National Barrier Mitigation Programme

Topographical and Bathymetric Surveys 2026

Scope of Services

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Contents

1 Introduction

Inland Fisheries Ireland invites tenders for topographical, LiDAR and bathymetric surveys for 67 areas across Ireland, which are divided into eleven lots based on their geographical location. This specification document provides tenderers with information regarding the scope of the services required.

Inland Fisheries Ireland is responsible for the National Barrier Mitigation Programme (NBMP), which involves mitigating barriers to fish passage on rivers and lakes throughout Ireland. The project spans the current Water Framework Directive cycle from 2023 to 2027 (Cycle 3). IFI's survey requirements relate principally to water courses and in-channel geometry. The surveys will be used to generate hydraulic river models and engineering drawings for formal planning applications.

As part of the design process Inland Fisheries Ireland are inviting tenders to undertake a topographical & bathymetric survey to identify all key features within the site area. Please refer to Appendix A to M which details each lot with a project description, location map and drawing showing the extent of the survey area required. It is recommended that a site visit be undertaken prior to tendering for the works. The area to be surveyed, contains the following features:

- Roads and laneways
- Buildings
- Watercourses (including weirs, culverts, bridges and flood plains)
- Boundaries (fences, hedges etc)
- Services (overground and underground – e.g. manholes)
- Fields and general areas.
- Proposed site access route

1.1 Project Description

Appendix A to M details each lot based on geographical location. A project description for each area is detailed within the lot showing the location, a brief history of the site, photos of the existing site and a drawing showing the extent of the survey required. In the pricing document, tenderers can choose which lot they want to tender for.

1.2 Aim of the Survey

The aim of the survey is to provide a detailed 2D & 3D model of the existing surface features and to provide inputs for industry standard hydraulic modelling software. The survey will form the basis for the detailed design and tender document preparation for the scheme

The scope of this survey contract is to carry out topographical, LiDAR and bathymetric survey within the scheme boundaries shown in Appendix A to M in accordance with the requirements outlined in this document. The site boundary can be made available to prospective tenderers in electronic format if requested. The primary tasks and associated document references are summarised in Table 1.2 below.

Establish and survey a Control Network that will enable mapping to be produced.	For the areas shown in each lot in **Appendix A to M**
Prepare and provide a Control Survey Report to be included in final survey report.	For the areas shown in each lot in **Appendix A to M**
Topographical & Bathymetric Survey	For the areas shown in each lot in **Appendix A to M**
Topographical, LiDAR and Bathymetric Mapping for use in AutoCAD & AutoCAD Civil 3D	Survey Database to include linework code sets with appropriate description key sets and survey text database file
Prepare and provide Digital Terrain Model for use in AutoCAD	For the areas shown in each lot in **Appendix A to M**
Prepare and provide survey data compatible with industry standard hydraulic modelling software HEC-RAS, MIKE, FLOOD MODELLER	For the areas shown in each lot in **Appendix A to M**
Prepare and provide a Final Survey Report	For the areas shown in each lot in **Appendix A to M**

Table 1.2 - Scope of Works Item

1.3 Employer & Employer's Representative

Inland Fisheries Ireland is the Employer for the Project. IFI shall provide day-to-day Project Management and will normally be the main point of contact for the Service Provider.

1.3.1 Contact Details

Contact Details	
EMPLOYER	**EMPLOYER'S REPRESENTATIVE**
Inland Fisheries Ireland	Donal O' Shaughnessy Engineer Grade II
Address: Inland Fisheries Ireland, 3044 Lake Drive, Citywest Business Campus, Dublin, D24 CK66, Ireland	**Address**: Ashbourne Business Park Dock Road Limerick V94 NPE0
Telephone: + 353 (0)1 8842 600	**Telephone**: + 353 (0) 61300238
Email: barriers@fisheriesireland.ie	**Email**: donal.o'shaughnessy@fisheriesireland.ie

2 General Requirements

The Service Provider will provide a topographical, LiDAR and bathymetric survey of the site according to the specifications described in this document. The aim of the survey is to provide a detailed model of the existing ground levels of the river channel, river banks, floodplain, weir, culverts, bridges, aprons, road geometry, existing buildings and structures, in-river infrastructure and features, location of utilities, geometry of existing flood plains and river bed levels.

2.1 Standards

The topographical, LiDAR and bathymetric survey shall be undertaken in accordance with the requirements set out in this Survey Specification. The Survey Grid that will be used for this project is ITM (Irish Transverse Mercator).

2.1.1 Horizontal Projection

All horizontal positions shall be based on Irish Transverse Mercator (ITM) (EPSG: 2157) projection.

2.1.2 Vertical Datum

All level data shall be transformed to Ordnance Datum, Malin using the OSGM02 and OSGM15 geoid models.

2.2 Quality Control

The Service Provider shall ensure suitable quality control procedures have been implemented during the Contract. Upon receipt of the survey data from the Service Provider, an assessment of the quality of the data is to be performed to ensure that it is accurate within the required tolerances and to the required formats. The Employer's Representative shall direct any corrective action required for deficient data, which will be rectified by the Service Provider at no additional cost.

2.3 Duties of the Service Provider

The successful Service Provider appointed to carry out these surveys will be required to hold all necessary Professional Indemnity, Employers Liability and Public Liability Insurances, with specific provision for working on, in or over water. The Service Provider, including any sub-contractors employed by the Survey Contract on the project shall comply with the Safety, Health and Welfare at Work Act 2005, and the Safety, Health and Welfare at Work (Construction) Regulations 2013 (S.I. No. 291 of 2013) and any amendment thereof. Traffic management required for this survey shall be in accordance with Chapter 8 of the Traffic Signs Manual and all associated guidelines and shall be provided by the Service Provider. Traffic management should be agreed with the Employer and An Garda Síochana, and the Local Authority as necessary.

A copy of the Service Provider's Health and Safety Policy is required to be submitted with the completed tender. The Service Provider shall submit a Health and Safety plan for the work prior to commencement of the survey. The Service Provider shall provide the Employer with a detailed programme, risk assessments and method statements within one week of the award

of this contract. The Service Provider shall provide the Employer with a traffic management plan prior to survey works commencing on a public road.

2.3.1 Access to Lands

It is the duty of the Service Provider and any sub-contractors employed by the Service Provider, to liaise with the Employer in order to obtain permission from landowners and occupiers, to access any lands as part of this survey. The Employer shall, where known, inform the Service Provider of areas of restricted access i.e. industrial sites, Iarnród Éireann, etc., and shall liaise with the relevant owner to obtain appropriate access.

The Service Provider has rights of access to any lands as agents of Inland Fisheries Ireland. Notwithstanding these rights, the Service Provider shall take reasonable measures to secure permissions of access at all times. IFI shall provide the Survey Contractor with a letter of introduction for landowners, which shall introduce the Service Provider's staff, describe the process of the survey and request, as a courtesy, landowners to make access available to the Service Provider.

The Service Provider shall undertake duties including but not limited to make themselves aware of the presence of any activities underway that may impede their work, and plan mitigating measures to avoid these impacting upon their programme to ensure efficient and timely delivery of the Contract.

The Service Provider should note that non-native invasive plant species such as Japanese Knotweed and Himalayan Balsam may be present within the proposed site area. Care must be taken to prevent the further spread of Japanese Knotweed and Himalayan Balsam or other noxious weeds whilst undertaking any survey works. Article 49(2) of the European Communities (Birds and Natural Habitats) Regulations 2011 makes it an offence to spread or allow/cause the dispersion of non-native plant species specified in the Third Schedule of the Regulations unless in accordance with a licence granted under said regulations. Japanese Knotweed and Himalayan Balsam are both listed in the Third Schedule to the Regulations. The Service Provider should not trample through areas of Knotweed or Himalayan Balsam but should survey the edges of the area and map it on the survey drawing/data.

The Service Provider shall undertake duties including, but not limited to the following, to ensure efficient and timely delivery of the Contract:

- Make themselves aware of the presence of livestock, sensitive agricultural (or other) crops, and farming activities underway that may impede their work, and plan mitigating measures to avoid these impacting upon their programme.
- Inform the landowner and the Employer of the extent of any work where cutting or trimming of bank edge vegetation is necessary. All normal protocols for work within private lands shall be followed, including the protection of habitat.

In cases where access is not possible to lands, the Service Providers shall provide a cross-section at the nearest available location where access is obtainable with reasonable efforts. They shall alert the Employer. Where it is not possible to gain access to private properties, it is acceptable to terminate the cross-sections at the private boundary wall, building face or fence. However, an assessment of the ground profile should be made and noted on the survey

cross-section. For example ‘left bank is flat for 20m to the warehouse’, or ‘ground profile continues to rise steeply for a further 10m then levels out’.

In addition to the duties set out above, Tenderers should clearly identify in their tender proposals any other requirements and procedures they shall undertake for resolving access to lands quickly and effectively.

2.3.2 Errors and Omissions

Unless otherwise agreed with the Employer, the accuracy of content for all deliverables is the responsibility of the Service Provider. The Employer will undertake a review of the deliverable on receipt and any errors or omissions identified must be corrected and/or resurveyed by the Service Provider at the Service Providers own cost, within a reasonable timeframe.

2.3.3 Identification of Field Operatives

Field operatives shall have identification badges clearly displayed which shall include personnel name, photograph, company name, logo, and date. Any employees of sub-Contractors working in the field during the Contract duration shall be provided with a badge by the Service Provider identical in appearance to the Service Provider’s badges.

2.3.4 Unavoidable damage to be reinstated by Service Provider

Where unavoidable damage occurs (e.g. rutting of access routes under normal plant passage) it is to be made good by the Service Provider.

2.3.5 Public Relations

Inland Fisheries Ireland (IFI) is committed to the maintenance and development of good public relations. The Service Provider shall ensure that its employees and agents are honest and courteous in their dealings with members of the public.

2.3.6 Media Management

The Service Provider will not initiate or respond to communications with the media other than to refer media queries to the Employer and alert the Employer to any contact from media and any photographic or filming activity which may relate to the scheme.

2.3.7 Pre-Commencement Meeting and Communications

The Service Provider shall attend a pre-commencement meeting with the Employer in advance of fieldwork commencing, to discuss all relevant environmental, health and safety, method statement, traffic management and programme items as required by the Contract. All documentation required to be submitted in accordance with this Contract shall be made available to the Employer for review in advance of the pre-commencement meeting and updated where required to include comments arising from the meeting. Subsequent communications shall take place via telephone and email during the project. The Service Provider shall allow for attendance at two (2 no.) online video conferences to be arranged at the discretion of the Employer should they be required.

2.3.8 Environmental Considerations for Surveys

Environmental protection is critical when conducting topographic and bathymetric surveys in rivers and lakes. All works must minimise disturbance to aquatic habitats, particularly in

ecologically sensitive or protected areas such as Special Areas of Conservation (SACs), Special Protection Areas (SPAs), Natural Heritage Areas (NHAs) and proposed NHAs (pNHAs). Maps of protected sites across Ireland are available at: https://gis.epa.ie/EPAMaps/.

