any surveyed value will be within 0.09m of the ‘true’ value, there is a 95% probability that it will be within 0.18m and a 99.7% probability that it will be within 0.27m of the true value.

Survey Detail Accuracy Band Table

Reproduced by kind permission from RICS publication *Measured surveys of land, buildings and utilities* 3rd edition ISBN 978 1 78321 064 0

<table>
<thead>
<tr>
<th>Plan accuracy (X,Y)</th>
<th>Height accuracy (Z)</th>
<th>Example survey types/uses</th>
<th>Equivalent legacy plot scale</th>
<th>Min size of feature shown true to scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Band</td>
<td>1 sigma</td>
<td>2 sigma</td>
<td>Band</td>
<td>Accuracy hard detail</td>
</tr>
<tr>
<td>A</td>
<td>+/- 2mm</td>
<td>+/- 4mm</td>
<td>A</td>
<td>+/- 2mm</td>
</tr>
<tr>
<td>B</td>
<td>+/- 4mm</td>
<td>+/- 8mm</td>
<td>B</td>
<td>+/- 4mm</td>
</tr>
<tr>
<td>C</td>
<td>+/- 5mm</td>
<td>+/- 10mm</td>
<td>C</td>
<td>+/- 5mm</td>
</tr>
<tr>
<td>Plan accuracy (X,Y)</td>
<td>Height accuracy (Z)(^1)</td>
<td>Band</td>
<td>1 sigma</td>
<td>2 sigma</td>
</tr>
<tr>
<td>---------------------</td>
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<td>---------</td>
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</tr>
<tr>
<td>D</td>
<td>+/- 10mm</td>
<td>+/- 20mm</td>
<td>D</td>
<td>+/- 10mm</td>
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<tr>
<td>E</td>
<td>+/- 25mm</td>
<td>+/- 50mm</td>
<td>E</td>
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</tr>
<tr>
<td>G</td>
<td>+/- 100mm</td>
<td>+/- 200mm</td>
<td>G</td>
<td>+/- 50mm</td>
</tr>
<tr>
<td>Band</td>
<td>Plan accuracy (X,Y)</td>
<td>Height accuracy (Z)&lt;sup&gt;1&lt;/sup&gt;</td>
<td>Example survey types/uses&lt;sup&gt;2&lt;/sup&gt;</td>
<td>Equivalent legacy plot scale</td>
</tr>
<tr>
<td>------</td>
<td>---------------------</td>
<td>-------------------------------</td>
<td>---------------------------------</td>
<td>-----------------------------</td>
</tr>
<tr>
<td></td>
<td>1 sigma</td>
<td>2 sigma</td>
<td>Accuracy</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>hard detail</td>
<td></td>
</tr>
<tr>
<td>H</td>
<td>+/- 250mm</td>
<td>+/- 500mm</td>
<td>Low accuracy topographic surveys, national urban area mapping, geotechnical mapping, tree surveys</td>
<td>1:1000</td>
</tr>
<tr>
<td>I</td>
<td>+/- 500mm</td>
<td>+/- 1000mm</td>
<td>Low accuracy topographic mapping, national non-urban mapping, general boundary mapping, asset mapping, utility survey - detection QL-B4 PAS 128 (UK)</td>
<td>1:2500</td>
</tr>
<tr>
<td>J</td>
<td>+/- 1000mm</td>
<td>+/- 2000mm</td>
<td>Low accuracy route/corridor planning surveys, large area GIS asset mapping</td>
<td>1:5000</td>
</tr>
<tr>
<td>K</td>
<td>+/- 30mm</td>
<td>+/- 60mm</td>
<td>Low accuracy measured building surveys, topographic surveys, high accuracy utility tracing, gross area surveys</td>
<td>1:200</td>
</tr>
<tr>
<td>L</td>
<td>+/- 2mm</td>
<td>+/- 4mm</td>
<td>Monitoring, high accuracy engineering setting out and fabrication surveys</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Where different accuracy bands are to be applied for plan and for height detail, the accuracy band shall be stated in the survey scope with a suffix XY, for the plan accuracy band and Z for height accuracy band. For example G-XY: L-Z means accuracy band G in plan and L in Z and could potentially apply to a level monitoring survey.

When selecting survey techniques, the surveyor shall justify their choice considering the error budget for the entire system, including position and orientation of the survey.
instrument, accuracy and precision of the instrument itself, the nature of the objects being surveyed (e.g. angle of incidence when scanning surfaces), and environmental conditions (e.g. refraction).

The deliverables shall be complete. The CSM shall be informed immediately if it is not possible to survey any particular data and any data which not been omitted shall be described and explained in the survey report.

In addition to the above, all data supplied by the surveyor shall have been surveyed in such a way (with sufficient redundancy and/or checks) that non-conformances with the specification can be detected without further fieldwork. The surveyor shall ensure that products conform with these specifications, the survey scope and guidance documents and shall carry out any remedial work as necessary at their own expense, before submitting final deliverables.

11.0 Standard specification for Autocad digital drawings – where applicable

11.1 The EA’s CAD and Object Standard and associated documents can be downloaded from: https://adoddleak.asite.com/adoddlepublic/dpd/7BAoGtrLaoqEUGtAGG. The standard is mandatory from May 2020 for all new projects commissioned through the Collaborative Delivery Teams (CDT).

11.3 The surveyor shall select the correct drawing frame from those provided with the CAD & Object Standard (EnvironmentAgencyAutoCADDrawingAndScheduleFrames.dwg).

List of drawing frames in EnvironmentAgencyAutoCADDrawingAndScheduleFrames.dwg:

<table>
<thead>
<tr>
<th>Sheet No</th>
<th>Size</th>
<th>Orientation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0001</td>
<td>A0</td>
<td>Landscape</td>
<td>Internal</td>
</tr>
<tr>
<td>0002</td>
<td>A0</td>
<td>Landscape</td>
<td>Supplier</td>
</tr>
<tr>
<td>0003</td>
<td>A0</td>
<td>Landscape</td>
<td>Supplier+Sub-Con</td>
</tr>
<tr>
<td>0004</td>
<td>A0</td>
<td>Landscape</td>
<td>Topo and Utilities</td>
</tr>
<tr>
<td>0005</td>
<td>A0</td>
<td>Portrait</td>
<td>Internal</td>
</tr>
<tr>
<td>0006</td>
<td>A0</td>
<td>Portrait</td>
<td>Supplier</td>
</tr>
<tr>
<td>0007</td>
<td>A0</td>
<td>Portrait</td>
<td>Supplier+Sub-Con</td>
</tr>
<tr>
<td>0011</td>
<td>A1</td>
<td>Landscape</td>
<td>Internal</td>
</tr>
<tr>
<td>0012</td>
<td>A1</td>
<td>Landscape</td>
<td>Supplier</td>
</tr>
<tr>
<td>0013</td>
<td>A1</td>
<td>Landscape</td>
<td>Supplier+Sub-Con</td>
</tr>
<tr>
<td>0021</td>
<td>A2</td>
<td>Landscape</td>
<td>Internal</td>
</tr>
<tr>
<td>0022</td>
<td>A2</td>
<td>Landscape</td>
<td>Supplier</td>
</tr>
<tr>
<td>0023</td>
<td>A2</td>
<td>Landscape</td>
<td>Supplier+Sub-Con</td>
</tr>
<tr>
<td>0031</td>
<td>A3</td>
<td>Landscape</td>
<td>Internal</td>
</tr>
<tr>
<td>0032</td>
<td>A3</td>
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<td>Supplier</td>
</tr>
<tr>
<td>0033</td>
<td>A3</td>
<td>Landscape</td>
<td>Supplier+Sub-Con</td>
</tr>
<tr>
<td>0041</td>
<td>A4</td>
<td>Portrait</td>
<td>Internal</td>
</tr>
</tbody>
</table>
Surveyors working directly for EA clients shall use the ‘Supplier’ templates. Surveyors working through a framework shall use the ‘Supplier+Sub-Con’ templates. Surveyors to select the most appropriate template for the work in agreement with the CSM but all topographic surveys shall use template 0004. Template 0053 shall not be used, because Word format files are required for station descriptions.

11.4 All drawings shall be presented in Autocad version 2014 .dwg format. Surveyed data shall be presented in ‘model space’. Drawing sheet layouts shall be drawn in ‘paper space’ with windows to the topographic data. The position and orientation of sheet layouts shall be optimised to minimise the number and size of sheet. Where practical, each drawing relating to a particular model shall be a tab in paper space. If hard copy plots are specified in the survey scope they shall be delivered in colour and folded.

11.5 All .dwg files shall also be submitted as zipped .dxf files.

11.6 All drawing sheets that are or would be submitted as hard-copy shall be also be submitted as PDF with multi-sheet PDFs for each Autocad drawing. Interactive PDF drawings shall be supplied if requested in the survey scope. These shall be ‘plotted’ to the same scale as hard-copy.

11.7 All survey data will be provided in three-dimensional data form (3D) unless otherwise noted in the Survey Scope. This means that all surveyed points shall be 3D, although these may be interpolated from a DTM.

11.8 Drawing shall be set up and delivered with UNITS set to metres or ‘Metre’, decimal, 3 decimal places, decimal degrees with 4 decimal places and angles measured clockwise from north. Millimetre units shall not be used unless specified in the survey scope.

11.9 Text shall not be smaller than 1.5mm at intended plot scale. Wherever possible a larger text size shall be used.

11.10 Each feature shall be placed in its appropriate layer in accordance with the EA CAD and Object standard par 2.5. The standard list of topographic features and their corresponding layer names is provided in the templates directory, file EA_UNICLASS_Codes.xls. Note however that underground utilities layers are specified within the CAD and Object standard.

12.0 Standard specification for data supplied for GIS

Where required in the survey scope, data to be supplied in ESRI shape file format.
13.0 Data Management and File Naming

13.1 The deliverables for every survey shall be referenced using a job number, which shall be obtained from the terrestrial surveyor covering the area concerned or through survey@environment-agency.gov.uk, using ‘Job number request’ in the subject line.

13.2 For surveys commissioned outside the Collaborative Delivery Teams (CDT):

13.2.1 All files shall be named JAAAAA_BBB_Free text, where JAAAAA is the survey job number, BBB is data product code (see survey scope para 2.4.1). Free text shall be used to provide further information. Note that “_” spacers must be used in file names to avoid confusion with field delimiters.

13.2.2 The file structure to be used for supply of data deliverables is provided as File Structure Template.zip in the Templates directory. Currently data is required only in the ‘All data’ format. Open data will be required at a later date when it will be specified in the scope of work.

13.2.3 The file structure for “All data” deliverables is:

```
J00XXX All Data
 Channel 1
 Data Files
 Drawings
 Photographs
 Channel 2
 Data Files
 Drawings
 Photographs
 Control
 Deformation
 Data Files
 Drawings
 Photographs
 Extent
 Flood Recording
 Data Files
 Drawings
 Photographs
 Report
 Thresholds
 Data Files
 Drawings
 Photographs
 Topographic
 Data Files
 Drawings
 Photographs
```

The spatial extent, as required under 13.4 below, shall be stored in the Extent folder.
13.3 For surveys commissioned through the Collaborative Delivery Teams (CDT), the CSM shall obtain a survey job number from the terrestrial surveyor covering the EA Area concerned or by emailing survey@environment-agency.gov.uk. File naming shall follow the requirements stated in the Employer’s Information Requirements para 1.2.3.11, subject to the following provision, which will ensure that the survey job number and type of data is recorded within each survey file name, and that the files can be sorted into the EA survey archive directory structure:

<table>
<thead>
<tr>
<th>Field Number</th>
<th>Field Descriptor</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>Role</td>
<td>‘G’</td>
</tr>
<tr>
<td>13</td>
<td>Title</td>
<td>Survey archive data, as specified in 13.2.1 above</td>
</tr>
</tbody>
</table>

The CSM shall ensure that these requirements are adhered to and shall submit the survey files to the terrestrial surveyor covering the EA Area concerned or to survey@environment-agency.gov.uk.

If a code is needed for a new product, a request should be emailed to survey@environment-agency.gov.uk.

13.4 As specified in the survey scope, mandatory products table, the spatial extent of the survey shall be saved in a digital format suitable for inputting to ArcGIS. Each feature shall have attributes that include the job number and type of survey, and use the following geometry types:

- **Channel:** Polyline *(will be the centre-line data as specified in Section IV 10.2.2.)*
- **Topographic:** Polygon
- **Deformation:** Polygon
- **Thresholds:** Points
- **Crest Levels:** Polyline
- **Flood Recording:** Points
- **Culvert:** Polyline
- **Waste Site:** Polygon
SECTION II – SURVEY CONTROL

1.0 Control Surveying

Except where otherwise defined in the scope, all horizontal and vertical control shall be derived directly or indirectly from OS Net® in accordance with paragraph 2.

Where vertical control is established using spirit levelling, paragraph 3 shall be used.

Where control is established using traversing, paragraph 4 shall be used.

A dynamic risk assessment is to be carried out before establishing any survey station to ensure that it is located in a safe place for the surveyor to observe and does not present a hazard for third parties, e.g. not close to road edges or blocking footpaths.

The surveyor shall take care to detect and correct errors in survey control observations and computations. Where there are existing survey control stations on the site, their values shall, where possible, be checked using network RTK (Real Time Kinematic) techniques with two sessions of three minute observations separated by at least 20 minutes. If the difference between the published height and the mean newly observed height exceeds 30mm, the discrepancy shall be referred to the CSM at the same time as the E6 control computations.

Environment Agency Control Station (EACS) numbers are issued by the Geomatics Survey Advisors (Terrestrial Surveyors). If in doubt, users should contact survey@environment-agency.gov.uk to obtain numbers. At least three working days’ notice is required. Surveyors should check with the survey advisors to ensure that the survey control data that they hold is up to date.

Results of all survey control observations and computations shall be presented to the Client survey manager before the Surveyor computes any detail survey observations. This will ensure that both parties are aware of any anomalies and they can be resolved before dependent work is carried out.

1.2 EACS

1.2.1 Historically, there have been six grades of EACS – E1 to E6. E3 stations are no longer established but included for reference. The grades are described as follows:
**E1 High Order Station:** The network of OS Net stations is now sufficiently dense that they have taken over the role of the E1 stations. With the exception of coastal areas where the distance to OS Net stations may be excessive or the coastline falls outside the framework of OS Net stations, no new E1 stations need be established. Where E1 stations are established they are to be positioned in perfect conditions and, for stations on the coast, shall be observed over at least one multiple of a full tidal cycle. Under these circumstances commercial GNSS processing software may be used.

**E2 Secondary Control Station** E2 stations will be established on stable structures. They are required on sites where the survey is being carried out to support a construction project of height accuracy of better than 15mm is required.

E2 stations will be established typically using static baselines of 5 to 18km length with a minimum observation period of two hours to E1 (OS Net) stations. This may be reduced to one hour only if DOP is set to less than 3.0, the station has a completely clear sky view and there is no risk of multipath. Baselines over 18km to E1 stations shall be observed for at least five hours, or three hours if site conditions are perfect and DOP is set to less than 3.0.