Cutting down trees or causing any damage to habitats is not permitted, although limited cutting of scrub or briars to gain safe access is acceptable. The Service Provider shall plan and carry out the works so that there is no negative environmental impact, identifying potential environmental risks in advance and setting out appropriate mitigation measures. Before site access is allowed, the Service Provider shall develop and agree with the Employer an Invasive Species Risk Management Method Statement to prevent the spread or dispersal of invasive plants.

When working in rivers, particular care is required to avoid trampling or disturbing riverbed gravels, especially during key fish spawning periods (November–March for salmonids and April–May for lamprey). If spawning nests ("redds") are encountered, they must be avoided. Where surveys take place within catchments supporting significant populations of the Freshwater Pearl Mussel (Margaritifera margaritifera), as indicated on the NPWS Margaritifera Sensitive Areas Map (S.I. No. 296/2009), additional precautions are required to prevent trampling or other disturbance.

The spread of invasive and non-native species must be prevented through implementation of the clean–check–dry protocol and disinfection of equipment before entering a new waterbody. More information is available at: https://www.fisheriesireland.ie/research/research-theme-biosecurity.
Special care is also needed to avoid the transmission of crayfish plague, a water mould fatal to the native white-clawed crayfish. All equipment and personal protective equipment (PPE) entering the water shall follow the clean–check–dry protocol and, where this is not feasible, be disinfected with Virkon Aquatic (or equivalent) or power-steam washed at high temperature. Guidance and up-to-date distribution maps are available at: https://invasives.ie/species-alerts/crayfish-plague-disease/.

Fuel handling, waste disposal and equipment maintenance shall comply with all environmental regulations to prevent pollution. Where possible, survey vessels should be fitted with low-emission engines.

An on-site ecologist is not required for these surveys. However, all activities must be carried out in strict accordance with the Service Provider's own safety and environmental procedures, including biosecurity measures and protocols to address health risks from invasive or native species, and to prevent contamination. Particular care must be taken when operating near spawning beds or habitats of protected species (e.g. freshwater pearl mussel), and all relevant procedures must be followed to ensure compliance with best environmental practice.

3 Health and Safety

3.1 General

The Service Provider, including any sub-Contractors employed by the Service Provider on the project shall comply with the Safety, Health and Welfare at Work Act 2005 and any amendment thereof. The Service Provider shall comply with best practice and relevant legislation in relation

to Health, Safety and Welfare at work, and it is their responsibility to ensure that all their staff are suitably briefed, equipped and trained in the appropriate use of PPE.

The Service Provider shall submit method statements including risk assessments to the Employer's Representative for approval prior to works commencing.

The following should be viewed as the minimum and non-exhaustive requirements of the Service Provider in relation to Health and Safety.

3.1.1 Safety Statements

The Service Provider shall possess an up-to-date and relevant Safety Statement, in accordance with Section 20 of the Safety, Health and Welfare at Work Act, 2005. The Service Provider shall ensure that the safety statement is up-to-date and relevant to the work activities to be undertaken during the Survey Contract. The Service Provider shall submit a list of all their operatives who will be on site, that have been inducted onto their Safety Statement and have signed to confirm such.

The Employer's Representative may seek clarification from the Service Provider in the form of task-specific method statements. The Service Provider shall retain a written record of the entire process detailed in this section on the Project Safety File.

3.1.2 Hazard and Risk Assessment

The Service Provider shall develop a Hazard and Risk Assessment for this Survey Contract. The Service Provider shall, for the duration of the Contract, actively assess and identify hazards, risks and suitable mitigation measures and amend and update the Hazard and Risk Assessment as necessary. The location and nature of any particular risks encountered shall be included in the Hazard and Risk Assessment by the Service Provider as their work on site progresses. A non-exhaustive Hazard and Risk Assessment for site visits, survey work, site inspections and other on-site activities is included in Appendix Q of this document.

3.1.3 Accidents and Dangerous Occurrences

The Service Provider shall immediately advise the Employer's Representative verbally, and at the earliest available opportunity afterwards in writing, of any accidents or dangerous occurrences, loss or damage to any personnel, third parties or property arising during the execution of their duties, in relation to this project. Such accident reporting to the Employer's Representative shall not relieve the Service Provider of their statutory responsibilities for accident reporting to the relevant statutory authorities and / or insurers.

3.1.4 Safety Meetings

Meetings will be arranged as required. These are envisaged to take place online.

3.1.5 Method Statements

The Service Provider shall be responsible for the production of method statements detailing the methodology for the execution and completion of all aspects of the survey work. Method statements shall include, but not limited to, the following:

- Proposed methods of execution for each activity whether directly controlled by the Service Provider.
- Identification of technical equipment to be used in the execution and completion of the survey work.
- Details of how the proposed methodology will ensure that impacts will be restricted to the best possible environmental option and shall include contingency plans and environmental procedures to minimise damage caused by accidents, spillages or other unforeseen events. Where work shall be subject to environmental requirements, these shall be stated.
- Procedures for notifying the relevant authorities where required.
- Method statements shall be submitted in full to the Employer's Representative for review two weeks prior to the commencement of the survey works on site.

3.1.6 Safety Inspections

The Employer/Employer's Representative may carry out on-site health and safety spot checks during the duration of the Survey Contract. These checks will be of adequate frequency and thoroughness to satisfy the Employer's Representative of the Service Provider's compliance with their health and safety obligations. The Employer's Representative will retain written reports of such inspections, and any corrective actions required of the Service Provider, on the Project Safety File.

3.1.7 Confined Spaces

The Service Provider may need to cause their staff to enter Confined Spaces during the execution of their duties in relation to this commission, therefore, adequate training for this purpose should be provided by the Service Provider in advance and confirmation of training, in the form of official certificated for each employee, be submitted.

3.2 Traffic Safety and Management Requirements

3.2.1 General

It is not envisaged that the Employer's survey requirements will necessitate interference with traffic flows or require partial/full road closures. It is expected that traffic management plans will generally be basic in nature.

Where the carrying out of the survey necessitates the planning, design, implementation, maintenance, modification, and removal of temporary traffic management measures in order to cater for the safety of both survey workers and road traffic users alike. The Service Provider shall be responsible for the planning, design, implementation, maintenance and removal of these temporary traffic management measures as required in order to complete the Survey in accordance with the Contract Documents.

The design and implementation of Traffic Safety and Management measures shall be carried out by a Traffic Management Design Specialist (TMDS) appointed by the Service Provider. The TMDS shall hold a valid Signing, Lighting & Guarding at Roadworks Construction Skills certificate and have a minimum of 5 years' experience in the installation and management of temporary traffic management.

3.2.2 Traffic Management Requirements

When planning and undertaking work on roads open to traffic, the Service Provider shall comply with guidance contained in the Department of Transport Tourism and Sport (DTTAS) Traffic Management Plan

Where the Employer's survey requirements necessitate more complex Traffic Management Plans, the Service Provider shall appoint a Traffic Management Design Specialist as described in Section 3.2.1. It shall be noted that all barriers in this work package are bridges which are open to road traffic flows.

The Service Provider shall phase the construction of any survey work which affects the public traffic in a manner acceptable to the Local Authority, An Garda Síochána, and the Employer's Representative. The Service Provider shall consult with the Local Authority and An Garda Síochána at least two weeks prior to carrying out the Survey which will affect public traffic.

4 Contract Programme and Method Statement

Within one week of Contract Award, the Service Provider shall provide the Employer with the Contract Programme and Method Statement of the activities the Service Provider intends to carry out, in order to meet the Contract timetable and the Specification.

The survey data shall be captured in full during 2026, subject to appropriate weather conditions. Draft deliverables shall be issued to the Employer's Representative 2 weeks after the completion of the fieldwork. The final deliverables shall be issued to the Employer 2 weeks after comments (if any) are issued by the Employer's Representative on the draft deliverables.

Commence Survey: Within two weeks of appointment

Deliverables Issue to Employer: Draft deliverables within four weeks of survey completion, final deliverables within two weeks of Employer's Representative comments (if any). Employer will issue comments (if any) within two weeks of receipt of full draft deliverables. These dates shall be confirmed in the agreed programme.

5 Survey Control Requirements

5.1 General

The Service Provider shall establish survey control stations and secondary control points in order to establish a horizontal and vertical control network from which to base the topographical and bathymetric survey. The establishment of these control points within the site area will ensure that future surveys can be conducted where required. The design of a control network should follow the RICS Guidance Note 'Guidelines for the use of GNSS in Land Surveying and Mapping 2nd edition (GN 11/2010)'.

A simple plan of the control network shall be prepared of the Survey Control Network including all baselines observed and connections to the Ordnance Survey of Ireland Active Network and included in the Survey Control Report.

A control report shall be produced for the site and included in the final survey report.

All survey control stations shall be referenced to the surrounding detail. The Service Provider shall prepare location diagrams for each control station such that it can be located without the need of survey instrumentation.

5.1.1 Schedule of Control Points

A schedule shall be prepared and submitted to the Employer's Representative in both digital and hard copy, giving the following information:

- The control point designation;
- Control point coordinates in the Irish Transverse Mercator coordinate system (ITM);
- The control point height value;
- A description of the control point;
- The Ordnance Survey of Ireland Active Network Stations used.

5.1.2 Location Diagrams

A location diagram shall be prepared for each permanent ground marker on a standard form, an example of which is shown in Appendix O, to be included in the Final Survey Report.

5.2 Horizontal Control Network

5.2.1 Framework

The horizontal control network shall consist of a framework of permanent ground markers to provide a suitable foundation for the production of a reliable and accurate topographical survey. The minimum number of permanent ground markers required is two; dispersed as evenly as possible across the area to be surveyed and as described in section 5.2.2.

All stations shall have an unobstructed view of at least one adjacent station.

Temporary Control Points shall be established as required for mapping purposes.

The horizontal control network will be designed in such a way as to enable the re-establishment, in terms of the OSI Coordinate Systems, of any or all of the permanent control markers should they happen to be destroyed. As such the horizontal control network, in terms of geometry, baselines and observation times, will comply with the principles of good network design.

5.2.2 Siting of Permanent Ground Markers

The Control Points shall be defined by permanent ground markers.

The location of each permanent ground marker shall be determined as follows.

- Permanent ground markers which are classified as Primary Control Points shall have 80% clear visibility above 10 degrees and be ideally clear of obstructions above 15 degrees elevation. The impact of possible vegetation growth around the site and on the

horizon shall also be taken into account. Each station should ideally be at least 10m (and preferably 25m) clear of obstacles such as buildings, electrical supply systems and radio masts that may cause GPS multipath problems.

- To ensure long-term integrity and avoid potential disturbance during future works, at least one control point should be positioned at a sufficient distance from the barrier under study. This precaution will help mitigate the risk of damage or displacement during construction operations.

- Temporary control points shall not be permanently marked.

5.2.3 Construction of Permanent Ground Markers

Permanent Ground Markers for Primary Control Points shall be stable for a period of 5 years and be of Type 2 construction, as illustrated in Appendix N, or some other permanent ground marker approved by the Employer's Representative.

Permanent Ground Markers for Secondary Control Points shall be stable for a period of 5 years and be of Type 1 or Type 2 construction, as illustrated in Appendix N, or some other permanent ground marker approved by the Employer's Representative.

5.2.4 Survey Grid

The Project Coordinate System for delivery of the finished survey shall be in Irish Transverse Mercator (ITM).

5.2.5 Accuracy Acceptance Criteria

The acceptance criteria specified below will relate each set of control points to the higher coordinate system, as such the Primary Control Network will be directly related to the Ordnance Survey of Ireland Active Network and the Secondary Control Network will be related to the Primary Control Network.

Adjacent Control Points shall be observed by direct measurement.

The adjustment of the network will be performed by means of a least squares network adjustment. The network design must reflect this requirement through the inclusion of redundant observation baselines to each station such that the statistical analysis is a realistic representation of the inherent errors of the network.

The adjusted control coordinates and associated error residuals to be used for comparison to the acceptance criteria, will be those derived from the fully constrained network in terms of the Irish Transverse Mercator coordinate system. The error residual is a value that represents the uncertainty in the coordinates of the control point in respect of the higher order control network.

All error residuals will be shown to a 95% confidence limit (2 standard deviations).

The error residuals must allow for realistic instrument heightening and positioning errors.

The permitted errors consist of two components. The first is a constant (e), in millimetres, which reflects the systematic and random errors inherent in the derivation of the coordinates of a

control point. The second term is a distance proportional term (p). This term is a dimensionless quantity but when used in the formula below it has the effect of being a ppm (parts per million) accuracy standard, e.g. when p=1 this represents a distance dependant error of 1:1,000,000 or 1 part per million. From these terms the accuracy for an observed point can be determined by:

95% confidence limit = $\pm \sqrt{(e^2+(\text{distance(km)} \times p)^2)}$ mm

The distance component will be determined by the shortest distance required to traverse from the closest higher order control point, through observed baselines, to the control point in question and then closing out on the next closest higher order control point.

When comparing coordinates and their associated error residuals, derived from the least squares adjustment, the residuals shall not exceed the following permitted errors:

● Primary Control Points

e = 5 millimetres

p = 0.05

● Temporary Control Points

Temporary Control Points will be coordinated in such a way that topographical features observed from them conform to mapping accuracies as defined in this specification.

5.3 Vertical Control Network

5.3.1 Framework

The Vertical Control Network will be coincident with Horizontal Control Network.

5.3.2 Datum

All levels shall be in terms of the Ordnance Survey of Ireland - Malin Head Vertical Datum.

The local datum will be realised by direct observation between the Primary Control Network and the Ordnance Survey of Ireland Active Network. The elevation of each primary control point will be derived in the Ordnance Survey Geoid Model 2002 (OSGM02) and Geoid Model (OSGM15™) to the ellipsoidal height of the station after the Horizontal Control Network has been constrained in the horizontal plane during the least squares adjustment process.

From the fixed elevations of the Primary Control Points, which define the local datum, the temporary control point elevations can be derived. The Service Provider

is free to choose the levelling methodology that they feel is best suited to achieve these accuracies.

5.3.3 Accuracy Acceptance Criteria

See section 5.2.5 for the definition of the Accuracy Acceptance Criteria.

When comparing elevations and their associated error residuals or levelling run mis-closes, they shall not exceed the following permitted errors:

- Primary Control Points

  e = 10 millimetres

  p = 0.05

- Temporary Control Points

  Temporary Control Points will be levelled in such a way that topographical features observed from them conform to mapping accuracies as defined in this specification.

5.4 Control Report

On completion of the fieldwork and adjustment, a control report shall be prepared detailing the methods used, a full network adjustment report, checks applied and any problems encountered.

It should be demonstrated that the results achieved are in compliance with this Specification this shall form part of the final Survey Report.

6 Topographical Survey

6.1 Introduction

Features to be surveyed shall be as defined in this Section. The line or point to be surveyed on a feature shall be at the feature's intersection with the ground surface unless otherwise required in this Specification. Identification of all objects shall be based upon their nature and surroundings. Where exact identification is not possible, a general purpose description shall be used. Any building or surface which is in a state of change at the time of the survey shall be annotated to this effect, with the boundary of the area of change indicated.

Where the approaches connect onto existing carriageways and footpath, a sufficient length of the existing road shall be surveyed that will allow the designers to determine the existing road alignment in both the horizontal and vertical planes. Where a cross section of points has been specified, this refers to the location of points to be surveyed across a feature.

The following is a non-exhaustive and approximate summary of the proposed survey works:

- River Channel
- Flood plain
- River Banks
- Bridges and apron
- Culverts
- Roadways (incl verges, boundaries, field accesses and domestic entrances)
- Buildings and Sports Fields
- Drains, ditches and watercourses (water line)
- Walls, Fences, Parapets and other Boundary Features
- Service Manholes/Gullies
- Lighting Columns
- Overhead lines
- Road Signage
- Trees
- Structures

6.1.1 Cross Section Details

It is the Service Provider responsibility to comply with the requirements of The RICS Guidance Note; Guidelines for the use of GNSS in Land Surveying and Mapping, 2nd Edition, as this document should be used to ensure best survey practice is followed when using GPS.

The generic survey requirements to be met are set out below.

- The survey of the required river channel cross-sections should be undertaken so as to accurately describe the hydraulic characteristics of the channel.
- Cross-sections will be surveyed perpendicular to the flow direction (for river channels, this will be perpendicular to the direction of the banks; for floodplains, it will generally be perpendicular to the general direction of the valley).
- All elevations and cross-sections shall be plotted as viewed from upstream to downstream.
- Cross-section offset will increase from left to right looking in the downstream direction. The cross-section deliverables will include channel offsets in HEC-RAS, MIKE and FLOOD MODELLER input formats. Channel offset in FLOOD MODELLER is taken from left hand extreme of cross section, therefore all offsets will be positive. Channel offset in MIKE is taken from river centre line, therefore offsets will be negative towards left bank and positive towards right bank. The channel centreline should be taken as the deepest bed point (as surveyed).
- Cross-section locations will be identified by a river identifier. The identifier will be based on river name and chainage measured from downstream to upstream, starting at 0 at the downstream end of each reach, to a resolution of 10m.
- Where it is not practical or safe to survey a channel cross section at the prescribed position or interval, the position of the surveyed section may be adjusted by up to 20m in either an upstream or downstream direction, provided the general shape of the channel does not change.
- The number of survey points in any cross section must be sufficient to describe changes in the shape of the cross section and include an adequate number of survey points appropriately located across the cross section to permit accurate representation of the channel geometry and hence conveyance within a hydraulic model. Generally, the distance between consecutive points should not exceed 2m. The vertical difference in level between consecutive points out of channel should not exceed 0.1m. On steep banks, recordings should be made at not greater than 5m intervals, providing the gradient of the slope between the points is constant. At the point where the cross-section finishes, a note should be included on the drawing to give details of the general description of the land beyond this point (i.e. what happens next).
- Intermediate crest levels should be taken to represent notable changes in crest elevation and at a minimum at 20m intervals. This will include low points or gaps, and confluences with tributaries and drains. Where there are step changes along a crest, points immediately adjacent to the step should be surveyed, to correspond with both elevations at this location. These points should be noted in the long sections for each reach and in the xyz output file for the left and right bank. All tributaries should be

labelled on the long section plot for the surveyed reach with their reach name where known.

- The elevations and diameters of pipes / outfalls discharging into the watercourses which are readily visible above or below the waterline should be surveyed, subject to a minimum diameter of 200mm. Where an outfall of any diameter is flapped, the pipe diameter, invert level, flap width and flap height shall be recorded, and the pipe identified as such. It is not expected that any underwater inspection is required to locate outfalls.
- All measurement shall be presented in metric units (metres).
- The river water level, time and date shall be recorded at the time of survey of each cross section and structure. This is to be labelled on the drawings.
- To assist the modellers in assigning roughness coefficients during the construction of the hydraulic models, the nature of the riverbed material and vegetation should be recorded at each cross section, and labelled accordingly on the drawings (e.g. silt, gravel, concrete, heavy weed, etc). Similarly, the nature of the bank / floodplain ground cover should be recorded and labelled on the drawings (e.g. pasture, arable, scrub, woodland, etc).
- Fences and walls that intersect the cross section will be surveyed with their type and height labelled on the drawing. Buildings that intersect the cross section will be surveyed with their type and name / number labelled on the drawing. A threshold level for each building should also be surveyed. There is no need to show these features to scale.
- Roads that intersect the cross section shall be surveyed with their name or number labelled on the drawing.
- Both the hard bed level and the silt top shall be surveyed at approximately the same points within a cross section. The hard bed will be shown as a solid line on the drawing with the silt top shown as a pecked line.
- The Cross-section data shall be provided in ASCII format files. Files that shall be submitted for each reach of watercourse in FLOOD MODELLER input format, MIKE input format and HEC Ras Cross-section XYZ format. Model input files should show the highest recorded bed level (i.e. soft bed where surveyed, otherwise hard bed). Individual model files for the hard and soft beds are not required.

6.1.2 Roadways

The geometry of all roadways and footpaths within the area to be surveyed at cross section of points at 10m intervals perpendicular to the roads are to be surveyed to highlight the road features such as road centreline, road markings, edge of road pavement, top of kerb, footpath, cycleway, verge, embankment slopes, entrances etc. These features shall be represented on individual layers. Shorter intervals may be required at junctions and entrances (including field accesses) to accurately define the junction corner radii. These road cross section points are to be defined as continuous 3D polyline Break-lines along the road. Changes in road surfaces such are asphalt, gravel, concrete, cycle track colouring, tactile paving, etc. are to be noted and placed on a 2D text notes layer in the AutoCAD drawing.

6.1.3 Buildings and Sports Fields

Building and Field outlines to be surveyed as 3D points at ground level and placed on a sports field or building point layer as appropriate. The type of field surface to be noted and placed on a 2d text notes layer in the AutoCAD drawing.

6.1.4 Drains, Ditches and Watercourses

Watercourses are present within the site. Cross sections of points for all watercourses is required at ~20m intervals perpendicular to the watercourse centreline are to be surveyed to highlight features such as centreline, bottom of bank, top of bank, etc. These points are to be connected by continuous 3d polyline break-lines along the watercourse. Spots level of water level to be indicated with date of survey and placed on a separate Water Level AutoCAD layer. Please refer to Bathymetric survey section for further details.

6.1.5 Walls, Fences, Parapets and other Boundary Features

The ground levels along walls, fence and other boundary features are to be surveyed at 10m intervals and significant changes in direction and gradient. These points are to be connected by continuous 3D polyline breaklines along the wall/fence at ground level. The width and type of wall, fence or boundary feature are to be noted and placed on a 2D text notes layer in the AutoCAD drawing. Spots level of the top of walls, fences, parapets and other boundary features to be indicated at 10m intervals and placed on a separate Top of wall, fence, parapet or other boundary feature AutoCAD layer.