For coastal survey work, long E2 baselines are not to be used as a substitute for establishing a new E1 station. E2s on the coast to be at a maximum spacing of 10 km. If E2 Intermediate Grade Station Control is required for any PGMs it must be established only from the E1 High Order Station Control Network.

**E3 Tertiary Control Station.** New E3 stations should no longer be established because their function is better served either by establishing E2 stations which are then used as base stations for base and rover RTK or by E6 stations. For the specification of existing E3 stations see versions of this specification up to and including V3.1.

**E4 Local Control Stations.** E4 stations shall, wherever possible, be established on stable structures as permanent or semi-permanent stations. However the E4 designation is also used for temporary stations when it is not convenient to install a permanent station. They are surveyed in plan and height.

E4 stations are for local control. For channel surveys they may be temporary pegs, but where they are used as reference objects for site surveys and traverse stations they should be permanent. Station descriptions and numbers are required only for permanent stations. They may be observed using GNSS, rapid static, base and rover RTK or network RTK methods, total station and/or levelling.

E4 stations shall be connected to and adjusted to E1, E2 or E6 stations for 2D/3D positioning or E5 stations, for level.

**E5 EA Bench Marks – altitude only station.**

Where a benchmark is required as control for a weir or similar structure, it shall be established on the site and double-levelled from an E2 or E6 station. E5 station markers may be newly established or historical EABM stations may be re-used.
E6 Network RTK control station
This designation is to be used for all permanent control points which are observed in plan and height directly using network RTK.

E6 stations shall not be established in isolation. Each E6 station shall be connected by spirit levelling to at least one other E6 station. Each E6 station shall be observed in accordance with Guidance Note - Network RTK GNSS Best Practice 2012 from The Survey Association, using two, three minute observations separated by at least 20 minutes. If the difference in height observed in the two sessions exceeds 30mm, a third session shall be observed following a further 20 minute interval.

Where pairs of E6 stations are closer than 100m apart, only one of the stations needs to be permanent unless, for example, the second station is required to serve as a reference object for total station observations from the first station.

Where there is no suitable location for permanent E6 stations either due to ground conditions, obstructed sky view or the likelihood of multipath effects, temporary E6 stations shall to be established in locations which are suitable. The surveyor shall establish a permanent E4 (if 3D coordinates are to be quoted) or E5 (if height control only is to be established) on a suitable structure nearby. The E4 / E5 station(s) shall be double-run spirit levelled from the temporary E6 stations. The description card for the permanent point shall indicate that it has been surveyed from E6 survey control.

The E6 control points (temporary or permanent) shall be spirit levelled in a closed loop (or double-run) and their heights adjusted holding the spirit levelling fixed i.e. the levels observed by Network RTK shall be adjusted to best fit the levelling.

<table>
<thead>
<tr>
<th>Station</th>
<th>Mean E6 GNSS Ht</th>
<th>Spirit Levelled Ht</th>
<th>Diff</th>
<th>Adjustment</th>
<th>Adjusted levelled Ht</th>
<th>Diff</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>12.436</td>
<td>12.436</td>
<td>0.000</td>
<td>-0.004</td>
<td>12.432</td>
<td>0.004</td>
</tr>
<tr>
<td>B</td>
<td>14.218</td>
<td>14.224</td>
<td>-0.006</td>
<td>-0.004</td>
<td>14.220</td>
<td>-0.002</td>
</tr>
<tr>
<td>C</td>
<td>9.856</td>
<td>9.863</td>
<td>-0.007</td>
<td>-0.004</td>
<td>9.859</td>
<td>-0.003</td>
</tr>
<tr>
<td>Sum</td>
<td></td>
<td></td>
<td>-0.013</td>
<td></td>
<td></td>
<td>0.000</td>
</tr>
<tr>
<td>Mean</td>
<td></td>
<td></td>
<td>-0.004</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Example adjustment of three E6 stations holding spirit levelled height differences fixed and applying a best mean fit onto the E6 GNSS heights. In this example the surveyor used the GNSS height of station A (12.436) as start level for the spirit levelling loop and levelled heights have been lowered by 4mm to best fit the network RTK observations.

The differences between network RTK observations at each station, the comparison and adjustment of pairs (or more) of E6 stations, and connections to existing control
and OSBMs shall be presented to the CSM at the time of survey (before any detail survey is computed). The results shall also be stated in the survey report.

**When establishing E6-based survey control the over-riding requirement is that the principles of self-checking and independent checking shall be followed in order to reduce the risk of making gross errors.**

1.2.2 **For site surveys**, at least two network RTK stations shall be observed on a site and if one is required as an RO for total station observations there must be sufficient distance between them for a ‘strong’ bearing control.

*The above diagram is an example of an acceptable control scheme for a site survey. Note that the distance between E6 stations ensures a ‘strong’ bearing, and that an OSBM and an existing E3 station are included in the levelling net to provide independent gross error check on the level control and to establish consistency with a previous survey.*

In situations where the survey is of a site which will be developed, the surveyor, in conjunction with the CSM shall locate sufficient survey control stations in places where they are unlikely to be disturbed during the period of construction, to enable the original survey control network to be used throughout the life cycle of the construction project.
1.2.3 For linear surveys, such as river channels, the following example scenarios are acceptable:

1. **Pairs** of E6 stations established at locations specified in the survey brief. One E6 of each pair is permanent, but if this is not possible, an E4 / E5 station is established from the E6 stations. Each pair of E6 stations shall be levelled and adjusted as in above table. E4 temporary stations established at base point on each cross-section by 5-second network RTK for plan (heights used for check only). Base points may be in locations with poor sky view or multipath conditions. RTK heights used for gross error check. E4 stations and one OSBM single levelled from, and adjusted to, E6 stations.

2. **Single** E6 stations established at locations specified in the survey brief. If E6s are not permanent, E4 / E5 station to be established near the temporary E6s and levelled from the E6. E4 temporary stations established at base point of each cross-section by network RTK for plan (heights for check only). Base points may be in locations with poor sky view or multipath conditions. RTK heights used for gross error check. E6, E4 stations and one OSBM levelled and adjusted by holding the internally adjusted levelling fixed and applying best mean fit onto E6 stations.

3. Temporary E4 stations are established at each cross-section base point and each fixed in plan, height and orientation by total station resection observation from a pair of temporary E6 stations. E6 stations to be placed with adequate resection geometry and preferably so that each E6 station can be used to fix two adjacent E4 base points. To limit errors due to earth curvature and atmospheric refraction, the distance between the total station and the GNSS stations shall not exceed 120m. Total station observations shall be used to check the level difference between the E6 stations.
Table to Summarise the 6 Grades of Station

<table>
<thead>
<tr>
<th>Grade</th>
<th>Use</th>
<th>Spacing</th>
<th>Marker</th>
<th>Obs Period</th>
<th>Source control</th>
<th>Computation</th>
<th>Record</th>
</tr>
</thead>
<tbody>
<tr>
<td>E1</td>
<td>Primary Control</td>
<td>c. 50km</td>
<td>Bernstine marker or EA bronze marker</td>
<td>A tidal cycle</td>
<td>4 OS Active Stations</td>
<td>Scientific / Commercial software</td>
<td>Pro-forma diagram + full report</td>
</tr>
<tr>
<td>E2</td>
<td>Secondary control. Eg. Along a river channel or a local site.</td>
<td>5-18km. Defined in the Scope</td>
<td>EA bronze marker</td>
<td>Minimu m 1 or 2 hours dependin g on sky view.</td>
<td>2 E1 stations</td>
<td>Commercial software</td>
<td>Pro-forma diagram + full report</td>
</tr>
<tr>
<td>E3</td>
<td>No longer used</td>
<td>1km</td>
<td>EA bronze marker or PGM</td>
<td>Minimu m 20 minutes static</td>
<td>2 E1 or E2</td>
<td>Commercial software</td>
<td>Pro-forma diagram + full report</td>
</tr>
<tr>
<td>E4</td>
<td>Individual control for sections</td>
<td>Cross-section interval. &lt; 1km</td>
<td>Peg /PK nail / punch mark</td>
<td>RTK for 120 seconds using a stabilised pole. / spirit level</td>
<td>E1, E2 or E3</td>
<td>Commercial software</td>
<td>Not required if station is temporar y (ie a peg)</td>
</tr>
<tr>
<td>E5</td>
<td>Altitude control only</td>
<td>As required</td>
<td>EA bronze marker</td>
<td>Levelled</td>
<td>E1, E2 or E3</td>
<td>Manual or electronic</td>
<td>Proforma diagram</td>
</tr>
<tr>
<td>E6</td>
<td>3D control station</td>
<td>As required</td>
<td>Permanent where possible</td>
<td>Network RTK in accordan ce with TSA guidance</td>
<td>Network RTK</td>
<td>Network software</td>
<td>Proforma diagram for permane nt stations</td>
</tr>
</tbody>
</table>
1.3 **Point Numbering System**

The following point numbering system shall be used for each control point unless otherwise specified in the brief:

AABBBCCCC, where AA is the type of point (E1, E2, E3, E4, E5), BBB is the Area code as given in the list below. CCCC is a sequential number which will be issued by the CSM. Note that in situations where the coordinates or level of an existing survey control station have to be revised by a subsequent survey, a new point number shall be assigned. The new description card shall refer to the previous point number.

<table>
<thead>
<tr>
<th>Area</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cumbria &amp; Lancashire</td>
<td>011</td>
</tr>
<tr>
<td>Greater Manchester, Merseyside &amp; Cheshire</td>
<td>013</td>
</tr>
<tr>
<td>West Midlands</td>
<td>031</td>
</tr>
<tr>
<td>Derbyshire, Nottinghamshire &amp; Leicestershire</td>
<td>034</td>
</tr>
<tr>
<td>Lincolnshire &amp; Northamptonshire</td>
<td>051</td>
</tr>
<tr>
<td>Cambridgeshire &amp; Bedfordshire</td>
<td>052</td>
</tr>
<tr>
<td>Essex, Norfolk &amp; Suffolk</td>
<td>053</td>
</tr>
<tr>
<td>West Thames</td>
<td>061</td>
</tr>
<tr>
<td>Hertfordshire &amp; North London</td>
<td>063</td>
</tr>
<tr>
<td>Solent &amp; South Downs</td>
<td>071</td>
</tr>
<tr>
<td>Kent &amp; South London</td>
<td>073</td>
</tr>
<tr>
<td>Wessex</td>
<td>111</td>
</tr>
<tr>
<td>Devon &amp; Cornwall</td>
<td>113</td>
</tr>
<tr>
<td>Northumberland, Durham &amp; Tees</td>
<td>121</td>
</tr>
<tr>
<td>Yorkshire</td>
<td>122</td>
</tr>
</tbody>
</table>
2.0 E1 and E2 Survey Control observed using GNSS

2.1 GNSS baselines shall be computed using NGS (National Geodetic Survey) absolute antenna models. Dependent upon project deadlines, baselines (particularly those involving GLONASS observations) should be computed using post-processed, in preference to broadcast, ephemerides.

2.2 Only independent baselines (i.e. from n concurrently observed stations only n-1 independent baselines can be formed) shall be used in least squares network computations of E1 and E2 stations. A minimally constrained adjustment shall be run holding one known point fixed. It shall demonstrate that the network is internally consistent and be used to investigate any outlier baselines. The computed GNSS altitude of other known points shall be compared with the published GNSS altitude for these points. If the difference is greater than 25mm the difference shall be reported to the Client survey manager before accepting the results. On acceptance of the minimally constrained adjustment, a constrained adjustment shall be run, holding all known points fixed unless otherwise agreed with the Client survey manager.

2.3 The comparison shall be tabulated in the survey report using the following format in the example file: V5.0_Templates\Spreadsheetformats\GNSS Unconstrained+ConstrainedResults.xls

2.4 Where base and rover RTK is used, the base station shall be established to E2 standards and shall, if possible, be permanent. If the base station is temporarily installed as a GNSS antenna on the roof of a car, the car shall remain stable during the period of the survey and the surveyor shall observe checks with the rover on to points which have also been observed using Network RTK observations. See Section X paras 3.0 and 4.0.

3.0 Vertical Control using spirit levelling

3.1 Spirit level run misclosures are to be assessed by using Clark's Formula of:

For level runs less than 1km: \[ E = 0.005 \sqrt{N} \] (where \( N \) = No. of set ups) or,

For level runs greater than 1km: \[ E = 0.012 \sqrt{D} \] (where \( D \) = traverse length in kilometres)

When using digital levels, maximum misclosures should be approximately half the above values. If not, it is likely that a gross error has been made and further checks should be carried out on the levelling to prove that there is no gross error.

When using an optical level to observe survey control the level run shall always close internally either in a loop or by double levelling. When using a digital level with automatic data recording, it is acceptable to single level between control stations provided that intermediate points are checked for gross errors using RTK.
For most work, E2 or E6 stations will be used as source control for spirit levelling of E4 and E5 stations. In these circumstances, wherever possible level runs shall open and close on different stations.

3.2 Stations must be observed as change points in a level run or as intermediate sights observed from two different, independent instrument set ups.

3.3 A vertical control diagram shall be produced showing the following:

(i) Positions of all benchmarks with their type, grid reference, and altitude.
(ii) Lines showing the levelled connections, the direction levelled, distances and misclosures.

3.4 Original levelling observations, reductions and computations are to be included as an annex to the survey report.

4.0 Total station traversing

4.1.1 Where theodolite / total station traversing is used to establish minor control (E4) for detail surveying, stations established using GNSS shall be used as source control for position and azimuth.

4.1.2 Wherever possible, traverses shall open and close on different control stations. Open traverses will not be permitted. Bearings shall close to better than 9" x square root of number of observed angles and shall be adjusted.

4.1.3 Horizontal distances shall be adjusted for grid scale factor and height above spheroid.

4.1.4 Plan misclosure shall be better than 1:20,000.

4.1.5 A horizontal control net diagram shall be produced showing the following:

(i) Positions of all EACS and existing control points with their names and reference numbers
(ii) Lines showing the observed bearings, distances or GNSS baselines
(iii) Error ellipses for each PGM (Control Surveys – National Grid only)

4.1.6 If vertical control is observed using total station observations the following conditions are to be met:

(i) This technique is not to be used to establish permanent survey control stations except with the prior agreement of the CSM.
(ii) All observations are to be reciprocal.
(iii) Height traverses are to be closed with a misclosure of better than 12mm x √km where km is the traverse length in kilometres.
(iv) The maximum length of traverse leg shall be 200m. If the technique is to be used over longer distances, observations shall be reciprocal and simultaneous, in accordance with accepted survey practice.
(v) At least two stations in the traverse are to be checked using level and staff and the result documented in the survey report.
4.1.7 Horizontal and vertical angles, slope distances, met observations shall be recorded and included with the survey report. Traverse / network computations shall be post-processed and included with the survey report. On-the-fly computations are not acceptable.

5.0 Survey Monuments

5.1 The Surveyor shall obtain the permission of landowners prior to establishment of EACS on privately or publicly owned structures.