6.1.6 Service Manholes/Gullies

Manholes and gullies cover top levels are to be surveyed as 3D points and placed on a Manhole/Gully point layer. The type and size of the cover to be noted and placed on a 2D text notes layer in the AutoCAD drawing. The invert level of all manholes is to be surveyed as a 3D points and placed on the Manhole point layer. The Invert level is to be distinguished from the cover level of the manhole with a text note. The inlet and outlet pipe diameters are also to be recorded and retained on a separate AutoCAD text layer.

6.1.7 Lighting Columns

The ground levels of all lighting columns are to be surveyed as 3D points and placed on a Lighting Column point layer. The type and size and height of the column and the length of the lighting fixture overhang are to be noted and placed on a 2D text notes layer in the AutoCAD drawing.

6.1.8 Overhead lines

It is probable that there are a number of overhead lines in the vicinity of the site. The locations of the overhead lines within or that cross the site are to be included in the survey. The ground levels of the poles are to be surveyed as 3D points and placed on an Overhead Line Pole point layer. The type and size and height of the poles and the approximate direction and heights of the overhead line wires as well as any stays are to be noted and placed on a 2D text notes layer in the AutoCAD drawing.

6.1.9 Road Signage

Road signage to be survey as 3D points at ground level and placed on a Road Signage point layer. The type, size and height of the sign to be noted and placed on a 2D text notes layer in the AutoCAD drawing.

6.1.10 Trees

The locations of trees within the boundary line of the survey to be included. The ground levels of the trees are to be surveyed as 3D points and placed on a Tree point layer. Any signage affixed to the tree should be noted, e.g. Preservation orders. No. of tree, tree type, tree trunk diameter, an approximate tree canopy diameter, etc. should also be noted on a 2D text layer in the AutoCAD Drawing.

The particular tree survey shall be limited to specimens with a trunk diameter exceeding 200 mm, located within a 50-metre corridor both upstream and downstream of the barrier. The survey extent shall align with the width of the study area as illustrated in the reference drawing. All other trees within the area shall be noted as such with 2D text on the drawing.

6.1.11 Structures

Dams, Bridges and Culverts are required to be surveyed. Piers, abutments aprons, retaining structures, bridge aprons, trash screens, etc. are to be surveyed as points joined with 3D polyline such that the size of the structure is determined. Soffit levels are also required to be surveyed. These points are to be connected by continuous 3D polyline break-lines. These features shall be represented on individual layers. The invert and soffit levels of all culverts is to be surveyed as 3D points and placed on the Culvert point layer. The Invert level is to be distinguished from the soffit level of the culvert with a text note. All culvert dimensions, directions and inverts are also to be recorded and retained on a separate AutoCAD layer. Should structures have an identification plate then the content of that should be recorded.

Both faces of the bridge structure are to be surveyed. Bridges details should be included in cross sections. The parapets do not need to be detailed but the road level on the centreline over the bridge should be included.

6.1.12 Weirs

For each weir, the following shall be surveyed:

- One cross-section along the full running length of the crest.
- One cross-section immediately upstream of the weir and one at the downstream toe of each weir, along the full running length of the weir. The interfaces of the weir with the natural riverbed shall be captured.
- For each cross-section above, 20 m out of bank shall be surveyed.
- The skew angle of the crest section shall be noted on the cross-section plot, along with whether the weir is breached or not.
- Details of any gates and/or movable control structures associated with the weir shall also be surveyed. Where such structures exist, the gate sill shall be surveyed as the

crest of the weir, and the movable structures clearly marked as such on any drawings.

- A long section plot through the centre of the channel, generally for a distance of 50–75 m upstream and downstream of the location, or as agreed with the Client, with bed profile points recorded every 5 m and more frequently where the bed profile changes rapidly. The long section plot shall include FLOOD MODELLER and Mike chainage. The FLOOD MODELLER/ISIS chainage will be taken from the downstream extent of the survey, whilst the MIKE chainage will be taken from the upstream extent. Each cross-section intersecting with the long section shall also be labelled on this long section plot.

6.1.13 Miscellaneous

The following information shall be included in the survey with respect to miscellaneous features outlined in the non-exhaustive list below.

- Mini-pillars
- Meters
- Landscaping areas
- Bus Stops (including shelters, size, location relative to road edge)
- Other control and communication cabinets
- Other manhole cover location, type, size, and levels
- Other miscellaneous chambers (including size and type and levels)
- Any other features related to services and drainage e.g. building downpipes

Where a run of service extends beyond the survey area, the survey should be completed as far as the next inline manhole or equipment on that line.

6.2 Accuracy of Topographical Survey

The planimetric co-ordinates of directly surveyed topographical points shall be correct to **± 0.010m** on carriageways and hard surfaces, and **± 0.025m** on other surfaces, when checked from the nearest control point.

The levels of directly surveyed topographical points shall be correct to within **± 0.005m** on carriageways and hard surfaces, and to within **± 0.025m** on other surfaces (except on ploughed or otherwise broken surfaces), when checked from the nearest control point. The spacing of points to define the planimetric features shall be such that interpolated points are correct to within **± 0.025m** on hard or well-defined features, and to within **± 0.050m** on other features.

The spacing of features and spot heights shall be such that the ground configuration, including all discontinuities, is correctly represented. The spacing of levels shall be such that interpolated points shall not deviate from the true ground surface by more than **± 0.025m** on hard or well-defined surfaces, and by more than **± 0.100m** on other surfaces.

6.2.1 Definition

Features shall be defined as 3D polylines and points with 2D notes as described in sections 6.1.2 to 6.1.13 above.

Features shall have sufficient points to ensure compliance with the standard of accuracy required by this Specification.

6.2.2 Tolerance Values:

The tolerance values stated are root-mean-square error (RMSE) values and the following conditions have to be satisfied:

- At least 67% of all readings must be correct to or better than the RMSE;
- At least 90% of all readings must be correct to or better than 1.65 times the RMSE;
- All readings must be correct to or better than 3 times the RMSE.

All readings not complying with the above 3 conditions including consequential errors shall be corrected by the Service Provider at no extra cost to the Employer.

6.3 Digital Terrain Model

6.3.1 General

Digital Terrain Models (DTM) shall be provided in the Irish Transverse Mercator.

6.3.2 Accuracy

The DTM will be derived from the topographical features and spot heights surveyed and as such will have the accuracies inherent in these features as specified in Section 6.2 of this Specification.

The DTM shall represent the ground surface only and shall exclude buildings, fences, utilities etc.

6.3.3 Definition

The DTM will be derived from the topographical features and spot heights surveyed and as such will have the accuracies inherent in these features as specified in Section 6.2 of this Specification. The area to be surveyed is described as the area to be surveyed on the drawings within each lot included in Appendix A to K.

The survey data will be triangulated to form a constrained Delaunay TIN (triangulated irregular network) AutoCAD surface model. For the purposes of this specification, the constraints on the triangulation will be made up of breaklines, and inclusive and exclusive boundary polygons.

All linear features that are included in the TIN surface will be assumed to be breaklines. Not all 3D features will be included in the TIN surface. No 2D features will be included in the TIN surface.

All significant grade changes in the terrain should be surveyed using three-dimensional strings / break-lines.

There will be no crossing break-lines in the model. Where two breaklines intersect on the ground, a point must be included in the ground model to resolve the elevation at the position of the intersection.

No non-surface data, such as overhead, underground features and water levels, shall be included in the TIN either as points or break-lines.

Strings representing single continuous features on the ground must consist of a single continuous string or polyline in the model.

Strings representing polygonal features such as boundaries, buildings, and ponds should be represented as closed strings or closed polylines.

There shall be no other three-dimensional data included in the TIN model that has not been directly surveyed on the ground surface.

Strings must not contain duplicate points or double back on themselves.

Gaps should not be used to break up separate strings.

The TIN surface should be verified, by the Service Provider, as being in good agreement with the ground.

All strings associated with a given road or similar linear feature must be oriented in the same direction.

Data should not be duplicated in the model.

Strings denoting linear features should contain at least two points.

Where two strings denoting 3D features meet at a common junction point they should share a common elevation at that point.

6.3.4 Format

The DTMs will be provided in AutoCAD DWG format, separate from the survey drawing file, comprising unexploded 3D Face objects. Boundaries shall be in the form of closed 3D Polyline objects.

6.3.5 Extent

The DTM will fully encompass the survey area as defined in the drawings within each lot included in Appendix A to M.

6.3.6 Topographical Mapping

All detail as specified in Sections 6.1 shall be included in the mapping.

Features shall be represented in accordance with the feature symbol tables in Appendix P.

Each feature type will be presented in a separate drawing layer. The layering system is to be agreed with the Employer's Representative prior to submission.

General areas are to be surveyed as spot levels at 10m grid intervals. Spot levels to be defined as 3D AutoCAD points at the appropriate location and level (i.e. information requiring 3D spot levels is not to be defined using AutoCAD blocks or 2D objects). Spot levels to be placed on a

Spot Level AutoCAD layer. The survey control PGM spot level points are to be placed on a separate Survey Control AutoCAD layer.

Spot levels along paved road surfaces shall be shown at 10 metre intervals along the road.

Invert levels of watercourses where cross-sections are not specified shall be shown at 10 metre intervals along the watercourse.

Contours shall be plotted at 0.5m vertical intervals, with every 5.0m contour shown as a double thickness line. The value of contours shall be shown at distances along the contour of not more than 150mm drawing scale.

Where steep slopes are encountered and it is not practicable on the plan to represent each contour fully throughout its length, the Service Provider may, with the Employer's Representative's approval, terminate certain intermediate contours.

In flat areas where the horizontal distance between contours exceeds 50 times the specified vertical contour interval the Service Provid shall provide supplementary spot levels at intervals not exceeding 20 times the specified vertical contour interval.

The output of the survey should be presented in a 3D AutoCAD drawing with AutoCAD notes included as 2D objects. This drawing should show a full plan of the area surveyed.

7 LiDAR Survey

7.1 Introduction

Features to be surveyed shall be as defined in this Section. The LiDAR elements of this specification are based on the LiDAR Base Specification (LBS) published by the United State Geological Survey. For clarification of terms used in this specification the glossary and figures in the USGS LBS should be consulted if required. For more details see https://www.usgs.gov/core-science-systems/ngp/ss/lidar-base-specification-online.

The location and extent of the LiDAR surveys required and any associated processed elevation data is shown hatched in the relevant appended drawings.

The horizontal positions of all raw survey data shall be based on WGS84 (EPSG: 4326) Survey data shall be transformed into Irish Transverse Mercator (ITM) (EPSG: 2157) and Irish Grid (EPSG: 29903) projections for the final processed deliverables. A consistent horizontal datum/projection must be used throughout the survey project for everything that has a geographic position or for which a position is to be determined. The vertical position of all raw survey data shall be based on WGS84 (EPSG: 4326). Survey data shall be transformed to Malin Head datum using both the OSGM15 geoid model and the OSGM02 geoid model for the final processed deliverables.