5.2 For each EACS established (other than temporary E4 or E6) a digital proforma shall be completed. The template for this is EACS_desc.doc. The digital file shall be named with the EACS reference. The description card shall include sufficient information to relocate the survey station visually. This may be achieved using photography of maximum resolution 1600 x 1200 px and / or measuring at least three dimensions to nearby features. The completed proforma shall be supplied in the format specified in the survey scope. National Grid coordinates and orthometric height shall be quoted for all stations except E5 for which altitude only is required. Where required, ETRS89 coordinates are to be quoted to 0.00001” in plan and 0.001m in elevation. National grid coordinates and heights shall be quoted to 0.001m. The description shall state if the coordinates and / or height have been determined by observations based upon E1 / E2 / E3 or E6 stations, the reference numbers of stations used and GNSS logging duration. The EACS details shall also be listed in an excel spreadsheet, the template for this is EACS_details.xlsx.

No EACSs or any other markings are to be placed into or onto a Listed Building or structure, nor on to an Ancient Monument.

5.3 The type of marker used depends upon:-

(i) survey specification
(ii) site limitation
(iii) ground conditions
(iv) landowner restrictions

Permanent stations shall be one of the following type, in order of preference:-

(i) Mark already present in the environment, such as existing survey nail, clearly defined manhole cover rim corner.
(ii) Stainless steel nail (e.g. PK nail)
(iii) EA bronze marker
(iv) Other permanent ground marker by exception (PGM, FENO, Bernstein)

The type of marker used for temporary stations shall be any of the following, depending upon the above criteria:

(i) Mark already present in the environment, such as existing survey nail, clearly defined manhole cover rim corner.
(ii) Stainless steel nail (e.g. PK Nail) or hilti nail
(iii) Indelible pen mark on concrete surface
(iv) Wooden peg or stake driven flush to the ground and with a painted top
(positioned only with the permission of the landowner and removed as soon as fieldwork has finished)

Temporary survey stations shall never be unmarked. They should be placed in situations where they will remain stable for several weeks or at least for the period of field survey work. Temporary stations should not be numbered for archiving purposes – designation such as TBM1, 2 etc is adequate. For all points except wooden pegs, simple descriptions (photograph) are required in case the validation surveyor needs to relocate the point. The Surveyor can assume that the validation surveyor can locate the station to within 3m using navigation-grade GNSS.

5.4 PK nails and Bronze EA markers shall be installed by drilling and fixing with an epoxy resin type compound into a stable and permanent structure. This will usually be concrete. Asphalt and kerb stones are not considered to be stable structures.

5.5 Permission of landowners shall be obtained prior to establishment of markers. At all times property shall be respected. Services Avoiding Equipment shall be used by suitably trained staff to search all areas where any form of ground penetrating station markers are to be inserted – other than PK nails or EABM studs or like markers. For markers penetrating more than 0.5m a search must be made with all appropriate service utility providers. Where temporary pegs are to be installed, they shall penetrate the ground to a maximum depth of 200mm. In all cases, Surveyor is to carry out a dynamic health and safety risk assessment.

5.6 Only biodegradable paint may be used for marking stations, using the minimum possible quantity of paint.
SECTION III – TOPOGRAPHIC SURVEY

1.0 Mapped Topography

1.1 Detail data shall be delivered using layers, feature codes and symbols as specified in Section I, para 11 of this specification.

2.0 Features

PGMs, EACs and OSBM shall be plotted as symbols with numbers. Their coordinates and altitudes will be tabulated in the notes panel.

The following table lists the features to be surveyed as standard. The survey scope lists additional features and those where options have to be selected. The tables are based upon RICS publication *Measured surveys of land, buildings and utilities* 3rd edition ISBN 978 1 78321 064 0 and reproduced here by kind permission of the RICS.

### 2.0.1 Permanent buildings/structures

<table>
<thead>
<tr>
<th>Feature</th>
<th>Feature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Archways, underpasses, culverts</td>
<td>Steps (generalised)</td>
</tr>
<tr>
<td>Bridge over, bridge under</td>
<td>Gullies</td>
</tr>
<tr>
<td>Buildings/structures detailed at plinth line</td>
<td>Rain water down pipes</td>
</tr>
<tr>
<td>Building/structure corners (spot heights)</td>
<td>Rodding eyes</td>
</tr>
<tr>
<td>Foundations (where exposed)</td>
<td>Steps: individual</td>
</tr>
<tr>
<td>Overhead features, canopies, porches, etc.</td>
<td>Steps and ramps, top and bottom (spot levels)</td>
</tr>
<tr>
<td>Ramps, loading bays</td>
<td>Waste pipes</td>
</tr>
<tr>
<td>Ruins</td>
<td></td>
</tr>
</tbody>
</table>

*Height detail could include spot heights, annotations, 3D graphics or other.

### 2.0.2 Temporary/mobile buildings

<table>
<thead>
<tr>
<th>Feature</th>
<th>Feature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Garden sheds, greenhouses</td>
<td>Temporary buildings or structures</td>
</tr>
<tr>
<td>Mobile buildings</td>
<td>Overhead features, canopies, porches, etc.</td>
</tr>
</tbody>
</table>
### 2.0.3 Road, path, track features

<table>
<thead>
<tr>
<th>Feature</th>
<th>Feature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Channel line – road</td>
<td>Pedestrian crossings</td>
</tr>
<tr>
<td>Carriageway edge</td>
<td>Speed humps/tables/traffic calming features</td>
</tr>
<tr>
<td>Drop kerbs</td>
<td>Traffic islands, details</td>
</tr>
<tr>
<td>Top of kerb</td>
<td>Back edge of footway</td>
</tr>
<tr>
<td>Road centreline, channel, kerb, pavement levels shown as text on drawings (surveyed at 10m intervals)</td>
<td>Changes of surface material (hard detail)</td>
</tr>
<tr>
<td>Crash barriers</td>
<td>Changes of surface material (soft detail)</td>
</tr>
<tr>
<td>Gullies, kerb outlets</td>
<td>Road markings, painted</td>
</tr>
<tr>
<td>Pedestrian barriers</td>
<td>Unmade tracks and paths (sides required)</td>
</tr>
</tbody>
</table>

### 2.0.4 Visible boundary features – walls, fences, hedges

<table>
<thead>
<tr>
<th>Feature</th>
<th>Feature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fences: with type, with height (if required)</td>
<td>Wall buttresses</td>
</tr>
<tr>
<td>Gates</td>
<td>Cadastral features (boundary markers, stones, beacons, posts, stakes etc.)</td>
</tr>
<tr>
<td>Hedges and ditches</td>
<td>Gate: direction of opening shown</td>
</tr>
<tr>
<td>Walls: with type, with height (if required)</td>
<td></td>
</tr>
</tbody>
</table>

### 2.0.5 Street furniture

<table>
<thead>
<tr>
<th>Feature</th>
<th>Feature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Belisha Beacons/special road crossings</td>
<td>Posts</td>
</tr>
<tr>
<td>Barriers</td>
<td>Mark Xet machines</td>
</tr>
<tr>
<td>Bollards</td>
<td>Troughs</td>
</tr>
<tr>
<td>Bus stops, bus shelters</td>
<td>Flagstaffs</td>
</tr>
<tr>
<td>Junction/control boxes</td>
<td>Vent pipes</td>
</tr>
<tr>
<td>Hoardings</td>
<td>Drainage channels</td>
</tr>
</tbody>
</table>

Page 29 of 74
<table>
<thead>
<tr>
<th>Feature</th>
<th>Feature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lamp posts</td>
<td>Cellar hatches and pavement lights</td>
</tr>
<tr>
<td>Telegraph/electricity poles</td>
<td>Cycle racks</td>
</tr>
<tr>
<td>Road signs</td>
<td>Litter bins</td>
</tr>
<tr>
<td>Traffic signals</td>
<td>Reflector posts</td>
</tr>
<tr>
<td>Post boxes</td>
<td>Salt/grit bins</td>
</tr>
<tr>
<td>Mile posts</td>
<td>Seats/benches</td>
</tr>
<tr>
<td>Notice boards</td>
<td></td>
</tr>
</tbody>
</table>

### 2.0.6 Statutory authorities' plant and utility covers where visible

<table>
<thead>
<tr>
<th>Feature</th>
<th>Feature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air valves</td>
<td>Marker posts</td>
</tr>
<tr>
<td>Cable TV inspection covers</td>
<td>Surveillance cameras</td>
</tr>
<tr>
<td>Cabinets (identified)</td>
<td>Telecoms inspection covers</td>
</tr>
<tr>
<td>Electricity covers</td>
<td>Telegraph poles</td>
</tr>
<tr>
<td>Electricity poles</td>
<td>Telephone call boxes</td>
</tr>
<tr>
<td>Fire hydrants</td>
<td>Pole stay wires</td>
</tr>
<tr>
<td>Inspection covers/manholes with level</td>
<td>Lamp posts</td>
</tr>
<tr>
<td>Gas/water stop valves and stop cocks (cover)</td>
<td>Overhead wires, (including building connections)</td>
</tr>
<tr>
<td>Water meter or gas meter covers (distinguished from valve)</td>
<td></td>
</tr>
<tr>
<td>Feature</td>
<td>Feature</td>
</tr>
<tr>
<td>------------------------------------------------------------------------</td>
<td>------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Ornamental/road side trees, including planting boxes</td>
<td>Tree spread (canopy diameter)</td>
</tr>
<tr>
<td>Edge of vegetation</td>
<td>Tree trunk girth at 1m above ground</td>
</tr>
</tbody>
</table>

### 2.0.8 Pitches/recreation

<table>
<thead>
<tr>
<th>Feature</th>
<th>Feature</th>
</tr>
</thead>
<tbody>
<tr>
<td>See scope for any requirements</td>
<td></td>
</tr>
</tbody>
</table>

### 2.0.9 Water features

<table>
<thead>
<tr>
<th>Feature</th>
<th>Feature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Watercourses (drains, ditches, streams, rivers) levels to be shown on drawn plans at [...]m intervals</td>
<td>Gabions</td>
</tr>
<tr>
<td>Waterline</td>
<td>Bottom bank below water level, surveyed from bank at arm’s length (where safe)</td>
</tr>
<tr>
<td>Water level</td>
<td>Floating structures/booms</td>
</tr>
<tr>
<td>Shore line (detail exposed at low tide)</td>
<td>Crest/spill levels</td>
</tr>
<tr>
<td>Bodies of water (ponds, lakes, reservoirs)</td>
<td>Outfall/culvert dimensions (min diameter 0.25m)</td>
</tr>
<tr>
<td>Top of banks</td>
<td>Machinery, pumps</td>
</tr>
<tr>
<td>Bottom of banks</td>
<td>Telemetry equipment</td>
</tr>
<tr>
<td>Weirs</td>
<td>Navigation beacons</td>
</tr>
<tr>
<td>Locks</td>
<td>Aprons, footings, sills, bases</td>
</tr>
<tr>
<td>Flood defence structures</td>
<td>Steps, access ladders</td>
</tr>
<tr>
<td>Flood/lock gates</td>
<td>Mooring posts, bollards, rings, piles</td>
</tr>
<tr>
<td>Flood/harbour/sea/retaining walls</td>
<td>Life rings/life buoys</td>
</tr>
<tr>
<td>Sheet piling</td>
<td>Rubbing strips</td>
</tr>
<tr>
<td>Groynes/sea defences</td>
<td>Ornamental water features</td>
</tr>
<tr>
<td>Waterfalls</td>
<td>Booms</td>
</tr>
<tr>
<td>Feature</td>
<td>Feature</td>
</tr>
<tr>
<td>---------</td>
<td>---------</td>
</tr>
<tr>
<td>Pipes/outfalls/culverts (min diameter 0.25m)</td>
<td>Gauge boards (relate readings on gaugeboard to survey height datum)</td>
</tr>
<tr>
<td>Piers, jetties, walkways, gantries, landing stages, bridges</td>
<td>Fishing platforms</td>
</tr>
<tr>
<td>Fountains</td>
<td>Pontoons</td>
</tr>
</tbody>
</table>

### 2.0.10 Earthworks and embankments

<table>
<thead>
<tr>
<th>Feature</th>
<th>Feature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bank bottom</td>
<td>Retaining wall, base</td>
</tr>
<tr>
<td>Bank top</td>
<td>Retaining wall, top</td>
</tr>
<tr>
<td>Hilltops, depressions and saddles (spot heights)</td>
<td>Sloping masonry, bottom</td>
</tr>
<tr>
<td>Mounds, spoil heaps</td>
<td>Sloping masonry, top</td>
</tr>
<tr>
<td>Quarries, pits and mineral workings (limit only)</td>
<td>Terraces</td>
</tr>
<tr>
<td>Quarries, pits and mineral workings, detailed survey</td>
<td></td>
</tr>
</tbody>
</table>

### 2.0.11 Industrial sites (e.g. treatment works, oil refineries, etc.)

<table>
<thead>
<tr>
<th>Feature</th>
<th>Feature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aerials</td>
<td>Pipe work or ducts (outline only)</td>
</tr>
<tr>
<td>Cable tracks/ducts (outline only)</td>
<td>Overhead pipes/cables</td>
</tr>
<tr>
<td>Chimneys</td>
<td>Overhead line tower/freestanding mast or pylon, including visible bases</td>
</tr>
<tr>
<td>Electric sub stations or transformers (perimeter fence only)</td>
<td>Tanks/storage chambers (outline only)</td>
</tr>
<tr>
<td>Filter beds (limits only)</td>
<td>Flood lights</td>
</tr>
<tr>
<td>Inspection pits</td>
<td>Earth rods</td>
</tr>
<tr>
<td>Inspection covers, gullies, ducts and conduits (spot levels)</td>
<td>Water taps/stand pipes/troughs</td>
</tr>
</tbody>
</table>
2.0.12 Railway features

<table>
<thead>
<tr>
<th>Feature</th>
<th>Feature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not required</td>
<td></td>
</tr>
</tbody>
</table>

Features listed in the survey scope shall be surveyed as 3D point or line features. Points for which the height is not valid shall be given a null height of -999:

2.1 Additional tables of features to be surveyed

The surveyor shall survey additional features as indicated in the survey scope.

2.1.1 Lakes and ponds

Points surveyed shall be positioned using the Surveyor’s judgement with the objective of producing 2.5D TIN DEMs of the soft and hard bed, as applicable.

2.1.2 Culverts

Spatial data of culvert(s) is required as specified in the survey scope.

2.1.2 Groundwater Boreholes

For surveys of groundwater boreholes, the Client survey manager shall provide sketches showing the location and access to the boreholes to be surveyed and details of the owner. The borehole shall be treated as if it is a permanent survey control station. If conditions are suitable it can be observed directly using GNSS to E2 standard. If not, a temporary station shall be established where conditions are suitable and the borehole shall be levelled from the temporary station. A photograph shall be taken of the borehole, marked up to show the position of the levelled point and included in a description card using template borehole.doc. The description shall include the Easting and Northing coordinates of the borehole accurate to within 0.2m.