The Survey Contractor shall provide details of the methodology for the establishment of Ground Control Points (GCPs) at each survey site, the accuracy of the GCPs and their co-ordinates and altitude in their native survey co-ordinate system.

7.2 LiDAR Data Collection

7.2.1 Aircraft and Instrumentation

The Survey Contractor shall provide and maintain all necessary plant and equipment suitable for carrying out the work for the duration of the survey. All aircraft utilised for the work shall be sufficient to undertake the required surveys and shall be piloted by a competent and experienced pilot. The Survey Contractor shall be responsible for complying with all statutory regulations. All aircraft used shall be fully licensed and certified so as to be permitted to fly in Irish Airspace. Aircraft, equipment, survey personnel and crews provided by the Survey Contractor for work in connection with the Contract shall be the Survey Contractor's responsibility at all times. The said aircraft, equipment, survey personnel and crews and any loss, injury or damage suffered or caused by them shall be at the Survey Contractor's risk throughout.

All LiDAR sensors used shall be capable of:

a) Detecting multiple discrete returns, with a minimum of 4 potential returns for each outbound laser pulse; and

b) Recording the intensity of each return.

Full waveform collection is not required, however, where full waveform data is collected, it shall be provided to the Client. All Laser equipment used shall be eye safe.

All LiDAR system components, including laser, Global Navigation Satellite System (GNSS) and Inertial Measurement Unit (IMU) systems, will have been calibrated, tested and certified by the manufacturer or by a calibration centre, recognised internationally or approved by the manufacturer, within two years prior to the date of the survey.

7.2.1.1 Flight Planning and Permissions

It will be the sole responsibility of the Survey Contractor to carry out all required flight planning and secure all required permissions to carry out the airborne surveys. It is the Contractor's responsibility to obtain flight permission from all relevant Irish aviation authorities, and in other areas where security clearance is required. This includes all permissions for use of airfields, aerodromes, and to enter any restricted airspaces as may be required to complete the works.

7.2.1.2 Flying Conditions

LiDAR data shall only be captured when the following criteria are met, unless otherwise agreed with the Client's Representative:

- Atmospheric conditions are cloud and fog free between the aircraft and ground during all collection operations.
- Ground conditions are snow free. Very light, un-drifted snow may be acceptable with prior approval from the Client's Representative.
- Ground conditions are free of extensive flooding or any other type of inundation.

Although leaf-off vegetation conditions are preferred, many factors beyond human control may affect dormant conditions at the time of any collection; therefore, this specification only requires that penetration to the ground be adequate to produce an accurate and reliable bare-earth surface for the prescribed QL.

7.2.1.3 Timing and Special Conditions for Data Capture

In coastal and tidal areas, data in the intertidal zone shall not be captured greater than 1.5 hours before or after the predicted time of Low Water. The most recent edition of the Admiralty Tide Tables shall be used for the purposes of establishing the predicted time of Low Water at any location. The Survey Contractor shall be responsible for obtaining Admiralty Tide Tables necessary for carrying out the works.

7.2.1.4 Flight Overlap

The Survey Contractor shall ensure a minimum swath overlap of 15% is achieved to support quality assessment between adjacent swaths and to minimise potential data gaps. The actual overlapping swath used in the data collection is at the discretion of the Survey Contractor to ensure the absence of data gaps in the usable portion of the swath (typically the centre 95% of the swath) and that the required data density is met.

7.2.1.5 Global Navigation Satellite System (GNSS) Requirements

All aircraft used shall be fitted with GNSS navigation systems and Inertial Measurement Units (IMU) of sufficient accuracy to allow capture of the data at the required accuracies.

Two GNSS base stations shall be used during LiDAR data capture. LiDAR observations are only to be made when data is received from six or more satellites and the Geometric Dilution of Precision (GDOP) is less than 4.

7.2.2 Intensity Values

Intensity values are required for each multiple discrete return. The values recorded in the LAS files shall be normalized to 16 bit, as required by the LAS specification version 1.5–R00 (American Society for Photogrammetry and Remote Sensing (ASPRS), 2025). Intensity normalization shall be strictly linear. Common image stretches (minimum-maximum, standard deviations, percent clip, histogram, and so forth) are expressly forbidden.

7.2.3 Pulse Density and Spacing Requirements

LiDAR pulse density and spacing for the survey extent area is defined in this specification as an Aggregate Nominal Pulse Density (ANPD) and Aggregate Nominal Pulse Spacing (ANPS). The aggregate pulse density/spacing is referred to as an overall pulse density/spacing whereby a swath may overlap other swaths completely, partially, or not at all. An overlapping swaths condition is achieved when a portion of the swath is covered with an adjacent flight line, flown on top of an existing swath with a single sensor, or acquired by two independent sensors using separate IMU's, with separate boresights on the same aircraft. A dual channel system using single Inertial Navigation System (INS) and boresight is considered to be acquiring single swath data. In swaths where a portion of the swath has no overlap then ANPD/ANPS is equivalent to Nominal Pulse Density and Nominal Pulse Spacing (NPD/NPS).

The required ANPS and ANPD is detailed in **Table 7-1 ANPS and ANPD requirements**.

Quality Level	ANPS (m)	ANPD (pulses/m2)
QL1	≤0.25	≥16.0
QL2	≤0.35	≥8.0
QL3	≤0.71	≥2.0
QL4	≤1.41	≥0.5

Table 7-1 ANPS and ANPD requirements

7.3 LiDAR Data Processing and Management

7.3.1 File Format

All collected LiDAR point cloud data shall be stored in the compressed version of ASPRS LASer File Exchange (LAS) format, LAZ (LASzip).

7.3.1.1 Standards

ASPRS LAS 1.54 – R00 shall be used for LiDAR point cloud data.

7.3.1.2 Pulse Data Record

Point Data Record formats 6, 7, 8, 9 or 10 shall be used for discrete pulse data. The format values depend if colour information is added and/or wave packets are added to the LAS record structure.

7.3.1.3 Full Waveform Data

If full waveform data are recorded during collection, the waveform packets shall be delivered to the Client. LAS deliverables, including waveform data, shall use external auxiliary files with the extension wdp to store waveform packet data.

7.3.1.4 Overlap and Coverage

Overlap pulses shall be identified using overlap bit 3 as described in Table 16 in LAS 1.4 – R15 specification. Overage points shall be identified using the LAS overlap flag in all point cloud deliverables which is Class 12.

7.3.1.5 Withheld Pulses

Withheld pulses due to noise, erroneous data points, and geometrically unreliable points shall be retained using classification bit 2 as per Table 16 in LAS 1.4 – R15 specification.

7.3.1.6 Swath Identification

A unique file identifier (File ID) for individual flight swaths shall be applied prior to data processing to identify each swath to source as identified in LAS 1.4 specification. Each point within the swath shall also be assigned a point source identifier (Point Source ID) that equals the unique file identifier. The unique file and point identifier shall be persistent and preserved through the data processing steps.

7.3.1.7 Open Access

Only open LAS format is to be used and no proprietary formats are acceptable.

7.3.1.8 Compression

For bulk storage of data, LAS files can be compressed into the lossless LAZ (LAS zip) format.

7.3.1.8 GPS Time

Each Global Navigation Satellite System (GNSS) aircraft positional measurement must be time stamped using Adjusted Global Positioning System (GPS) Time, at a precision sufficient to allow a unique timestamp for each LiDAR pulse. The encoding tag in the LAS header shall be properly set.

7.3.1.9 Measurement Units

Measurements shall be in metres (m) and must be specified to a minimum of 3 decimal places.

7.3.2 Pulse Classification

The Survey Contractor shall classify all LiDAR pulse data, except pulses identified as Withheld. The software, processing and use of ancillary data to achieve the classification

accuracy threshold are at the discretion of the Survey Contractor. The classification scheme shall be based on LAS 1.4 – R15 specification for Point Data Record Format 6-10, Table 17. All pulses not identified as Withheld must be processed for classification. No data in LAS point cloud is to remain assigned to class 0 (created but not processed for classification).

The minimum required class designation is identified in **Table 7-2**.

Classification Value	Description
0	Created, Never Classified
1	Unclassified
2	Ground
3	Low vegetation
4	Medium vegetation
5	High vegetation
6	Building
7	Low Point (Noise)
9	Water
10	Rail
11	Road Surface
17	Bridge deck
18	High noise
19	Overhead structure
20	Ignored ground (typically breakline proximity)
21	Snow (if present and identifiable)
22	Temporal exclusion (typically non-favoured data in intertidal zones)

Table 7-2 Minimum LiDAR classification scheme

7.3.3 Tiling

The Survey Contractor shall prepare and deliver all data deliverables using a standard tiling scheme. Each tile shall be uniquely defined in the data sets in both time and position.

7.3.3.1 Size

The tiles shall have a size of 1km x 1km, unless otherwise agreed with the Client's Representative.

7.3.3.2 Condition

All tiled deliverables shall edge match seamlessly with no gaps or overlap.

7.3.3.3 Type

Pulse, point and raster data shall use the same tiling scheme.

7.3.3.4 Index File

A digital index file as ESRI shapefile shall be provided with the data.

7.3.4 Derivative Products

7.3.4.1 Digital Surface Model (DSM)

The Survey Contractor shall generate any DSM from the "first-return" LiDAR mass point data. This shall include ground and non-ground points such as vegetation and buildings.

Void areas, i.e. areas outside the survey extents but within the tiling scheme, shall be coded using a "- 9999" value.

All DSM's shall be provided as raster data in TIFF (GeoTiff) format unless otherwise agreed with the Client's Representative. BIGTIFF format is acceptable where the size of the file exceeds 4GB.

Any compression of the files shall be undertaken using lossless compression. The software used to compress any files shall be agreed in advance with the Client's Representative.

7.3.4.2 Digital Terrain Model (DTM)

The Survey Contractor shall generate any DTM from the LiDAR mass point data classified as "Ground" only, so that it defines the "bare earth" ground surface.

Hydro-flattening shall be undertaken for natural and man-made water bodies and watercourses as defined below:

a) Non-tidal water bodies with a surface area greater than 625m^2.

b) Non-tidal watercourses greater than 30m nominal width. This should not unnecessarily break a watercourse into multiple segments. At times it may reduce below 30m for short segments. The Survey Contractor shall use their best professional judgement in these cases.

c) Flat and level bank-to-bank with a gradient following the immediate terrain.

d) Watercourses should break at road crossings and bridges.

e) Sinks must not be filled.

f) The entire water surface edge must be at or immediately below the surrounding terrain.

g) Tidal variations over the course of the collection or between different collections may result in discontinuities along shorelines. The Survey Contractor shall agree if and how these shorelines and water bodies will be processed with the Client's Representative in advance of processing.

h) Any additional data layers created for the purpose of hydro-flattening such as masks or break lines shall be provided to the Client as ESRI shapefiles. The Client shall be provided with all necessary data to re-produce the DTM from the mass point data.

i) The methodology used for hydro-flattening shall be agreed in advance with the Client's Representative.

Void areas, i.e. areas outside the project boundary but within the tiling scheme, shall be coded using a "-9999" value.

All DTM's shall be provided as raster data in TIFF (GeoTiff) format unless otherwise agreed with the Client's Representative. BIGTIFF format is acceptable where the size of the file exceeds 4GB. Any compression of the files shall be undertaken using lossless compression. The software used to compress any files shall be agreed in advance with the Client's Representative.

7.4 LiDAR Data Validation

The Survey Contractor shall undertake the following quality checks to provide confidence that the quality requirements of this specification are fulfilled:

- Positional Accuracy
- Spatial Distribution and Regularity
- Pulse Density
- Data Voids
- Pulse Classification Accuracy
- Relative Accuracy

7.4.1 Positional Accuracy

The verification of LiDAR positional accuracy, both horizontal and vertical, shall be undertaken using independent check points. Check points shall be divided into non-vegetated areas and vegetated areas. The check point validation process shall follow, at a minimum, the ASPRS guidelines for Positional Accuracy Standards for Digital Geospatial Data 2014 (ASPRS, 2014). The ASPRS guidelines provide the recommended number of

check points for horizontal and vertical accuracy assessment of elevation data as a function of the survey area. The check points shall be conducted for Non-Vegetated Vertical Accuracy (NVA), Vegetated Vertical Accuracy (VVA) and Fundamental Horizontal Accuracy (FHA) assessments as described below.

The check points for NVA assessment shall be surveyed in clear open areas devoid of vertical features (such as vegetation, vehicles, pipes, wires, etc.) where LiDAR pulses have single returns. The survey area must be a minimum of (ANPS * 5)2 and shall have a slope of less than 10 degrees. Acceptable land cover types include open areas of low grass, such as lawns or golf courses, bare earth and urban paved areas. Ground that has been ploughed or otherwise disturbed is not acceptable. The survey shall be adequately distributed to cover the whole extents and all varieties of land cover types within it.

The assessment of VVA shall be undertaken in vegetated areas, such as tall grass, crops, brush land, short trees and forests. The survey area must have a minimum size of (ANPS * 5)2 and shall have a slope of less than 10 degrees.

The accuracy requirements for NVA, VVA and FHA are included in **Table 7-3**.

Quality level	RMSEz (nonvegetated) (m)	NVA at the 95- percent confidence level (m)	VVA at the 95th percentile (m)
QL1	≤0.050	≤0.1	≤0.15
QL2	≤0.100	≤0.2	≤0.30
QL3	≤0.100	≤0.2	≤0.30
QL4	≤0.200	≤0.4	≤0.60

Table 7-3 Absolute vertical accuracy requirements for LiDAR and digital elevation models

The check points for the assessment of FHA shall be acquired over well-defined linear features with distinct breaks in elevation or intensity, such as road markings, buildings, walls, railway tracks and road pavement edges. The areas must be flat and shall have a slope of less than 10 degrees with hard or compacted surfaces.

The accuracy requirements for FHA are included in **Table 7-4**.

Quality level	RMSEx (m)	RMSEy (m)
QL1	≤0.050	≤0.050
QL2	≤0.100	≤0.100
QL3	≤0.100	≤0.100
QL4	≤0.200	≤0.200

Table 7-4 Absolute horizontal accuracy requirements for LiDAR and digital elevation models

Check points shall not be surveyed in areas of extremely high Near Infrared (NIR) absorption (e.g. fresh asphalt, wet soil, or building roofs with an asphalt surface), or in areas near abrupt

changes in NIR reflectivity (e.g. white beach sand adjacent to water) as such abrupt changes usually cause unnatural vertical shifts in LiDAR elevation measurements.

In land covers other than forested and high-density urban, the check points shall have no obstructions above 15 degrees over the horizon.

Check points shall be an independent set of points used for the sole purpose of assessing the vertical and/or horizontal accuracy of the data collection and shall not be used in calibration or integrated into the data acquisition.

Historical check points may be used, provided they were acquired within the last three years and not used in calibration or data acquisition of the current project. Historical points must meet all the check point requirements included in this specification and the surface conditions at the check point must be temporarily invariant and verifiably undisturbed. The Client's Representative must be advised in advance if historical check points will be used and the Client reserves the right to reject any or all points.

The Survey Contractor shall use a TIN model to conduct the comparison between point data and check points for vertical accuracy testing of the point data. First and only pulse data shall be used to create a TIN. The TIN shall be used to extract an interpolated value at the location of the ground sample check points were collected for the comparison.

7.4.2 Spatial Distribution and Regularity

The spatial distribution of pulses within the geometrically usable portion of the swath (typically 95% of the centre portion of the swath width) shall be collected with a uniform distribution to represent a regular lattice distribution. Although LiDAR sensors do not collect in regular distributed pattern, the collection shall be designed and carried out to produce an aggregate first and only return point cloud that approach a regular lattice of pulses as defined in the requirements below.

Uniformity of the spatial distribution and regularity of pulses distribution is assessed through a distribution grid using individual (single) swaths with the first and only return pulses within the geometrically usable centre part of each swath and excluding acceptable data voids. The resolution of the distribution grid should be twice the design ANPS. The grid cells will be round up to nearest integer grid cell size. The uniformity requirement is to have at least 1 pulse per distribution grid cell at least 90% of the time.

The approach used to count LiDAR pulses within the distribution grid will be dependent on the software tool used. Some software tools use a count based on pulses that fall within the grid cell and others use a search radius to count pulses that fall within a grid. For software tools that use a search radius approach for determining counts within a grid cell, the search radius shall be equal to the design ANPS.

This analysis is only related to regular and uniform point distribution. The assessment is not for assessing ANPD or NPD across the survey extent area.

7.4.3 Pulse Density

The Survey Contractor shall conduct a data check to verify that ANPD has been achieved across the survey extent area. A pulse density grid shall be used to assess whether the pulse density has been achieved.

The pulse density verification shall be conducted using a 20m x 20m pulse density grid covering the survey extent area.

The Survey Contractor shall demonstrate that ANPD is satisfied at least 90% of the time within the pulse density grid cells for the survey extent area based on first and only returns. A visual grid output with red cells showing areas which do not meet the specified ANPD requirements and green for cells meeting the specified ANPD requirements. A histogram distribution shall be used to quantify the pulse density distribution.

Insufficient pulse density may result in the requirement for the Survey Contractor to reacquire data in deficient areas at the discretion of the Client's Representative.

7.4.4 Data Voids

Gaps in LiDAR point cloud data can occur as a result of surface absorption or refraction in the near infrared, sensor issues, processing anomalies, and improper data collection. Data voids arising from errors in collection and processing must be identified and corrected by the Survey Contractor.

A data void is defined as any area greater than or equal to $(4 \times ANPS)^2$ which is measured using first and only returns. Data voids within a single swath are not acceptable, except in the following circumstances:

- where caused by waterbodies;
- where caused by areas of low near infrared reflectivity, such as asphalt or composition roofing;
- where caused by LiDAR shadowing from buildings or other features; or
- where appropriately filled in by another swath.

Any overlapping swath used for fill in must meet all requirements of this specification.

Data voids larger than the threshold may result in the requirement for the Survey Contractor to reacquire data in deficient areas at the discretion of the Client's Representative.

7.4.5 Pulse Classification Accuracy

The Survey Contractor shall demonstrate the pulse classification accuracy using a minimum of five 20m x 20m grid cells across the survey extent area. The grid cells shall be well distributed across the survey extent area and the types of terrain/ground conditions encountered (e.g. urban areas, vegetated areas, sandy beaches, shingle beach, sand dunes). The grid cells will be agreed with the Client's Representative in advance. No more than 2% of non-withheld points shall have a demonstrable classification error within the survey extent area.

The Survey Contractor shall assess the classification by comparing known ground control points and/or using ancillary information including high resolution ortho-imagery or other relevant geospatial datasets.

Point classification must be consistent across the entire project. Variations in the character, texture, or quality of the classification between tiles, swaths, flights, or other unnatural divisions are grounds for rejection of the entire deliverable.

7.4.6 Relative Accuracy

The accuracy of pulse returns shall be consistent across the usable portion of a single swath and in the overlap areas of swaths. The Survey Contractor shall use the following relative vertical accuracy checks to validate the data collection.

Intraswath (smooth hard surface repeatability)

Intraswath assessment shall use a single swath with only single returns in a non-vegetated area. The assessment shall be conducted on smooth hard surfaces to determine the vertical elevation discrepancy calculated using the Root Mean Square Difference (RMSDZ) between the minimum and maximum. The assessment shall use a gridded signed difference raster with cell size equal to 2 x ANPS rounded up to closest integer. The sampling area shall be approximately 50m^2 in area and shall be conducted for multiple locations both across the swath and along the swath within the usable portion of the swath. A minimum of three sample areas per swath for all swaths in the survey extent area shall be used. The sampling area shall be evaluated with a signed difference raster between the maximum and minimum elevation for each grid cell.

Interswath (swath overlap difference – RMSDZ)

The assessment of two swaths for interswath consistency shall be achieved by generating a gridded raster from single returns in non-vegetated area. The comparison shall use a gridded signed difference raster with a cell size equal to 2 x ANPS rounded up to the closest integer for each swath. The assessment shall be conducted by subtracting the difference between the grid surfaces. Root Mean Square Difference ($RMSD_Z$) between minimum and maximum calculated for the points in the raster surface shall not exceed the values included in

Quality level	Smooth surface repeatability, RMSDz (m)	Swath overlap difference, RMSDz (m)
QL1	≤0.03	≤0.04
QL2	≤0.06	≤0.08
QL3	≤0.06	≤0.08
QL4	≤0.12	≤0.16

Table 7-5 for each quality level.

Quality level	Smooth surface repeatability, RMSDz (m)	Swath overlap difference, RMSDz (m)
QL1	≤0.03	≤0.04
QL2	≤0.06	≤0.08

QL3	≤0.06	≤0.08
QL4	≤0.12	≤0.16

Table 7-5 Relative vertical accuracy for LiDAR swath data

7.5 Deliverables

All geographic data, both raw and processed data, shall be georeferenced.

All digital data obtained during the course of the survey work and during the processing is to be provided to the Client in its native co-ordinate reference system. This includes all raw data and control points and associated files to enable the Client to replicate any processing performed by the Survey Contractor, including but not limited to Aero-triangulation reports, Image support files (interior and exterior orientation data for each frame or image swathe) and Camera centre air station coordinates.

All specified processed data is to be provided to the Client in the co-ordinate reference systems and height datums as specified in this document together with any data and files to enable the Client to replicate the processing.