2.2 Levels:

Where a 2.5D TIN DTM is specified in the Products Table of the survey scope, level strings shall be observed as follows so that in combination with detail strings observed under para 2.2, an accurate model can be generated from the survey data:

(i) In open featureless areas a regular grid of levels will be surveyed to depict the terrain. The maximum distance between adjacent points in the DTM is stated in the survey scope.

(ii) In all other areas sufficient height information will be surveyed in order to fully describe the topography. Adequate height information will be surveyed to create a digital terrain model of the survey area sufficient to generate contours at the interval specified in the Survey Scope.
2.2.1 Spot heights shall be recorded in the following locations except where the ground is obscured by vegetation or other obstructions:

(i) at salient points such as tops of humps and bottoms of depressions;
(ii) at water level at the time of survey along rivers, streams, ditches, and other water features.
(iii) along the tops and bottoms of banks, embankments and cuttings and retaining walls. Any low points in raised banks shall be surveyed.
(iv) along the centre lines of roads and tracks at significant changes of gradient.
(vi) in built-up and wooded areas, spot heights shall be recorded along roads and tracks and also in open spaces at the maximum spacing specified in the survey scope.

2.2.3 For survey of spot heights on the top of silt and/or base of silt (hard bed) in lakes or watercourses the surveyor shall use a flat-bottomed staff to observe the top of silt and survey at intervals stated in the survey scope ‘Water features’ table.

2.2.4 Topographic surveys containing watercourses shall extend (where safe) approximately 1m (safe arm’s length) into the watercourse from the water’s edge, unless otherwise stated in the survey scope.

3.0 Survey of raised flood defences

The surveyor shall refer to the Data Requirements Library (DRL) (https://environment.data.gov.uk/asset-management/drl-app/asset-types). Survey is restricted to Defence ‘Embankment’, ‘Wall’ and ‘Flood Gate’ sub types and their elements. Each instance of each defence sub type has an Asset ID number. For the full extent of each Asset ID, each cross-section of the defence should contain the same element types in the same order (eg ElementSequence=1: Berm, ElementSequence=2: ExposedFace, ElementSequence=3: Crest, ElementSequence=4: LandwardFace). There should not, for example, be a length sheet piling present only for part of an asset. If this is not the case, or there are other anomalies on site between the spatial position and extent of the defence as shown in the EA records, the asset number and asset subtype, they shall be referred to the CSM.

3.1 Flood defence crest level string and cross-section data

Where specified in the survey scope para 2.4.1, ‘Products table – Digital data files’ ‘Flood defence crest level string and cross-section data’ the following applies:

The surveyor shall observe crest level strings and cross-sections at the spacings specified in the survey scope. The Surveyor should note that sometimes embankment crests rise from ‘defence’ level up to the level of features crossing the defence, such as roads. These ramps should be excluded from the data because they will mislead subsequent data analysis.

Cross-sections shall be observed at the ends of each defence and at the maximum spacing along the defences stated in the survey scope. For defences shorter than half...
the maximum section spacing only a single section shall be observed near the mid point of the defence, provided that this is typical of the defence shape.

Cross-sections are to extend 10m from the toe of the defence. If there is a property boundary within 10m the section shall stop at the boundary. If there is a river within 10m, the surveyor shall include the near river bank and take a point at arm’s length into the channel, provided it is safe to do so.

Photographs are to be taken at the first cross-section and then at alternate cross-section locations, looking downstream. In addition, photographs are to be taken at locations where the defence is damaged.

The surveyor shall supply coordinate data for crest level and cross-section data in CSV format using the following fields:

The first line in the file shall be populated ‘Version_5.0’, to show that it has been produced using this specification and the date of survey.

The second line of the file shall be populated with asset number, “Left_bank” “Right_bank” or “Unknown_bank”, and defence sub-type in lower case.

Left bank or right bank information indicates if the defence is to the left or right of the watercourse (looking downstream) and therefore identifies the exposed and landward facing slopes of the defence. It is vital for ensuring the slope information is correctly entered into the Agency’s Asset Information System.

The third line shall show field header information

<table>
<thead>
<tr>
<th>Defence ID</th>
<th>Cross-sect No (blank if not a cross-section)</th>
<th>Survey Pt No</th>
<th>Easting</th>
<th>Northing</th>
<th>Height</th>
<th>Code1</th>
<th>Code2</th>
</tr>
</thead>
</table>

Code1 shall be used to indicate
- Points marking berm, toes and crest of defence as ‘BERM’, ‘TOE’, ‘CREST’ ‘EDGECREST’. EDGECREST is used to indicate the point of maximum change of gradient between the embankment slope and a relatively flat embankment top. A berm is a zone of flat ground between the exposed toe of an embankment or wall and the watercourse. BERM marks the top of the river channel bank. If no berm is shown, berm ElementWidth=0 and berm ElementSlope=0.
- Defects in the defence, which would allow water to pass as ‘DEFECT’

Code 2 shall be used to show the width of ‘DEFECT’ in metres or other notes.
Example data:

<table>
<thead>
<tr>
<th>Defence ID, XS No, Survey Point Number, Easting, Northing, Height, Code 1, Code 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>38476, 38476.001, 38476, 450864.074, 323354.421, 34.266,</td>
</tr>
<tr>
<td>38476, 38476.001, 38476, 450864.678, 323356.645, 34.372,</td>
</tr>
<tr>
<td>38476, 38476.001, 38476, 450865.035, 323358.869, 34.372,</td>
</tr>
<tr>
<td>38476, 38476.001, 38476, 450865.589, 323361.049, 34.408, TOE,</td>
</tr>
<tr>
<td>38476, 38476.001, 38476, 450866.136, 323363.234, 34.522,</td>
</tr>
<tr>
<td>38476, 38476.001, 38476, 450866.560, 323365.009, 34.597,</td>
</tr>
<tr>
<td>38476, 38476.001, 38476, 450866.834, 323366.968, 34.705,</td>
</tr>
<tr>
<td>38476, 38476.001, 38476, 450867.286, 323368.969, 34.840, EDGECREST,</td>
</tr>
<tr>
<td>38476, 38476.001, 38476, 450867.486, 323370.558, 34.901, CREST,</td>
</tr>
<tr>
<td>38476, 38476.001, 38476, 450867.777, 323372.088, 34.898,</td>
</tr>
<tr>
<td>38476, 38476.001, 38476, 450868.543, 323374.378, 34.894,</td>
</tr>
<tr>
<td>38476, 38476.001, 38476, 450869.196, 323376.235, 34.834,</td>
</tr>
<tr>
<td>38476, 38476.001, 38476, 450869.554, 323378.147, 34.801, EDGECREST,</td>
</tr>
<tr>
<td>38476, 38476.001, 38476, 450869.828, 323379.850, 34.643,</td>
</tr>
<tr>
<td>38476, 38476.001, 38476, 450870.179, 323381.729, 34.544, TOE,</td>
</tr>
<tr>
<td>38476, 38476.001, 38476, 450870.627, 323383.374, 34.532,</td>
</tr>
<tr>
<td>38476, 38476.001, 38476, 450871.382, 323384.994, 34.530,</td>
</tr>
<tr>
<td>38476, 38476.001, 38476, 450872.187, 323386.694, 34.624,</td>
</tr>
<tr>
<td>38476, 38476.001, 38476, 450872.392, 323388.493, 34.655,</td>
</tr>
<tr>
<td>38476, 38476.001, 38476, 450872.574, 323389.756, 34.578,</td>
</tr>
<tr>
<td>38476, 38476.001, 38476, 450872.457, 323391.878, 34.454, BERM,</td>
</tr>
<tr>
<td>38476, 38476.001, 38476, 450872.634, 323392.516, 34.077,</td>
</tr>
<tr>
<td>38476, 38476.001, 38476, 450872.023, 323373.789, 34.804, CREST,</td>
</tr>
<tr>
<td>38476, 38476.001, 38476, 450851.036, 323372.979, 34.951, CREST,</td>
</tr>
<tr>
<td>etc</td>
</tr>
</tbody>
</table>

Note that capitals and precise spelling are required. Fields for which there is no data shall be left blank – not deleted.

Data shall be presented with increasing chainage in the downstream direction and with cross-sections observed left to right (looking downstream). In situations where it is difficult to decide which direction along the defence is pointing ‘downstream’, the surveyor shall use their best judgement, and note in the survey report. Note that this is not the same as the convention for channel surveys.

Where an edge of the crest is coincident with the highest point on the cross-section (CREST), and EDGECREST and a CREST point shall be recorded, but the CREST point shall always be located between two EDGECREST points in the data file.

The longitudinal data shall be continuous, so for a string of defences, the end of one defence shall have the same E, N coordinates as the start of the next, but the height may be different.

Drawn plan, long-section and cross-sections and digital data shall be supplied as selected in the survey scope (Products table – Graphical). Separate data shall be provided for each defence ID, so that it can be stored with other data for specific defences in EA systems. If drawn sections are not specified in the survey scope, the surveyor shall provide draft-standard drawn sections to assist visualisation and validation of the data.

Where XXXXXX is the flood defence ID, cross sections shall be numbered XXXXXX.001, 002 etc and photograph files shall be numbered XXXXXX.001, 003
etc so that the section numbers cross-reference. Survey points shall be numbered XXXXXXX_001, _002 etc. Data files shall be named YYYYYY_XXXXXX_XYZ where YYYYYY is the job number. Drawings shall be numbered ZYYYYYY_XXXXXX_01, 02 etc, where Z will be T for location plan, X for cross-section and L for long section. If location map and long section are on the same drawing ‘T’ shall be used.

An ArcGIS data shape file is required for crest level data with asset number and upstream/downstream crest levels identified in attribute data.

3.2 Flood defence string DTM

Where this is specified in the survey scope, the surveyor shall observe a string DTM of the defence.

In accordance with the Data Requirements Library, points shall be observed at 10m spacing longitudinally along the exposed and landward edges of each element of the defence. Strings can be observed in either direction.

Data shall be supplied in .csv format in the following structure:

<table>
<thead>
<tr>
<th>Defence ID</th>
<th>Survey Pt No</th>
<th>Element name</th>
<th>Exposed or landward edge</th>
<th>Easting</th>
<th>Northing</th>
<th>Height</th>
</tr>
</thead>
</table>

Defence ID is the identification number in the EA’s AIMS database.

Survey point number should be sequential along the string line and refer directly to the surveyor’s survey records.

Element name and spelling is to be identical to that used in the DRL.

For exposed edge, ‘E’ shall be used. For landward edge ‘L’ shall be used.

Data shall be continuous with neighbouring defences.

Example data:

Version_5.0
embankment
Defence ID,Survey Point Number,Element name, Exposed/Landward Edge, Easting, Northing, Height
38476.P001.ExposedFace.E,450864.074,323354.421,34.266
38476.P003.ExposedFace.E,450865.035,323358.869,34.372

4.0 2.5D Grid digital data

This paragraph refers to all data supplied a raster grid data which is typically extracted (‘binned’) from point cloud data (multibeam Hydrographic, aerial LiDAR, terrestrial laser scanning or photogrammetric).
Data shall be supplied at the resolution (grid cell size) specified in the survey scope.

The data shall be positioned and orientated on the OS National Grid as follows:

![Figure 1](image)

Raster grid cell shall be centred so that the coordinates of the edges of the cell are multiples of the raster grid cell size. Eg for a grid cell size of 0.5m the coordinates of the centre of the cells shall end .25 or .75.

Level data shall be in metres above ODN as Esri ASCII grid format, sorted firstly by decreasing northing and secondly by increasing eastings.

If CSV format data is supplied, data points will also be sorted firstly on decreasing northings and secondly on increasing eastings. Trailing zeros are not permitted for Eastings/Northings and comma delimiters will be in the same column for all records so that the data is also effectively space-delimited.

### 5.0 3D Views and Fly-throughs

Where specified in the Products table – Graphical, in the Survey Scope, the CSM and the surveyor shall agree the position, view direction and angle of view for 3D views and the trajectory alignments, speed and distance between successive images and direction and angle of view of the flythroughs, by viewing the data together. For 3D views, the product will be JPEG view and a map showing the position, orientation and viewing angle. For flythroughs, the product will be a digital map showing the location of the view along each trajectory and a movie file following the route of the trajectory.
SECTION IV – CHANNEL SURVEYS

Where specified in the scope, the client or the client’s representative shall walk the section of river to be surveyed with the surveyor. This is necessary to:-

- Agree detailed requirements where the surveyor might otherwise be uncertain.
- Ensure that the surveyor is aware of critical data which might not be obvious to him / her.
- Establish a level of trust and communication between the surveyor doing the work and the client who will be using the data.

1.0 Presentation and Format of Data

1.1 Unless specifically excluded from the survey scope, data is to be delivered in accordance with the latest version of the EACSD format, the specification for which can be downloaded from www.eacsd.co.uk. Before delivery, the surveyor shall ensure that the EACSD data runs error-free through the on-line validator which is also available on www.eacsd.co.uk and shall provide the validation certificate with the supplied data. Note that there is a field for time of survey in the header for each section. This information is required for model calibration purposes. Surveyor shall ensure that the time is set correctly in instruments before commencing the survey.

1.2 The Surveyor is also to provide digital channel survey data in other formats as specified in the survey scope. These may be proprietary to particular flood modelling software packages. Provided that the proprietary format can accommodate the data, the Surveyor shall supply data which contains the same detail as the equivalent EACSD file.

1.3 Surveyor shall provide a comma-delimited text file of point number, Easting, Northing, Height for all as-surveyed points before any adjustments are made to, for example, snap on to cross-section lines.

1.4 Graphical data is to be supplied as selected in the products table of the survey scope. Data is to be presented graphically on key plan / section location maps, cross-sections, structure sections and long sections (as specified in Scope Product table – Graphical (digital data and PDF)) all presented in Autocad .dwg format all in accordance with Section I. Example drawings are included in NatSpecTemplatesV5.0.zip and prefixed SectionIV_.

1.5 The completed plots will include the Environment Agency standard legend that will be used in conjunction with the title box and frame (supplied in. DXF).

1.6 Left Bank and Right Bank are defined as viewed looking downstream.
1.7 When congested data would cause over-writing of the coordinates under plotted sections, the descenders should be cranked to allow the values to be plotted without over-printing.

1.8 All cross-sections, whether open channel or structure, shall be viewed looking downstream. A note: “All cross-sections are viewed looking downstream” is to be included on each sheet of cross-sections and stated in the survey report.

1.9 Water level at time of survey shall be shown on all sections.

2.0 Cross-sections

2.1 Cross-sections are to be surveyed normal to the centre line of the channel at the interval specified in the Survey Scope and/or as shown on the contract mapping. On tightly meandering channels, cross-sections shall be located where the channel is running parallel with the valley. This removes the need for ‘dog-leg’ cross sections across a flood plain.

2.1.1 Structures not falling at the specified interval are to be surveyed, unless varied in the Survey Scope.

2.1.2 Cross-sections shall be surveyed where the channel significantly changes width.

2.2 Where it is not practical to survey a section at the prescribed position or interval the position of the section may be moved. However, the interval between two adjacent sections shall not exceed the prescribed interval.

2.3 Cross-sections are to be surveyed viewed downstream and the origin or zero chainage of the cross-section must be established on the left bank (LB) of the channel viewed downstream. However, where a section is only required through the Right Bank, the origin or zero chainage shall be located on the waterside of the bank, i.e. in the channel.

2.4 Each individual structure cross-section will be given a relevant title included in the section header. Open Channel Sections should not normally have a title.

2.5 In addition to cross-sections through the channel, cross-sections will extend from the channel to the true land level on each side and at least 5m beyond the bank top unless mentioned otherwise in the Survey Scope. Where there is a defence, trees or bushes/shrubs line the channel the section shall extend to 5m beyond the vegetation, but no more than 50m from the channel. Beyond the extent of the cross-section, a general indication of the ground form shall be given as a label e.g. “flat”, “rises steeply”. The point used for the longitudinal section bank top shall be indicated with a ‘C’ on the plotted cross-section.

Note: Where a bank top is raised above the surrounding ground (flood plain), the crest is defined as the line along the bank top over which water will spill from the river onto the surrounding ground. Where there is no raised bank, the crest is the point marking the change of gradient from surrounding ground to eroded channel.
2.5.1 Points along the cross-section are to be surveyed at an interval which accurately depicts the shape of the channel. For open channel sections, the drawn line of the cross-section shall be correct to better than +/- 0.1m in height allowing for up to 0.2m movement along the section line. For structure details, the drawn line of the cross-section shall be correct to better than +/- 0.04m in height allowing for up to 0.04m movement along the section line.

2.5.2 Bushes, trees, fences and buildings adjacent to the channel cross-section are to be shown as symbols – not true to scale.

2.5.3 Buildings are to have their floors or damp-proof course level indicated. Where they cannot be determined the threshold level shall be recorded. Buildings will be labelled with name and/or number, type and whether damp-proof course exists.

2.5.4 Fences will be labelled with their type and height.

2.5.5 Road crossings will be labelled with name and/or number.

2.5.6 The treatment of secondary channels around islands or shoals will be defined in the scope.

2.6 Bed Levels

2.6.1 Bed levels will be measured directly whenever and wherever possible. Where direct measurement is impossible, where, for instance, the water depth is too great or other causes make it impractical, then it will be sufficient to read the depth of water against a staff or to use echo sounding and to relate these readings to a measured water level.

2.6.2 Modellers are generally required to base their models on the current state of the river bed. Therefore, by default, the bed level shall be taken on top of silt (soft bed), and a note added to the drawing to indicate that only soft bed has been shown. Hard bed levels, at base of silt, shall be surveyed if specified in the survey scope. These shall be observed in the same place and with same E, N coordinates as the corresponding soft bed level. In the EACSD data file they shall appear immediately following the corresponding soft bed level.

2.6.3 The nature of the bed material will be recorded and plotted on the section in simplified form, e.g. 'Gravel' based on the material and vegetation types detailed in EACSD_V5.0.doc. Surfaces outside the water area will also be labelled.

2.7 Surveying methods

Detail surveying shall follow the principle that all observations shall be subject to self-checking and independent checking to ensure that gross errors are detected. This paragraph is intended to reflect this principle.

The surveyor shall use an appropriate surveying method for the section concerned. If the cross-section is surveyed using total station techniques the base point shall be used
for the total station set up. The surveyor may use another E4 station or a remote RO to established orientation. Observations must be checked for gross errors (eg instrument or pole height errors). The checking method(s) used shall be documented in the survey report.

If there is a clear sky view and the accuracy specification can be met, GNSS RTK or network RTK detail survey methods may be used. The base point peg shall be observed at the same time as the cross-section using the same technique.

2.8 National Grid Reference and cross-section Orientation

2.8.1 Channel Surveys may be merged with photogrammetric or LiDAR surveys of the flood plains and therefore positional accuracy must be of the same order. Survey control for cross-sections shall be monumented as temporary stations.

Only in exceptional circumstances and by prior agreement will it be acceptable to position sections from OS mapped detail and use a compass to determine orientation.

2.8.2 The section data shall also be plotted against an Ordnance Survey background to give the true position of the section. See also 9.2.1.

2.8.3 Where required by the survey scope, the national grid coordinates shall be shown on the descender for each open channel cross-section point on the cross-section drawings.

2.9 Cross-section Reference Numbers

2.9.1 Cross-sections shall be numbered using the template AAABB_CCCCC, where AAA is an abbreviation for the watercourse name, which shall be unique for the river catchment, BB is the number 01 to 99: 01 for the main channel and 02, 03 etc for side channels, braids etc. ‘_’ is a spacer for clarity. CCCCC is the chainage of the section expressed as a whole number. See para 10.1.1.

2.10 Scale

2.10.1 Scales are defined in the Survey Scope.

2.11 Merging Data from Previous Surveys

2.11.1 Any requirement for merging data with data from a previous survey will be noted in the Survey Scope. Validation checks shall be made between new and old survey control. Data shall be merged so that the correct sequence of chainage across the section and along the channel is maintained. A note of this shall be added to the cross-sectional plot.

2.11.2 Cross-sections from a previous survey shall be updated if there is a significant change (e.g. a new structure).
2.12 **Flood Plain Sections**

2.12.1 If flood plain cross-sections are required, this will be noted together with the interval in the Survey Scope.

2.13.2 Sections will be plotted at the scales defined in the Survey Scope.

2.12.3 A Flood Plain Section will be taken normal to the centre line of the valley and not necessarily at right angles to the centre line of the channel. Because of this, flood plain sections may appear 'dog-legged' on the key plan. These sections may be defined on the contract mapping.

### 3.0 Structures

3.1 Unless otherwise stated in the survey scope, a section shall be surveyed on the upstream side of each structure which significantly affects the river flow at bank-full flow condition. Structures include bridges and culverts (see 4.0), weirs, mills, pipe crossings (greater than the diameter stated in the survey scope) and impounding structures of any kind. Natural features, which act as structures, such as rock outcrops, shall also be included. Structures which are not to be surveyed shall be photographed. The photographs and NG coordinates of the position of the structure shall be included as an appendix to the survey report. If there is any doubt, the Surveyor should consult the CSM to confirm whether a section is required.

3.2 All pipe crossings, including those too small to require a cross-section to be taken, shall be shown on the longitudinal section, along with critical levels and dimension. Overhead power and telephone cable crossings are to be noted and their position and their clearance height over the centreline of the channel plotted on the longitudinal section. Underground crossings (water, gas, power etc.), where evident on site, are also to be noted and their position plotted on the longitudinal section.

### 4.0 Bridges and Culverts

A bridge is defined as a permanent structure spanning the channel. Cross sections of temporary and ad hoc crossings are not required unless specified in the Survey Scope. However, such crossings shall be shown on the longitudinal section.

4.1 A complete elevation of the upstream side is to be taken with particular attention paid to the measurement of the bridge openings and flood arches. Surveyor shall survey the bed level where the structure enters the bed. Details of any bridge piers will also be shown. Soffit, invert and springing levels will be added as labels. The structure section shall include banks behind the structure.

4.2 The downstream elevation will be presented as viewed looking downstream and is required to be surveyed when specifically requested or where it is different from the upstream side. Even when a Downstream elevation is not required, the downstream soffit, top of parapet, invert, bed level and bank crests are to be measured and added.
to the longitudinal section. This information is also to be shown ‘ghosted’ on the upstream elevation drawing if requested in the survey scope.

4.3 The length of the bridge tunnel is to be measured parallel to the watercourse and this, together with hard inverts on aprons and their extent, added as labels on the cross-section plot.

4.4 Where a bridge changes section within its length and that change is significant, then an additional section shall be surveyed at the change.

4.5 At bridges, the channel section surveyed will be assumed by the modellers to be representative of the reach. Where the bridge structure constricts river flow, the open channel section details should be observed where they are representative of the reach – not necessarily up against the structure. See paragraph 9.0 for a decision tree indicating open channel cross-section survey requirements up and downstream of structures.

4.6 Where a structure is not normal to the channel but is skewed, the skew span will be measured and presented on the drawings, together with the approximate angle of skew, this being the angle between the bridge face and a line normal to the channel. The length of the bridge tunnel will then be the channel length through the bridge parallel to the watercourse, not the distance at right angles to the roadway.

4.7 Where a structure extends 10m beyond the top of the bank, then the complete elevation will be surveyed with its cross-section. Where a bridge spans the flood plain, then all relevant flood arches (and other openings that could take flood water, such as pedestrian subways) must be included in the cross-section. In any case, the complete cross-section shall be drawn in model space. If it is too long to be drawn as a single section in paper space, the Surveyor shall use cartographic judgement to either retain the standard scale and draw the section across two or more paper-space windows or change the section scale, whilst ensuring that cross-section text remains legible.

4.8 When a culvert is longer than 30m, a cross-section will be taken at entrance and exit.

4.9 Under no circumstances shall the Surveyor enter a confined space which has not been notified to him/her in the Scope and for which no proper procedures have been adopted.

5.0 Weirs and Drop Structures

5.1 A weir is defined as a permanent or temporary structure that impounds a head of water at normal summer levels greater than the height defined in the Survey Scope.

A drop structure is defined as a natural or man-made step in the channel bed that will be surveyed, as defined in the Survey Scope.

5.2 A cross-section will be taken across the crest of the weir, viewed downstream with structure details incorporated as shown in the Survey Scope. For labyrinth weirs and
other weirs that do not cross the river in a straight line perpendicular to the river, the actual length of the weir shall be stated clearly on the cross-section drawing.

Additional cross-sections will be taken immediately upstream and downstream of the weir crest, viewed downstream and normal to the centreline of the channel as shown in the Survey Scope.

5.3 In the case of moveable gates or boards, the gate sill will be considered as the crest of the weir.

5.4 Levels are to be taken on the tops of all gates and moveable boards. Where gates are open, levels are to be taken on the bottom of the gate. Where possible the maximum opening height of the gate is to be measured and noted on the drawing.

5.5 Levels across the weir crest or on aprons shall not be taken as soundings.

5.6 Moveable control structures, such as weir gates, should be distinguished from fixed structures such as sills and weir crests, by marking them with a diagonal cross.

5.7 A longitudinal section through the centre line of the weir (but NOT through a drop structure) will be produced in cross-section format showing all structure details, such as positions of gates and bridge crossings, extending both upstream and downstream to the natural riverbed. This will be plotted viewed from the right Bank so that water flows from left to right. The detailed data shall be included with the long section data in the EACSD file.

5.8 Longitudinal sections through weirs are to be numbered with the same section number as the downstream elevation, suffixed with an alpha character (e.g. N.NNNA).

5.9 The longitudinal section will show the following information:

(i) upstream water level
(ii) upstream bed level
(iii) weir crests, gates and any bridge structures
(iv) upstream and downstream extent of any apron
(v) downstream water level
(vi) downstream bed level, including maximum depth of scour hole where it is safe to obtain levels
(vii) water and bed levels at the tail of any weir pool

5.10 An additional cross-section will be taken both upstream and downstream of the weir where the channel returns to its normal cross-section and is free from the influence of deposition and scour.

6.0 Mills

6.1 The downstream and upstream elevations are to be measured as for bridges with additional sections taken at significant changes in the section within the mill
6.2 The internal control structures are to be measured as for Weirs (Part II, Section IV, Clause 5.0).

6.3 Gate opening heights are to be measured if practical.

7.0 Locks

7.1 Open channel cross-sections shall be surveyed immediately up and downstream of the lock chamber where the channel regains its normal width, at the lock gates and at the mid point of the lock chamber.

7.2 Cross-sections at the lock gates shall be taken through the pivot guides of each lock gate, upstream and downstream. All sill apron levels will be detailed together with the controlling mechanism and individual gate levels.

8.0 Natural Constraining Features

8.1 Features such as rock formations, which cause gradient changes or affect water levels, are to be treated as weirs.

8.2 Changes in water level gradient over shoals and aprons, and sudden changes in bed level are to be measured and added to the longitudinal section.
9.0 Surveying Open Channel Sections Up and Downstream of Structures

The following decision tree shall be used to decide what needs to be surveyed and how it is presented:

Type of structure:
Bridges, culverts and pipe crossings

Is the structure skew by more than 5 degrees to the channel?
Yes

Is the channel section at the structure representative of the full open channel section up/downstream of the structure?

No
Surveying

Survey the channel section at the structure (+/- 1m from structure)

Presentation on Cross-section Drawings

Draw the channel and structure section together

EACSD v3.2 Data

Section data to include open channel + structure data

Weirs and drop structures, mills and locks

Upstream channel and downstream channel sections to be surveyed.

Yes

Upstream channel and downstream channel sections to be drawn separately

No

Upstream channel and downstream channel sections to be shown in the data as separate surveyed open channel sections.
10.0 Longitudinal Sections

10.1 Chainage

10.1.1 Each cross-section shall be provided with a chainage. This is the distance running in the upstream direction along the centreline of the channel from the downstream extent of the survey. The maximum chainage shall be 99999m. The survey scope shall state whether the CSM or the surveyor shall establish the channel centreline and define the chainage used for the survey. The channel centreline shall generally be derived from the OS MasterMap Water Network, which can be downloaded from the partner side of the Defra Data Services Platform (DSP). Note that it is subject to Ordnance Survey copyright. Culvert alignments are generally up to date in the AIMS Asset Bundle dataset which is also available from the DSP. Should the surveyor find that the supplied polyline does not reflect the channel on the ground, the surveyor shall inform the CSM and agree a course of action to resolve the problem. Zero chainage will be at the downstream extent of the watercourse unless otherwise specified in the Survey Scope. The cross-sections shall be plotted on the Key Plan from actual surveyed section points, and annotated with their section number (see 2.9.1).

10.1.2 Running chainages along the watercourse shall be noted on the levelling sheets, with the start point and direction of work clearly defined. Chainages shall be noted at boundaries, ditches, drainage pipes and other identifiable features, indicating on which bank these features appear. Cross-section chainages will also be noted and clearly referenced.

10.2 Key Plan

10.2.1 A digital key plan based upon OSMasterMap data, will be produced for each longitudinal section to show the cross-section positions and watercourse centreline. Whenever possible this plan will be incorporated into the same sheet as the longitudinal section. When so incorporated it will be aligned to match the longitudinal section in AutoCAD paper space mode. It is acceptable for the plan to be inverted. The national grid, with at least one grid intersection annotated with coordinates and a north point shall be visible on all drawings produced in paper space.

10.2.2 The river centrelines referred to in 10.1.1 shall be provided as polyline features in GIS format, with one feature representing each channel surveyed. The attributes should include the job number, year of survey, and channel name.

Surveyors without access to GIS may render the polylines in AutoCAD as a file named CLXXXXXX.dwg where XXXXXX is the job number.

10.3 Content/Presentation of Longitudinal Section
10.3.1 Where a longitudinal section is required it will be produced from the recorded data at the scales shown in the Survey Scope and presented flowing downstream from left to right.