All digital reports, notes and metadata shall be delivered as part of the survey data package and within the relevant folders, which the report refers to, using a consistent and logical naming convention throughout the project.

7.6 Data

The following deliverables are required for the LiDAR data:

- Raw point cloud data (LAS Format)
- Classified point cloud data (Las Format)
- Filtered and classified point cloud data (LAS Format)
- Point cloud tile index (Vector Format)
- LiDAR swaths (Vector Format)
- Digital Surface Model (Raster Grid Format)
- Digital Terrain Model (Raster Grid Format)
- Tile Index (Vector Format)

8 Bathymetric Surveys

8.1 Introduction

Bathymetric surveys will be a key requirement of the IFI Barriers Team. In-river geometry and channel features will be key components for building accurate 2-dimensional hydraulic computer models. The bathymetric survey will map the underwater features of rivers, or lakes by measuring water depth and floor contours. Using technologies like single-beam or multi-beam echo sounders, GPS, and sonar, the survey collects data to create detailed charts of underwater topography. These surveys will be used for the design of barrier mitigation projects including the construction of 1 dimensional and 2 dimensional river models. The bathymetric data will also help identify hazards, monitor sediment movement, and support engineering projects. Accurate depth information is critical for accessing the depth characteristics of rivers and barriers to fish migration.

8.2 Bathymetric Specification

Bathymetric surveys in rivers within Ireland must comply with specific technical standards to ensure data accuracy and consistency. Surveys can generally be undertaken with GPS but, where warranted by the size and nature of the site, surveys should use single-beam or multi-beam echo sounders, integrated with high-precision GNSS, preferably RTK or PPP, to achieve centimetre-level positional accuracy. It will be necessary to generate a $1m^2$ DTM of the bed profile with depth contours shown on survey drawings at suitable intervals, as agreed with the Employer's Representative. The DTM model of the riverbed may be used to generate in-river cross-sectional data at the intervals shown in the drawings within each lot included in Appendix A to M.

All survey and related work shall be carried out in favourable weather conditions. Due account is to be taken of the effect on the quality of the data being gathered. Work should not continue if frequent gaps or interference are created in the data because of operation in unsuitable conditions or if the survey/sounding accuracy cannot be achieved. The Service Provider shall notify the Employer and Employer's Representative promptly should survey work be delayed due to weather conditions.

All equipment must be regularly calibrated, and sound velocity profiles should be collected to correct depth readings. Surveys must conform to the UK Hydrographic Office (UKHO) and Maritime and Coastguard Agency (MCA) guidelines, aligning with the Standards for Hydrographic Surveys Special Publication No. 44 published by the International Hydrographic Organisation (IHO) and the Civil Engineering Specification for the Water Industry (CESWI).

Water level corrections must reference Ordnance Datum (OD). Post-processing should include full quality assurance, error checking, and the production of bathymetric surfaces or contour maps using approved Irish/UK geospatial formats.

The Service Provider shall take all practicable and necessary precautions to prevent pollution of land, ditches, streams, rivers, drains, beaches, watercourses, lakes and the like and to prevent erosion of their beds or banks, from survey operations.

Details and locations of all identified services shall be included in the final data to be notified and submitted to the Employer.

8.3 Accuracy and Spatial Resolution

Survey points shall be recorded at intervals of at least 1m along survey lines, perpendicular to the river at 1m spacings. This should extend 20 metres upstream and 20 metres downstream from the barrier along the river corridor. Beyond this initial extent, survey points shall continue to be recorded at 20-metre intervals, in accordance with the layout and dimensions specified in the project drawing. Where rapid changes in riverbed levels are observed to occur, additional points shall be taken to accurately record the change in profile.

Records are to be processed and reviewed in the field on an ongoing basis in order to identify features that may require further investigation.

The following minimum absolute accuracies are required for the hydrographic/bathymetric survey points:

- Horizontal accuracy ± 10mm
- Vertical accuracy ± 25mm

8.4 Position Fixing

All Hydrographic/Bathymetric Survey models are required to extend seamlessly to adjacent land. Any land survey work necessary to achieve this shall be undertaken in accordance with the relevant section of this document.

8.5 Echo Sounders

If required, the Service Provider shall propose the type of echo sounder to be used in the Method Statement included in any tenders submitted. Echo sounders shall be of types designed for survey work and which can be adjusted to meet the requirements of differing speeds of sound and differing transducer drafts. The frequency used shall allow the clear definition of the bottom level. Where automatic digitising of the bed data is used a method must be provided which allows positive identification of which part of the return signal has been recorded. Echo sounders designed and sold purely for navigational purposes are not acceptable.

8.6 Single Beam Echo Sounding Equipment

If two systems are used, the preferred system is to be nominated “Primary”.

The system must produce a digital record that is capable of being processed in an automated system.

The system is to operate at frequencies capable of determining the first bottom return in depths generally less than 10m. Where the system has multiple frequencies, the highest frequency is to be operated and logged in depths generally less than 10m.

Single Beam Echo Sounding Equipment must be calibrated precisely. The sound velocity as determined by the Service Provider is to be verified at the start and finish of sounding. Methodology and results are to be outlined in the Survey Report.

Where an echo sounder has multiple frequencies, each frequency is to be calibrated independently in order to allow for the different response times of the transducers. When such

echo sounders are used, the depths logged in digital form are to be those arising from the highest frequency used, to ensure that the highest resolution is maintained.

A digital terrain model is to be created from the cleansed data using an average gridding algorithm, with a cell size no larger than $1m^2$.

8.7 Multibeam Echo Sounder Equipment

If chosen by the Service Provider MBES must be calibrated precisely and be undertaken prior to each survey project or after any significant component swap-out. Methodology and results are to be outlined in the Survey Report. The following procedures are to be undertaken:

- Target Detection Capability Verification to validate the system ability to detect targets of the minimum size required by the contract.
- Acoustic noise interference test.
- A cross-line analysis with topographic cross sections to verify the system capabilities after corrections have been applied.

All data is to be cleansed of outliers and the outer beams of the swath removed to ensure a high confidence reference surface is produced.

A digital terrain model is to be created from the cleansed data using an average gridding algorithm, with a cell size no larger than the average footprint of the inner beams. Each beam depth from processed check lines shall then be compared against the reference system and statistics computed. Statistics are to include: beam number, mean, maximum and minimum differences and standard deviation.

8.8 Employer's Representative

The Employer's Representative will have authority to:

- Assess the methods and equipment proposed for the conduct of the surveys;
- Assess the quality of the data gathered;
- Advise the Service Provider on all aspects of the survey to ensure that the work meets the standards required by the Employer.

The Service Provider shall offer every facility to the Employer's Representative to enable inspection undertaking the fieldwork whenever deemed necessary by the Employer.

8.9 Hydrographic/Bathymetric Deliverable Data

The format of digital hydrographic/bathymetric data shall be delivered in the following file formats. Where deliverables are required in multiple coordinate reference systems and / or vertical datum, a separate file shall be provided for each.

Processed Data Set

Format: GSF and comma separated ASCII XYZt, where:

- X is Easting in Irish Transverse Mercator (ITM)(EPSG: 2157)
- Y is Northing in ITM (EPSG: 2157)

- Z is elevation in metres to Ordnance Datum Malin (OSGM15™ geoid model) and separately in Ordnance Datum Malin (OSGM02 geoid model)
- t is UTC date/time (DD:MM:YYY HH:MM:SS)

Contours

- Data: contours at 200mm contour intervals.

Format: AutoCAD with the coordinate data referenced to ITM (EPSG: 2157) and elevation data referenced to Ordnance Datum Malin (OSGM15™ geoid models) and separately in OSGM02 or otherwise agreed with the Employer.

The Service Provider shall provide all data including raw data. The Service Provider shall provide the information and files necessary for the Employer to reproduce the processed data set from the raw data.

INSPIRE compliant metadata shall accompany all digital data using an embedded .xml file with the same name as the digital data file.

8.10 Health & Safety Considerations for Bathymetric Surveys

Health and safety are paramount when conducting a bathymetric survey in a river or lake environment. Key considerations include:

- ***Personnel Safety***: All staff must wear appropriate personal protective equipment (PPE), including lifejackets, non-slip footwear, and weather-appropriate clothing.
- ***Vessel Safety***: Boats should be fully certified, well-maintained, and equipped with safety gear such as radios, first aid kits, flares, and fire extinguishers.
- ***Training and Briefing***: All personnel must be trained in water safety and receive a safety briefing before operations.
- ***Weather Monitoring***: Surveys should only proceed in suitable weather and water conditions.
- ***Emergency Preparedness***: A clear emergency response plan must be in place, including man-overboard procedures and communication protocols.
- ***Risk Assessments***: Detailed site-specific risk assessments and method statements (RAMS) should be completed and followed.
- **Equipment Handling**: Safe lifting and deployment techniques must be used to avoid injury from heavy or overboard equipment.

9 Reporting & Deliverables

9.1 General

Drawings will be supplied in digital format only with no paper copies necessary.

Drawings will be supplied in AutoCAD format and pdf format.

Drawings will be provided in the **Irish Transverse Mercator** coordinate system and to Malin Head Vertical Datum (OSGM15™ geoid model and separately to OSGM02).

The Service Provider should also note the below delivery requirements.

9.2 Site Records

The Service Provider shall keep a daily record on-site for the duration of the survey fieldwork. The record shall include survey activities, personnel employed and a description of weather conditions.

For the LiDAR survey, the Survey Contractor shall prepare a flight report providing a technical summary of each sortie. The flight report shall contain the following information for each flight:

- Name of client
- Name and address of the Survey Contractor
- A unique ID for each lift.
- The take-off and landing times for each lift.
- The aircraft make, model, and tail number.
- The instrument manufacturer, model, and serial number.
- The date of the instrument's most recent factory inspection/calibration.
- General weather conditions.
- General observed ground conditions.
- All inflight disturbances and notable head/tail/crosswinds.
- All inflight instrument anomalies and any inflight changes in settings.

9.3 Deliverables

A table summary of the deliverables required is included below:

Deliverable	Format	Co-ordinate system / datum required
Bathy ES XYZ Soundings If used	Comma separated ASCII XYZt, TIN, DWG and PDF	ITM/OSGM15 & ITM/OSGM02
Topographic Survey Data	Comma separated ASCII XYZt, TIN, DWG and PDF	ITM/OSGM15 & ITM/OSGM02
LiDAR Survey Data	ASPRS LASer File Exchange (LAS) format, LAZ (LASzip),TIFF (GeoTiff) , DWG and PDF	ITM/OSGM15 & ITM/OSGM02
Hydraulic model input file	FLOOD MODELLER input format, MIKE input format, HEC RAS input format	ITM/OSGM15 & ITM/OSGM02
Digital Photographs	JPEG	n/a
Survey Report	PDF	n/a

Table 8.2 Deliverable Summary

9.4 Drawings

IFI uses AutoCAD Civil 3D 2025 as their main drawing software.