It will show the following:

(i) The deepest bed level at each section, both hard bed (solid) and silt line (pecked).*
(ii) The water level at each section.
(iii) The bank crest levels derived from crest point levels shown on the cross-sections, the left bank as a pecked line and the right bank as a bold line.
(iv) The extent and level of any concrete sill or apron together with appropriate label (i.e. V nn.nn).
(v) The section number and chainage of each section and the altitudes of each of the plotted points. The chainage shall be quoted to the nearest metre except when the scale of the survey makes it appropriate to quote the chainage to decimetres.

* By default, models are run using the soft bed and therefore the deepest SB levels should be extracted from the cross-section data and shown on the profile. The lowest HB level on a cross-section should only be shown on the profile (or in EACSD data) if it is lower than the lowest SB level, as this indicates that there is silt in the centre of the channel, even if not in at exactly the same point as the lowest SB level. If the lowest HB level on a cross-section is higher than the lowest SB level, this indicates silt in the sides of the channel, not the centre and should not therefore be used.

10.3.2 Each bridge, overhead crossing, weir, mill etc. will be shown on the longitudinal section with its critical levels (soffit, invert, deck, crest etc.) indicated labelled V invert, Δ soffit. Where soffit and invert levels have been surveyed at both upstream and downstream elevations both will be labelled on the longitudinal section.

10.3.3 The water line for each day will be labelled at its limits with the appropriate date.

10.3.4 Tributary channels are to be measured and depicted where they cross the bank crest line. Three points are usually adequate to describe a ditch, but more should be taken where the tributary is large.

Where the feature takes the form of a controlling structure such as a weir, sluice or overfall, then a complete cross-section will be measured.

The tributary name will be added as a label.

10.3.5 Field drains and other infall structures greater than the diameter stated in the survey scope are to be measured with either invert or soffit surveyed. Individual diameter sizes and appropriate bank indicator shall be added as labels together with either a soffit or invert level. The existence of a flap valve shall be added as a label.

10.3.6 Side weirs, etc, which are not part of the main channel shall be shown with critical levels as variations to the bank crest.
10.3.7 Where changes in the levels of bank, bed or water level occur between cross-sections, these changes are to be measured and added to the longitudinal section. The longitudinal section should represent an accurate and complete profile of the channel to ensure that low spot and level changes are identified. See 9.5.

10.3.8 To aid clarity insets shall be used at locations where detail is dense e.g. Mills.

10.4 Gaugeboards

10.4.1 Any gaugeboards encountered in the course of a channel survey shall be surveyed. The position shall be determined to +/- 2m and the height of a graduation on the board to within 10mm with respect to the nearest survey control station. The gaugeboard, with reference number, shall be shown on the location map and the reference number, E, N, graduation value and surveyed height shall be tabulated in the survey report.

10.5 Flood defence levels

10.5.1 River banks that are raised above the surrounding ground and other linear raised features are classified as flood defences. A flood defence is defined as an object (generally an embankment or wall) which provides a flood protection benefit.

10.5.2 The crest level of these flood defences shall be surveyed at intervals stated in the survey scope and at any low points. Surveyed points shall be accurate to within 1m in plan and 0.02m r.m.s.e in height above ODN. The crest level string data shall be incorporated within the drawn long section (10.3.1 (iii)) and in the EACSD long section data. The ‘crest’ is defined as the level at which water will flow over the defence to lower ground beyond.

10.5.3 The crest level of wall defences shall be taken on the top of coping stones, the lower side of coping or at both locations, as specified in the survey scope.

10.5.4 If flood defences are to be surveyed for asset management purposes, Section III, para 3.0 applies and should be specified in the survey scope.

11.0 Photography – additional to Section I

Surveyor to take digital photographs of each open cross-section location and of each structure and will include a levelling staff to indicate scale. Both the upstream and the downstream faces of bridges will be photographed. Photo files are to be named in accordance with the EACSD specification and provided with labels quoting the section number, name of the bridge and road number if one exists plus the chainage to the face photographed.

The photo file resolution should be limited 1600x1200 to reduce file sizes. 360 degree photos or video files can also be referenced, if specified by the Client.
SECTION V – DEFORMATION MONITORING SURVEYS OF STRUCTURES INCLUDING GAUGING STATIONS

This specification covers survey work for an initial survey to establish of a new monitoring system, and the observation of repeat surveys of an existing monitoring system. The term reference point refers to a survey point located in a place that is not expected to move and the term monitoring point refers to a survey point on the structure that is being monitored.

Monitoring surveys shall be carried out to accuracy band L unless otherwise specified in the survey scope.

1.0 Initial Survey

1.1 Surveyor is required to establish reference survey control stations, comprising a ‘site benchmark’ and three other reference stations. These shall be located on structures which can reasonably be considered stable in the long term. One reference point shall be observed as an E2 station. All other reference stations and the monitoring points are to be surveyed with reference to this point. but if none of the reference stations is suitable for GNSS observations, a temporary station shall be established in a suitable location and the reference stations levelled / traversed from that point.

Monitoring points shall be established on the structure(s) which is to be monitored in approximate locations shown on the contract map. These points shall be designed to move with the structure. Records of their location (sufficient to enable them to be found unambiguously and with ease) shall be submitted with the survey report, enabling the points to be found for subsequent monitoring surveys. The survey scope and contract map shall indicate which points are to be used for plan and/or height monitoring.

For the initial monitoring survey the surveyor shall design a survey with sufficient redundancy to detect errors and carry out statistical analysis to assess accuracy. The surveyor shall produce a plan showing the location of the reference and monitoring points and agree a suitable method of presentation of the results – typically a spreadsheet, which shall be populated with baseline survey values. The surveyor shall also design charts which will show changes to the baseline survey as bar charts. The survey report shall provide sufficient information to enable another surveyor to carry out a repeat survey.

Any site-specific equipment which would be needed in order to carry out repeat surveys shall be provided to the CSM as survey deliverables.

1.2 Hydrometric gauging stations
For monitoring of hydrometric gauging stations, one of the reference stations shall be designated the site benchmark.

1.2.1 Gauging weirs and flumes

The position and level of dip plates and the level of a value on each gauge board shall be observed.

Levels of internal reference points within the gauge hut are to be surveyed. These will usually be a metal plate surrounding a circular hole on the top of the instrument bench. The interior of the hut is to be photographed and the positions of levelled points identified on the photo.

A minimum of four general photographs are to be taken of each site and photos shall be taken of the points levelled for the spreadsheet, marking up where the level was taken. This is particularly important where there is a risk of ambiguity. Photo file names are to be the same as the description of the feature which is used in the spreadsheet, not using sequential numbers.

For gauging weirs, the following shall be observed:

- A precise cross-section shall be observed along the crest of weir. The maximum distance between section points shall be 1m. The base and top of outer wingwalls shall be included in the section and the section shall extend at least 5m beyond the wingwalls. The lowest level of the crest shall be surveyed. If necessary, the surveyor shall use a special survey staff in order to survey the weir crest accurately: particularly so as to accurately level ‘V’ notches. If the structure is a flume, the ‘crest’ shall be taken across the narrowest part of the flume.
- Points at the base of the upstream and downstream slopes.
- Cross-sections are to be observed near the upstream and downstream extents of the concrete apron and shall extend 5m beyond the wingwalls.
- The distance between the wingwalls at the crest at weir level, half way up the wingwalls and at the top of the wingwalls.
- A long section shall be observed through the centre of the weir (or for each sub-weir if it is a compound weir) i.e. at right angles to the crest line at the midpoint of each crest section running from 5m upstream of the toe of the upstream slope of the weir or the inlet cill to the overall weir structure if this is further upstream or the end of the wing walls if this is further upstream to a point 5m downstream of the toe of the downstream slope of the weir or the outlet cill of the “stilling basin” or the downstream end of the wing walls if these are further downstream.
- Distances between pairs of steel pins as required in the scope.

For flumes, the following shall be observed:
1.2.2 Ultrasonic gauging stations

In addition to the relevant requirements for gauging weirs stated above, the following applies:

- The CSM shall provide with the survey scope, guidance on the operation of ultrasonic gauging stations, diagrams clearly identifying the features to be measured, cross-sections required at each gauging station and design details of the transducer racks.
- Date and time of survey is to be recorded along with water level, velocity and total flow at the time of survey. This information can be obtained from the local EA Hydrometry and Telemetry team.
- Path length between the centre of each transducer (not the face) and its pair on the other side of the channel.
- Level of transducer, measured in the centre of the face.
- For exposed transducers, the height difference between the top of the transducer mount and the centre of the transducer and the diameter of the transducer shall be measured. These dimensions can be applied to all measurements. A photograph indicating the points measured shall be included in the survey report.
- Rack Lengths as defined on the site diagrams
- Path angles: the angle between the flight path (transducer to transducer) and the river flow. This is usually defined by the riverbanks. If river flow is not parallel with the river banks the bearing of each river bank shall be recorded.
- The bearing and slope of non-vertical transducer racks
- Unless otherwise shown on the site diagram, cross-sections shall be surveyed for each transducer pair. Cross-section points shall extend from top of bank to top of bank and be observed at maximum interval of 2m and within 0.5m of the flight path and moved perpendicularly onto the flight path during processing. If the river bed is soft, readings shall be taken on the hard and soft
bed. Cross-sections shall also be observed perpendicular to the bank at the upstream and downstream transducer(s) and three cross-sections shall be observed equally spaced between the upstream and downstream cross-sections. In addition three cross-sections are required upstream of the gauging station at intervals of 2 x river width, in order to reveal any approach conditions (e.g. shoals) that could disturb flow at the gauging station.

- Channel width is required for all cross-sections taken.
- The channel bed along the path between each pair of transmitting and receiving transducers is the ‘measuring zone’. In this region, the river bed level shall be interpolated at equal intervals so that there are at least 50 points. The simple arithmetic average bed level shall be computed from the interpolated points and stated in the data table. The measuring zone does not include channel banks.

1.3 The survey results shall be presented using a spreadsheet based upon template GaugingStation.xls and as plan with long- and cross-sections.

1.4 The survey scope shall state if there is a requirement for a topographic survey of the site and/or cross-sections up/downstream of the weir. If so, these items will be specified in the topographic and channel survey parts of the survey scope respectively.

2.0 Repeat Surveys

The CSM shall provide the surveyor with records of the previous monitoring survey.

2.1 The reference points shall be surveyed with the intention of detecting relative movement between each point and thereby establishing their stability.

Any reference points which have been destroyed shall be replaced.

If stated in the survey scope, the surveyor shall observe an E2 station to check the site levels against the OS Net reference.

The surveyor shall present the results to the CSM before proceeding with computation of any detail survey work. For hydrometric surveys, the CSM shall discuss the results with the hydrometric client and decide whether the site benchmark is to be revalued.

2.2 Any monitoring points which have been destroyed or obscured shall be replaced and the replacements documented in the survey report, to avoid ambiguity in interpreting the survey results.

All monitoring observations made for the initial survey shall be repeated and the results added to the appropriate spreadsheet.

For structure deformation surveys, the surveyor shall make any necessary revisions to the plan showing the location of monitoring points and provide the updated plan.
For hydrometric gauging stations, updated plan and profile drawings shall be produced. Where the results of the previous monitoring survey were presented in a table on the drawing, the data shall be copied into gaugingStation.xls and the table deleted from the drawing.

2.3 For hydrometric gauging stations, the topographic survey of the site shall be updated to reflect any significant changes.

The survey scope shall state if surveys of cross-sections up / downstream of gauging stations are to be repeated.

2.4 Deliverables shall be the same as the previous repeat survey, but if the previous survey showed tabular data on the drawing, this shall be transferred to a spreadsheet (using template GaugingSta.xls). The table on the drawing shall be deleted and replaced with a reference to the spreadsheet.

2.5 A comprehensive survey report shall be prepared which shall contain all the information required for an independent surveyor to understand the survey without reference to previous surveys.
SECTION VI – HYDROGRAPHIC SURVEYS

1.0 Products

1.1 As specified in the Products table of the survey scope, Surveyors shall supply bed level, water depth, erosion/deposition data / dredging data as 2.5D Grid models, aligned to the National Grid as specified in Section III para 5.0.

1.2 Where specified in the Products table of the survey scope, the survey data shall be plotted against an OS Mastermap background to produce charts. Where applicable, the Surveyor shall use the same map sheet layout as prepared for previous surveys. Where there is no previous layout available or the previous survey was not plotted to this specification, the Surveyor shall design map sheets in Autocad paper space with the objective of minimising the amount of ‘paper’ used. For rivers, the sheet layout shall be designed so that the river falls in the centre of strip maps, where several strips fit on each drawing sheet. Sufficient grid intersections shall be numbered on each strip along with north point. Each strip shall be plotted so that water flows from left to right and top to bottom. Hydrographic charts shall be produced showing layer-shaded water depth (see para 2.1) using data produced under 1.1 above. A five metre grid of levels shall be extracted from the data and plotted on the drawings. Depths shall be shown as positive numbers to one decimal place.

1.2.2 Where specified in the survey scope, dredging charts are to be produced. The CSM shall provide drawings showing the extent and depth of dredging below sounding datum. Surveyor shall compute grid data and shall show this in terms of layer shading in accordance with 2.2 below. The surveyor shall make enquiries concerning obstructions to dredging (eg utilities passing under the waterway) and show them on the dredging plan.

1.2.2.1 Surveyor shall calculate the volume of material to be dredged and depict it as a label against each discrete area of dredging or as a schedule of volume against centreline chainage when the dredging is continuous along the channel.

1.2.3 Where specified in the survey scope, erosion/deposition charts are to be produced. The CSM shall provide grid data for the previous survey and the Surveyor shall compute a surface of grid data for the difference between the two surveys. Deposition shall be recorded as positive values.

1.2.4 Where specified in the survey scope, a longitudinal section of the centre-line of the river shall be produced from the Hydrographic data. The section shall be provided in hard-copy and as ASCII file of chainage and height ODN.
2.0 Layering Schedule

### 2.1 Sounding Layers

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<thead>
<tr>
<th>Depth</th>
<th>Colour</th>
<th>Autocad Colour No</th>
<th>R</th>
<th>G</th>
<th>B</th>
</tr>
</thead>
<tbody>
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<td>0.5m Red</td>
<td>1</td>
<td>255</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
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<td>1.0m Orange</td>
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<td>255</td>
<td>191</td>
<td>0</td>
</tr>
<tr>
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<td>1.5m Yellow</td>
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<td>255</td>
<td>255</td>
<td>0</td>
</tr>
<tr>
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<td>2.0m Green (light)</td>
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<td>63</td>
<td>255</td>
<td>0</td>
</tr>
<tr>
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<td>2.5m Green (dark)</td>
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<td>0</td>
<td>165</td>
<td>41</td>
</tr>
<tr>
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<td>0</td>
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<td>174</td>
<td>0</td>
<td>0</td>
<td>127</td>
</tr>
<tr>
<td>4.0m</td>
<td>4.5m Magenta (light)</td>
<td>211</td>
<td>255</td>
<td>127</td>
<td>255</td>
</tr>
<tr>
<td>4.5m</td>
<td>5.0m Magenta (dark)</td>
<td>212</td>
<td>165</td>
<td>0</td>
<td>165</td>
</tr>
<tr>
<td>5.0m</td>
<td>And deeper</td>
<td>White</td>
<td>7</td>
<td>255</td>
<td>255</td>
</tr>
</tbody>
</table>

### 2.2 Dredging Areas

<table>
<thead>
<tr>
<th>Thickness to be dredged</th>
<th>From</th>
<th>To</th>
<th>Colour</th>
<th>Autocad Colour No</th>
<th>R</th>
<th>G</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dredging depth and below</td>
<td>No dredging required</td>
<td>White</td>
<td>7</td>
<td>255</td>
<td>255</td>
<td>255</td>
<td></td>
</tr>
<tr>
<td>Dredging depth 0.25m above dredging depth</td>
<td>Gold</td>
<td>Orange</td>
<td>40</td>
<td>255</td>
<td>191</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>0.25m above dredging depth 0.5m above dredging depth</td>
<td>Cyan</td>
<td>4</td>
<td>0</td>
<td>255</td>
<td>255</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.5m above dredging depth 1.0 above dredging depth</td>
<td>Royal Blue</td>
<td>160</td>
<td>0</td>
<td>63</td>
<td>255</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.0m above dredging depth Water surface</td>
<td>Red</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
SECTION VII – SITE SERVICES SURVEYS

1.0 General

1.1 This specification is based upon standard PAS128 / PAS 256, which may be obtained from BSi. For guidance, the Client Survey Manager should refer to PAS128 / PAS256 and the RICS Measured Surveys of Land Buildings and Utilities 3rd Edition.

1.2 The CSM shall provide the Surveyor with any existing utilities records held by the Environment Agency as Quality Level D data.

1.3 The surveyor shall be liable for all costs arising from carrying out the survey, including traffic management.

2.0 Deliverables

2.1 The surveyor shall supply plans showing the utilities information against a suitable map background as indicated in the Products table of the survey scope and using the Environment Agency’ standard layering convention (Section I, para 11)

3.0 Survey Method

Underground services surveys shall be carried out to the Level of survey specified in the survey scope. The levels of survey are defined as follows:

Quality Level D: The lowest level of survey being essentially a utility record search.
Quality Level C: A reconnaissance survey correlating, where possible, the results of the record drawings with surface features related to the buried utilities thus improving the quality of the record data.
Quality Level B: A detection survey of utilities carried out using, as a minimum, the two techniques of electromagnetic location and ground probing radar (GPR). There are four accuracy bands within Quality Level (QL) B which the surveyor allots to each utility detected. These reflect the accuracy and confidence of the detection results.
Quality Level A: The highest level being a verification survey where critical utilities are exposed so that their precise position and depth can be verified.

The Quality Level required is stated in the survey scope. Note that for a specified quality level, the work necessary to achieve the levels above it must also be carried out. Eg for a QLB survey, QLs C and D must also be achieved.

If dye tracing is used to establish connections along culverts, the Environment Agency’s document 1063_08_RA for dye tracing.doc “Generic COSHH assessment – tracing pollution/drainage water using a dye material” shall be followed.
4.0 Other requirements

4.1 Only bio-degradable paint spray markers may be used to mark traced lines

4.2 If specified in the scope, hand-drawn sketch records are required for all chambers containing pipes including dimensions of all incoming and outgoing pipes, invert levels and any other relevant information. These are to be scanned at 150dpi and submitted with the report.

4.3 Discrepancies between the number of pipes or cables entering a duct and the number emerging from it will be reported immediately to the CSM.

5.0 Presentation

5.2 Where discrepancies between the number of pipes or cables entering a duct and the number emerging from it are detected, a label will be added to the duct line on the plot indicating the discrepancy.

5.3 The data for each separate service shall be held in a separate AutoCAD layer in accordance with the standard stated in Section I, para 11. Individual services shall be annotated to indicate their quality level and band.

5.4 A note is to be added to the “notes” panel of every drawing: “All services are below ground unless otherwise indicated” and a disclaimer will be added to each drawing sheet as follows, "These services were surveyed on (date). The survey has been carried out according to the requirements of PAS128. See the survey report for further details. The existence of such services at the given date does not absolve the user from further services investigation before works commence”.

5.5 The boundary of the area surveyed is to be shown with a line which cannot be confused with the service symbols, and all services crossing the boundary shall be shown plotted up to that line.

5.6 All existing records referred to for the survey shall be listed on the drawing with details of drawing reference or number, source (including address and telephone numbers), date of record, scale, assessment of reliability and any discrepancies found. Personal information shall not be stated on the drawing.

5.7 If specified in the survey scope, surveyor is to mark out services on the ground using the colour codes specified in TSA guidance Appendix 4.
SECTION VIII – POST FLOOD RECORDING SURVEYS

1.0 Purpose of Survey

The survey scope shall specify if the survey is required for information gathering and / or to survey plan and height of previously identified points.

2.0 General

Surveyors engaged in this work shall display their ID cards at chest height and shall carry an explanatory letter from the Environment Agency at all times. Copies of the letter may be handed out to bona-fide residents. Any left-over letters must be shredded.

Where the surveyor is required to conduct interviews with members of the public, the time to be allocated shall be stated in the survey scope. If the surveyor finds that this aspect of the work is taking longer than budgeted, the surveyor shall inform the Client Survey Manager immediately and agree any additional work.

3.0 Surveys for information gathering

The survey is required in order to identify properties that have been flooded, flood water levels, flood water flow routes and record narrative information from local people.

As marked in the survey scope products tables, the survey shall be presented as completed flood recording spreadsheets (propfloodrec.xls for flooding of buildings, floodmk.xls for other flood marks) with referenced photographs and 1:1250 / 1:2500 scale mapping annotated with spatial information gathered including flood outline information, flow routes and location of points which are to be surveyed. A separate record is required for each property in propfloodrec.xls but not all fields (eg survey information) in propfloodrec.xls and floodmk.xls can be completed. The surveyor shall also show any points (eg river gaugeboards) which should be levelled.

4.0 Survey of flood marks and other information

The surveyor is required to carry out survey work in accordance with Section I, II, III, XI and other appropriate sections of this specification and according to the guidance provided Survey_National_Specifications_Templates_V5.0\Guidance\Post Flood Recording Surveys.pdf. All levelling shall be observed in closed loops starting and finishing (if possible) on different control points. Levelled flood marks shall be correct to within 20mm when checked from the nearest control point. The deliverables are completed spreadsheets (propfloodrec.xls, floodmk.xls). Levels shall be added to
the mapping by automatically plotting from coordinates in the spreadsheets. This is intended to aid interpretation of the event and is to be clearly legible.

All flood marks should have an accompanying photograph with the staff/pole on the mark. The evidence can add confidence when using the level for flood modelling.
SECTION IX – CONSTRUCTION SURVEYS AND AS-BUILTS

1.0 Introduction

Refer to Survey_National_Specifications_Guidance_V5.0 - Para 7, for guidance on surveying for construction works.

2.0 Setting out

The surveyor shall ensure that the necessary survey information has been provided to enable the construction works to be set out and verify that its version is current.

The surveyor shall survey critical topographic features (e.g. places where new construction ties in with existing features, such as flood banks) shown on the design drawings to ensure that there is consistency between the survey control and the survey detail used for the design of the project.

The surveyor shall carry out best practice checks to ensure that any survey control information provided is internally consistent and shall check the National Grid coordinates and heights (ODN) of the survey control stations (site benchmarks). The results shall be presented to the CSM.

If there is no survey control information available, the surveyor shall establish their own points in accordance with the provisions of Section II of this specification, ensuring that there are sufficient points for the duration of the construction works, that they are suitably protected from damage by site activities and that they can be reinstated if necessary.

The surveyor shall ensure that deliverables clearly and unambiguously define the coordinate reference system(s) used for the project and any site scale factor which may apply.

All set out points shall be checked independently and a record retained of the results.
 SECTION X – SURVEYING TECHNIQUES

1.0 Introduction

The Surveyor is free to choose the most appropriate technique to produce survey products specified in earlier sections of these specifications and the survey scope.

However, particular techniques are subject to the following clauses, which are intended to assure the product quality.

If the Surveyor’s proposal is to use a technique which is not covered, is partially covered by this section of the specifications, or if they consider this specification or guidance to be out of date, they are required to demonstrate that the method has been tested thoroughly and produces products that satisfies the specification.

2.0 Levelling

Wherever practical, digital level and barcode staff shall be used. If a digital level with automatic data recording is used, an intermediate sight will have the same status as a back sight or fore sight. If an optical level is used, intermediate sights to critical points shall be observed twice from different setups or by reading stadia as well as middle hair.

Level instruments shall be calibrated by the Surveyor before each survey commences and at a maximum interval of two weeks during a survey project.

Computation of levelling shall be made by post-processing, not by processing on the fly.

Level runs shall start and finish on benchmarks, preferably different benchmarks and to form a continuous network.

The following shall be supplied to the validation surveyor at the same time as data delivery:

- Two peg test results
- Original level staff readings and computations
- A levelling diagram, clearly showing benchmark identifiers.
- Photographs of BMs and TBMs.
3.0 Control observed using GNSS

Observation stations are to be established in places where the sky view is clear. There should be no obstructions above 10 degrees elevation and no objects likely to cause multipath errors. GDOP and coordinate quality filters are to be set in the receiver: ‘automatic’ quality threshold settings are not permitted.

For all GNSS observations, dual frequency, survey quality GNSS receivers shall be used. For network RTK observations, receivers shall in addition receive signals from the GPS, GLONASS and the Galileo constellations.

Surveyors shall use processes to ensure that antenna details and height are correct. Eg height of instrument measured in metres and feet/inches, reading photographed etc.

GNSS observations are to be transformed on to OSGB36 using OSTN15 and Ordnance Datum Newlyn using OSGM15.

For guidance on good practice for static GNSS observations, the RICS Guidelines for the Use of GNSS in Land Surveying and Mapping, 2nd edition shall be used as reference.

RINEX data for all (including the Surveyor’s) GNSS observations is to be retained by the surveyor and supplied to the CSM on request and at no additional cost. All baseline computations (full log file) and network adjustment log files (unconstrained and constrained) shall be provided in digital form with the survey report.

Network RTK observations shall be made in accordance with the TSA guidance note Guidance Note - Network RTK GNSS Best Practice 2012.

4.0 GNSS for detail surveying using base and rover and network RTK

Base and rover RTK and network RTK techniques may only be used under site conditions for which they are suitable - ie clear sky view and no multipath and using equipment that can receive all signals from all operational GNSS constellations.

If Base and rover RTK is used, the base station shall be observed for at least one hour and processed as if it was an E2 station.

Infill services, which use satellite transmitted data if there is a break in reception of network RTK services are not to be used, regardless of reason.

When heights are surveyed using Real Time Kinematic GNSS (RTK), a particular point, preferably a previously surveyed point with a known height, shall be surveyed before the start and after completion of survey observations. In addition, the Surveyor shall monitor coordinate quality data during the survey and force re-initialisation if the figure is high or appears unstable.
Network RTK observations shall be made in accordance with the TSA guidance note "Guidance Note - Network RTK GNSS Best Practice 2012.

4.1 All Terrain Vehicles (ATV)
These are typically quadbikes on which a GNSS antenna is mounted. The GNSS points are observed in either base and rover or network RTK kinematic mode. The GNSS observations are subject to the same specification as pole mounted RTK.

The GNSS receiver is to be mounted vertically over a front wheel.

Before each survey, the difference of height between GNSS antenna and ground is to be measured and the verticality of the pole adjusted. This is to be done whilst the vehicle is positioned on a hard surface and with the ATV driver in place.

When used on steep slopes, raw observations from the system are to be adjusted for pitch and yaw of the ATV unless otherwise stated in the survey scope. Software routines used for this purpose are to be independently validated.

When driving along breaks of slope, the GNSS antenna must be positioned over the break of slope.

During the survey there must also be a surveyor on foot available to observe features that are inaccessible to the ATV. The surveyor shall also observe checks on ATV data by observing points in the tracks of the ATV at a frequency specified in the Survey Scope.

4.2 Backpack mounted GNSS
The surveyor places the GNSS equipment in a backpack and walks the survey. The GNSS equipment operates in kinematic mode and is subject to the same specification as if it is mounted on a pole. The accuracy of this technique suffers because the height of the GNSS antenna above the ground is not fixed whilst the surveyor is walking. The height of the antenna above ground can be determined by standing over a survey control point and this should also reveal the offset of the antenna in plan.

4.3 Wheel mounted GNSS
The GNSS antenna is mounted on a detail pole, the bottom of which is attached to the axis of a bicycle wheel. The bicycle wheel has a larger contact area with the ground and will therefore sink less. The pole is held vertical as the surveyor walks, unless the equipment compensates for a tilted pole. The GNSS kinematic survey technique is subject to the same specification as if there was no wheel. There will be position errors for points surveyed on slopes due to the difference between the plan position of the hub of the wheel and the plan position of the wheel in contact with the ground. These differences should be corrected using validated software routines.

5.0 Photogrammetry for topographical surveys
If the surveyor is required to fly new photography, RICS guidance note *Earth observation and aerial surveys* shall be followed.

5.1 Large format photography from higher altitude manned aircraft

The accuracy that can be attained using photogrammetry depends upon the scale of the photography. The following table gives a guide:

<table>
<thead>
<tr>
<th>GSD</th>
<th>Digital Camera</th>
<th>Photo scale</th>
<th>Film Camera (legacy)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>XY</td>
<td>Z</td>
<td>XY(6’&amp;12”)</td>
</tr>
<tr>
<td>0.030</td>
<td>0.090</td>
<td>0.045</td>
<td>1:2000</td>
</tr>
<tr>
<td>0.040</td>
<td>0.120</td>
<td>0.060</td>
<td>1:3000</td>
</tr>
<tr>
<td>0.050</td>
<td>0.150</td>
<td>0.075</td>
<td>1:4000</td>
</tr>
<tr>
<td>0.100</td>
<td>0.300</td>
<td>0.150</td>
<td>1:5000</td>
</tr>
<tr>
<td>0.150</td>
<td>0.450</td>
<td>0.225</td>
<td>1:7500</td>
</tr>
<tr>
<td>0.200</td>
<td>0.600</td>
<td>0.300</td>
<td>1:10000</td>
</tr>
</tbody>
</table>

Accuracies are given in metres r.m.s.e. 

In accordance with the requirements of the survey scope, photography may be obtained from EA archives or from one of the commercial archives or may be flown to order. All new photography shall be digital and supplied with GNSS and INS data for the exposure position of all photographs. Imagery shall also be supplied at reduced resolution for quick viewing and a legible flight diagram shall be supplied. All shall be supplied on media (e.g. hard disks) provided by the Surveyor.

Where photography is to be supplied by the CSM, the following will be provided:

(i) Photographic images in digital format either directly from a digital camera or scanned images from archive film.
(ii) Calibration certificate / data for camera.
(iii) Digital flight diagram clearly showing run and photo numbers on a map background.

5.2 Photogrammetry from Unmanned Aircraft (UA) / Drone-mounted aerial photography

Photography shall be acquired with minimum 80% forward overlap and 25% side overlap and have a nominal ground sample distance (GSD) as specified in the survey scope. Flying of UAs shall comply with current CAA regulations. The surveyor shall provide copies of CAA current valid certification for the pilot(s) who will operate the drone(s) and for the mission, where applicable. As a minimum requirement, photography shall not be taken in poor light, visibility or wind conditions.

These are minimum conditions. If the surveyor intends to enhance the quality of the photogrammetric survey by taking measures beyond the minimum stated here, these should be stated in their survey proposal together with the benefits for the client.
5.3 Photogrammetry from terrestrial hand-held photography.

Photography shall be acquired with minimum 80% forward overlap and 25% side overlap and have a nominal ground sample distance as specified in the survey scope. All photography to be taken with the same camera and in the same, or gradually changing, orientation. Conditions of bright light, shadows and wind movement of vegetation are to be avoided. Motion of the camera between photographs is to be predominantly sideways rather than closer or further from the object.

5.4 Photo ground control and ground truthing

5.4.1 The photogrammetric models produced using the aerial photography shall be controlled using precise GNSS PPK (post processed kinematic) positioning of the photographic exposures and / or by observing sufficient photo ground control points to achieve the product accuracy required.

Where GNSS PPK is used to determine the position of photographic exposures, additionally at least four photo ground control points shall be established near the corners of the survey area and used to verify / enhance the control provided using PPK data.

Where GNSS PPK positioning of the photographic exposure is not used, sufficient ground control points shall be established to control the photogrammetry and achieve the specified survey accuracy. Points shall be established around the perimeter of the photogrammetric block and evenly within the block.

Navigation-grade GNSS shall never be used to control photogrammetric models.

5.4.2 Survey ground control for drone-mounted photogrammetric surveys shall always be premarked. Points shall be printed targets, preferably with coding enabling the processing software to identify them automatically. They shall be clearly visible in the photography. They shall be removed from the site following completion of the survey.

5.4.3 Only if for some reason some premarked points are not useable, or by prior agreement with the CSM, shall the surveyor identify features on the imagery and use these as photo control. The surveyor shall use industry standard practices to identify and survey suitable plan and height control points in the photography. Each point shall be marked up clearly on the photography and sketches shall be provided in the survey report.

5.4.4 In addition to ground control points, the survey shall be ‘ground truthed’ to demonstrate that it has achieved the accuracy required. Ground truth points shall be surveyed evenly over the site and at the density specified in the survey scope.

5.4.5 If the Survey Scope Products table – Digital data files indicates that a 3D point cloud is a required deliverable, a dense point cloud shall be delivered. It shall be tiled so that the maximum file size is 5GB, or by agreement with the CSM.
5.4.6 If the Survey Scope Products table – Digital data files indicates that a 2.5D Grid DTM is a required deliverable, the dense point cloud shall be filtered to remove all points above bare earth and ‘binned’ so produce data of the specified cell size in accordance with Section III para 4.0.

5.4.7 If the Survey Scope Products table – Digital data files indicates that an orthophoto is a required deliverable, the accuracy of all parts of the image shall conform to the accuracy specification stated in para 2.4.3 (iii) of the Survey Scope. The orthophoto shall be split into butt-joined rectangular tiles as necessary to ensure a maximum file size of 40MB, or as agreed with the CSM.

5.4.8 If the Survey Scope Products table – Digital data files indicates that a mesh model is required, the model shall comply with paragraph 7.4 of this Section.

5.5 The level of detail provided in the survey report should be as necessary for the techniques used. The report shall include:

- Coordinate files for photo exposures including date and time of each exposure
- Coordinate file of ground control points
- Coordinate file of points used for validation / ‘ground truth’ purposes, including comparisons with the photogrammetric model and statistical analysis.
- Camera make, model, focal length, pixel rating and GSD
- Camera calibration certificate, for medium and large format metric cameras.
- Camera calibration computation for cameras used for small format (drone-mounted) photogrammetric projects.
- Aircraft make and model
- Equipment make / model and techniques used for GNSS PPK survey control of the aircraft, coordinates and computations
- Survey ground control point descriptions
- Aerial triangulation computation including residuals on to all survey control
- Camera calibration results
- Product details, including resolution and accuracy
- Comments and lessons learned

5.6 Unless otherwise stated in the survey scope, for photogrammetric surveys only, the Surveyor is not required to undertake any field verification to survey features obscured on the photography (eg by trees or parked cars).

6.0 Total station observations for topographical surveys

Lines of sight from tacheometric survey where the height coordinate will be used in a 3D string shall not exceed 150m unless the surveyor computes heights using earth curvature and refraction corrections that correct for these errors within the accuracy required of the survey.

When used to survey soft features, such as top of silt in a river bed or sand surface on a beach, the prism pole must be fitted with a plate to prevent the tip of the pole sinking into the surface.
Surveyor shall observe at least one detail point on each setup that is common with a
detail observation from another instrument set up and quote the coordinate
comparison in the survey report.

Surveyor shall retain all raw data (angles, distances and met observations) with
project data. All computations shall be made by office-based post processing – not
processing on the total station, on the fly. The computation shall be submitted with
data for validation.

7.0 Terrestrial laser scanning

7.1 General

This section covers laser scanning from static setups and from moving vehicles and
boats. Airborne LiDAR is covered by para 8.0 below.

Ground truth points shall distributed evenly within the point cloud at the density
specified in the survey scope. They shall not be located close to ground controlled
points.

Raw scan data shall not be delivered, but the surveyor shall retain the data for at least
six years and make available free of charge to the client on a single request. Each raw
scan shall have associated metadata as shown in Section 7.4.3 of Metric Survey
Specifications for Cultural Heritage (3rd edn). Metadata records shall be supplied for
all raw scans.

Surveyor shall provide control and registration information for all raw scans on the
site coordinate system. The residuals from registration shall be stated in the survey
report.

Registered and geo-referenced point cloud data shall be delivered in the format
specified in the survey scope.

The data shall also be retained by the surveyor for six years and shall be supplied
within one week of request by the Environment Agency. The data shall be supplied
free of charge for the first three requests. Thereafter a reasonable fee may be charged.

7.2 Scanning from tripod set-ups

Tripods are normally used for static set ups but it is possible to mount the scanner on a
vehicle that is stopped at successive scan positions. If this method is used, it is vital to
ensure that the vehicle remains sufficiently stable during the scanning process.

Survey control for scanning shall be surveyed targets in the scans and surveyed scan
positions. These points shall be surveyed in accordance with Section II of these
specifications. Surveying for EA purposes will nearly always be conducted from
stable platforms, so if available for the scanner concerned, the dual axis compensator
shall be switched on. Control must be located so as to provide strong position fixing in three dimensions. There must be sufficient redundancy in the survey control to enable errors to be detected and corrected as well as to achieve the required accuracy.

There shall be an overlap of at least 20% between scans so that, where there is sufficient detail in the overlap, cloud-to-cloud registration can be used. The results of registration shall be quoted in the survey report.

Sufficient scans shall be observed to describe the object to be surveyed and avoid voids in the data.

7.3 Mobile scanning

Mobile scanners can be mounted on vehicles, on boats or may be handheld.

At tender stage, the Surveyor shall provide documentary evidence that the proposed mobile laser scanning system has been tested in similar situations and sky view conditions to those that will be experienced in the area to be surveyed and produces point cloud data to the accuracy required. If surveyor surveys objects within the scan data for the purposes of adjusting the Smoothed Best Estimate Trajectory (SBET), these objects shall not be in the same location as the ground truth sites.

For handheld scanning systems that rely upon measurements to objects within the point cloud to determine the SBET, the trajectory of each scanning session shall start and close at the same location. The surveyor shall establish survey control to transform the point cloud data to the survey grid and height datum.

Surveyor shall provide details of the observations and calculations used to determine the relative positions of the scanner and GNSS receiver(s) and synchronisation of the scanner, GNSS and IMU. Surveyor shall document and provide all survey data used to position and orientate the vehicle during the survey, including the raw (and adjusted – if any) SBET.

The surveyor shall ‘ground truth’ the survey by surveying, using an independent method, objects in the scan data at intervals along the vehicle route as specified in the survey scope. Ground truth sites shall be located at least 100m from objects used to adjust the SBET. The comparison of three dimensional coordinates shall be provided in the survey report.

7.4 Production of mesh models from photogrammetric or laser scan point clouds.

Where specified in the survey scope, a mesh shall be computed from the point cloud.

The mesh shall be a surface composed of adjoining 3D triangles. The mesh shall be composed so that no point in the source point cloud shall deviate from the surface by greater than the distance stated in the survey scope.

The mesh shall be delivered as 3DFACE entities in Autocad DXF format and also as Autocad FBX format, including texture data if specified in the survey scope.
8.0 Surveying using LiDAR techniques

8.1 The surveyor shall provide the following information and materials:

(i) DSM, DTM and point cloud data, as specified in the Products table of the survey scope. Point cloud data shall be stored with time stored as GPS standard time not GPS seconds of the week and include all returns.

(ii) Any Arcview extensions that are required to use the data together with full instructions for installation and use.

(iii) Include in the report:

- Statement of survey requirements as given in the scope, departures from the scope and reasons for change.
- Any factors during the flight or encountered during processing that might affect the quality of the survey.
- Standard information concerning instrument specifications, serial numbers and calibration. This can be included as a separate document updated as appropriate.
- Statement of last instrument calibration before the survey. When and where the calibration was made and results.
- Flight map showing actual flight lines
- Flight data logbook / log sheets including details of atmospheric and other conditions during the flight.
- Flight coverage map.
- Statistical analysis of LIDAR against ground survey at ground truth sites and, if LIDAR is adjusted to ground control, details of the residual systematic biases and RMSE statistic before and after adjustment.
- Statement on coordinate system(s) used and transformations used to affect coordinate change.
- Description, coordinates and level of LIDAR base stations and copy of network adjustment used to establish the stations. Where OSNET Stations are used details of stations and data rates used should be provided

8.2 Survey ground control shall be suitable to achieve the required survey accuracy.

8.3 Surveyor shall retain all recorded laser height data for a period of at least six years and shall make available to the client at cost if requested.

8.4 A ground truth survey site shall be observed for each mission polygon and shall be at least 50m x 50m size on a gradient of less than 1%. If none already exists, a ground control point shall be established on the site and connected to the LIDAR base station by at least 1 hour observation. A minimum of 100 detail points shall be surveyed by
8.5 Flight lines shall be planned with a minimum overlap of 20% and an average overlap of 30%.

8.6 Surveyor shall undertake quality control and verification of the data. This shall include visual inspection as well as statistical analysis. The visual check shall cover inspection for gaps in data coverage and comparison with existing digital data (where available). The data shall be checked for line offsets and errors due to roll, pitch, yaw and scale and other anomalies. Surveyor shall ensure that the accuracy of the DTM falls within the specification in all parts of the survey area.

9.0 Hydrographic Surveys using single- or multi-beam echosounding techniques

9.1 If terrestrial survey techniques are used the appropriate paragraphs above will apply.

9.2 For single beam echosounding surveys the surveyor shall supply 3D point data in comma delimited text format for the points surveyed.

9.3 Calibration of hydrographic survey equipment

Calibration results shall be performed in accordance with the requirements of the UK Hydrographic Office Survey Specification Acoustic, which is available from: https://datahub.admiralty.co.uk/portal/apps/sites/#/marine-data-portal/pages/seabed-mapping-services

9.3.1 The 3D offsets between GNSS (or survey prism), IMU and echosounder shall be surveyed. The offsets shall be orientated to the vessel axes and shall be correct to better than 10mm along each axis. A copy of the surveyed measurements shall be included with the survey report. The survey shall be repeated whenever new equipment is installed.

9.3.2 The plan position of the vessel shall be determined by GNSS PPK or total station. Soundings shall either be determined from water level or from the height coordinate from the GNSS PPK / total station – whichever method is most appropriate for conditions in the survey area.

9.3.3 Bar checks to calibrate for effects of temperature and salinity shall be made at the beginning and end of each day’s surveying and at times during the day when the water conditions are observed to change.

9.4 Multibeam echosounding

9.4.1 All Multibeam Swathe Hydrography data collected shall comply with the UK Hydrographic Office Survey Specification Acoustic, which is available from: https://datahub.admiralty.co.uk/portal/apps/sites/#/marine-data-portal/pages/seabed-mapping-services. ‘HI’, where quoted in the document, is to be read as ‘survey scope’. The following exceptions apply;
• Where the provisions of this specification (the whole document) conflict with those of the CHP specification, this specification shall take precedence.

• If, for any reason, the charge surveyor believes that site conditions beyond their control (e.g., presence of river weed) will adversely affect the quality of the survey data, the surveyor shall contact the Client Survey Manager immediately.

• The charge surveyor on board the vessel shall not necessarily have IHO/FIG Category A Qualifications (Section B4.1.1) but will be sufficiently experienced and qualified to make and implement operational decisions.

• Unless otherwise stipulated in the Scope, additional investigations of wrecks (Section B4.2.8) are not required beyond the usual seafloor sounding density required for IHO S-44 Feature Detection.

• Static positioning checks and Swath Hydrography Repeatability tests (Sections B4.4.9 and 4.4.10) are not required where separate Ground Truth, Single beam Hydrography, or other independent verification data is used to cross check the performance of the Multibeam Hydrography system.

9.4.2 All data collected in Shallow Coastal (<20m), Estuarine and Riverine environments shall meet the vertical uncertainty of IHO S44 ‘Special Order’ specification.

9.4.3 In Riverine environments the total vertical uncertainty for each cell shall not exceed a maximum of 0.15m (rmse, 1σ). Systematic bias shall be less than +/-0.05m.

9.4.4 Where specified in the survey scope, surveyor shall collect point cloud data at the base of weir structures in order to detect undercutting. This can only be done when there is no water flowing over the weir as air bubbles may render the data useless. The Surveyor shall liaise with the relevant EA Waterways staff to endeavour to switch flow away from the weir to be surveyed. Surveyor shall liaise with the EA Waterways staff and give at least two days notice. If this is not possible, this aspect of the survey shall be abandoned and the Client survey manager informed immediately.

9.4.5 Surveyor shall retain raw and processed data and database files suitably backed up until completion and acceptance of the project including calibration, multibeam, vessel position and water level data. This data is required as a project deliverable for validation purposes.

9.4.6 The minimum density required is 10 soundings per square metre. The surveyor shall endeavour to stay within a maximum of 50 soundings per square metre.

9.4.7 A plan shall be produced showing areas where no Hydrographic observations have been obtained.

9.4.8 The presence of weed and other obstructions to the multibeam shall be noted in survey records.
9.4.9 If depth data (as opposed to bed level above ODN) are required, they shall be supplied as positive numbers below a specified level. The surface model shall extend to the water edge as defined by existing survey (supplied by the client) or from OS MasterMap data.