The following topographical, LiDAR and bathymetric drawings are required:

- One AutoCAD file (ITM) topographical map with all features and contours defined as 3D polylines using their surveyed heights as specified in Section 6. Text size on drawings shall be 2.5mm at an original scale of 1:500.
- One AutoCAD file with survey database loaded Including linework code sets, appropriate description key sets and survey database text file.
- Additional AutoCAD layers to suit individual working arrangements may be acceptable with bathy natural features, constructed features, submerged details, spot heights and contours etc. on separate layers. Additional layers shall be agreed with the Employer after award of tender.
- Drawings for each site are to be provided in a PDF file.

Bathymetric outputs for each site to include:

- DTM of surveyed area (1m^2 grid generated from spot levels);
- Detailed plan showing all boundaries, embankments and other in river features;
- Contours/Depth Contours at 0.2m intervals;
- Cross-sections & longitudinal sections, the exact locations shall be agreed during the data processing stage on a project specific basis;
- PENZD (Comma delimited) or ASCII file or .csv file or equivalent file type.

9.5 Digital Terrain Models

Digital Terrain Model (Surface), in ITM, as specified in Section 6.3, shall be supplied as separate drawings.

9.6 Reports

Reports required for the control survey are outlined below.

On completion of the survey, the Service Provider shall deliver to the Employer a detailed survey report covering the control survey and the topographical survey which describes at a minimum the methods, techniques and equipment used, accuracies achieved, corrections made, issues encountered and descriptions/locations of permanent ground markers used in the survey.

Reports required are as follows:

- **Survey Control Report** with the following information as a minimum:
    - schedule of survey control points in accordance with Section 5
    - Easting and Northing Coordinates ITM (EPSG:2157) with corresponding elevations in, Height above Ellipsoid (HAE), OSGM02 and OSGM15 for any Survey Control Points.
    - survey control network diagram
    - numerical results
    - network adjustment files
- **Topographic, LiDAR & Bathymetric Survey Report** with the following information as a minimum:
    - date of survey
    - details of specification being followed
    - outline methodology
    - name of surveyors
    - computing and presentation of survey
    - equipment make, model, serial numbers, and calibration certificate
    - site photography
    - details of quality control for site and processing work
    - survey issues or difficulties encountered on site
- **Additionally for the LiDAR Survey** with the report shall include, but is not limited to, the following:
    - Flight trajectories
    - Details of system calibration checks
    - Results of relative (flight run) matching and details of any adjustments made
    - Source of primary ellipsoidal height control

- Details of ellipsoid to orthometric corrections applied including any final adjustments
- Results of vertical and horizontal accuracy validation
- All survey control coordinates, site id and check point comparisons in both Excel spreadsheets and ESRI shapefile formats, unless a different format is agreed with the Client's Representative

The final copy of the survey report must be issued in PDF or Microsoft Word 2024 or later format.

9.7 Supply of Digital Data

Digital data shall be supplied on an appropriately sized single USB flash drive which will not be returned or via a File Sharing platform,

10 Appendices

Appendix A to M – Lot 1 to 13 (Refer to attached appendices)

Appendix N Construction of Permanent Ground Markers

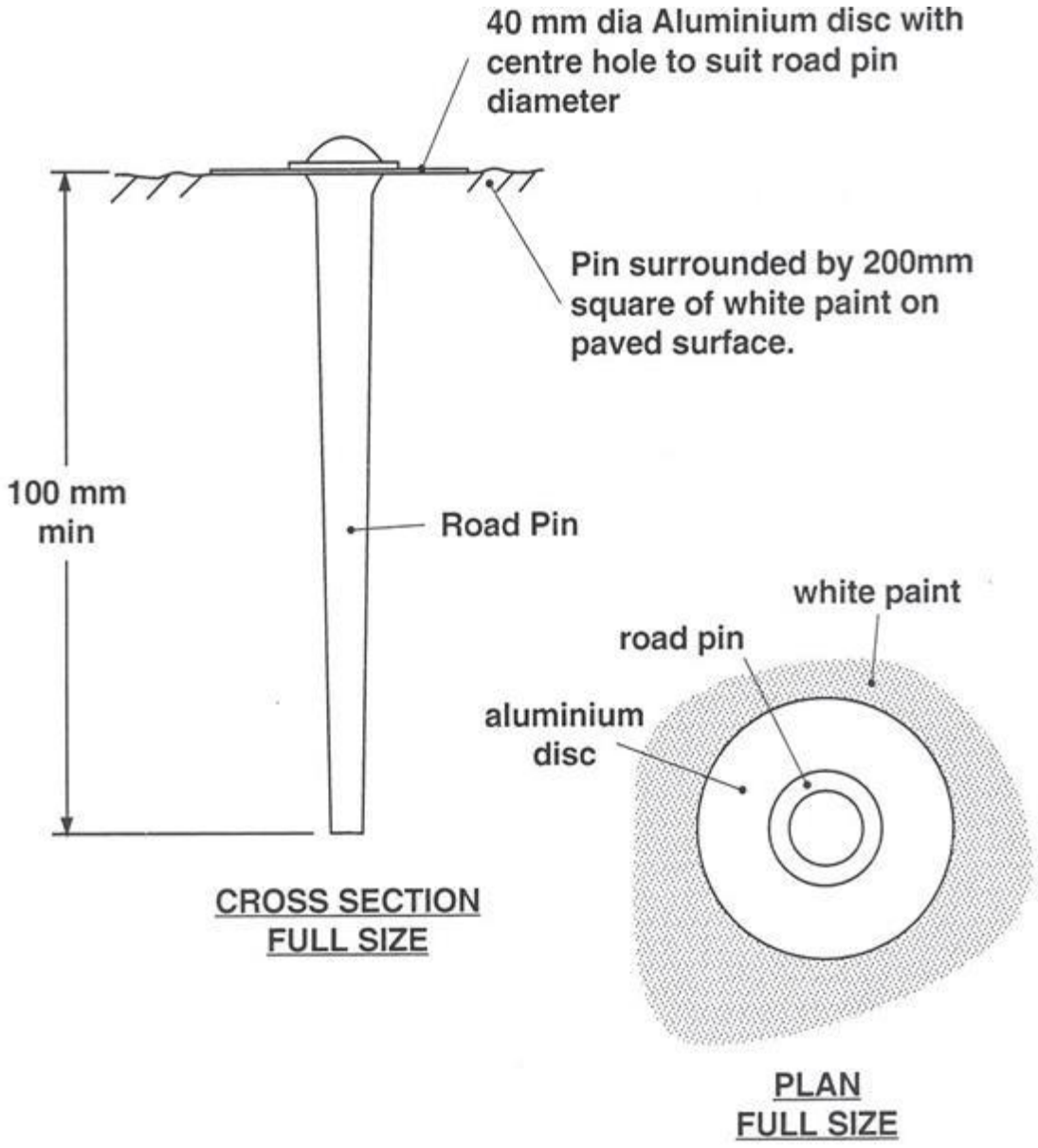


Fig. 1

PERMANENT GROUND MARKER TYPE 1
(FOR DENSE, VERY STABLE PAVED SURFACES)

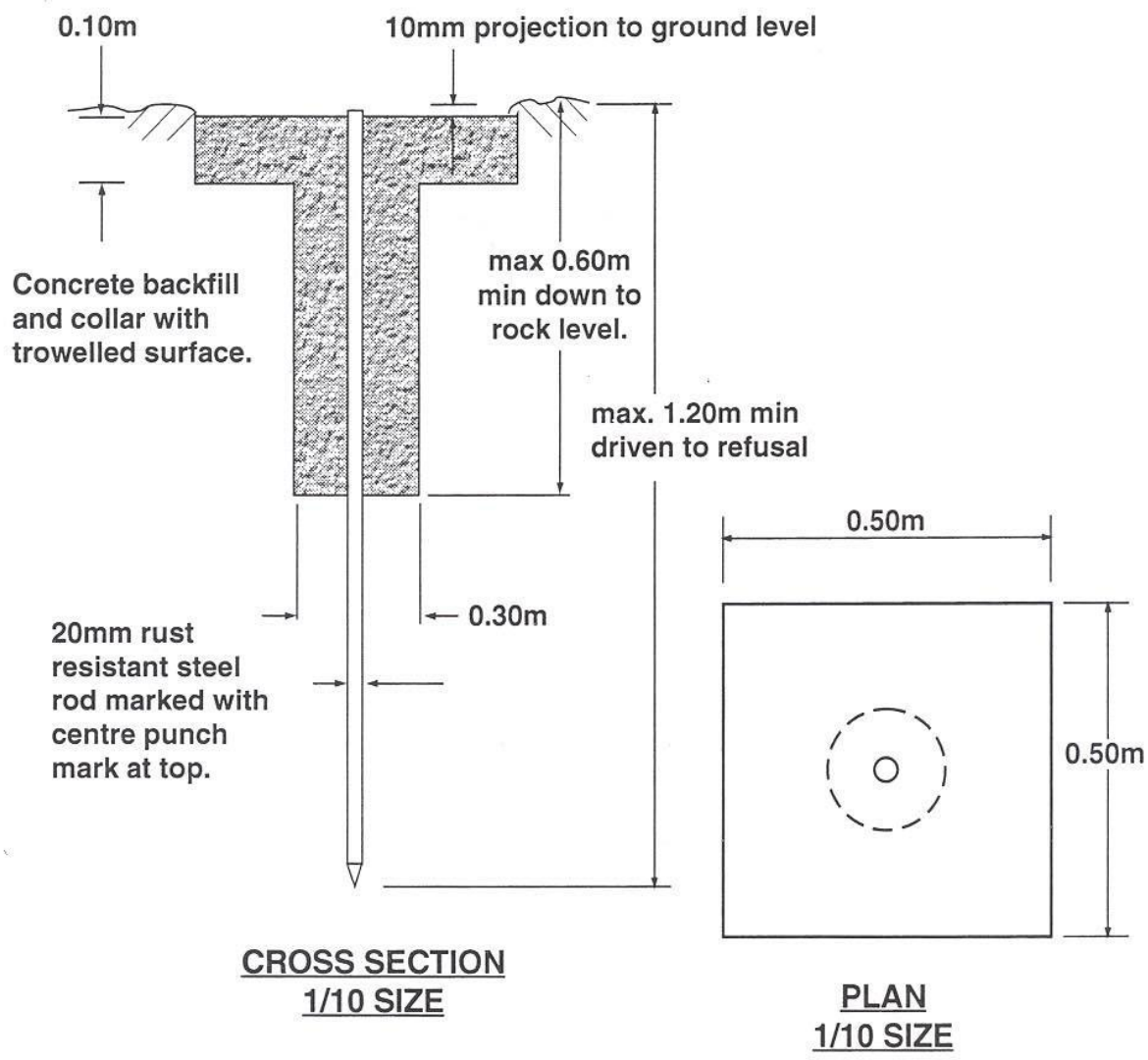


Fig. 2

PERMANENT GROUND MARKER TYPE 2

Appendix O - PGM Location Diagram

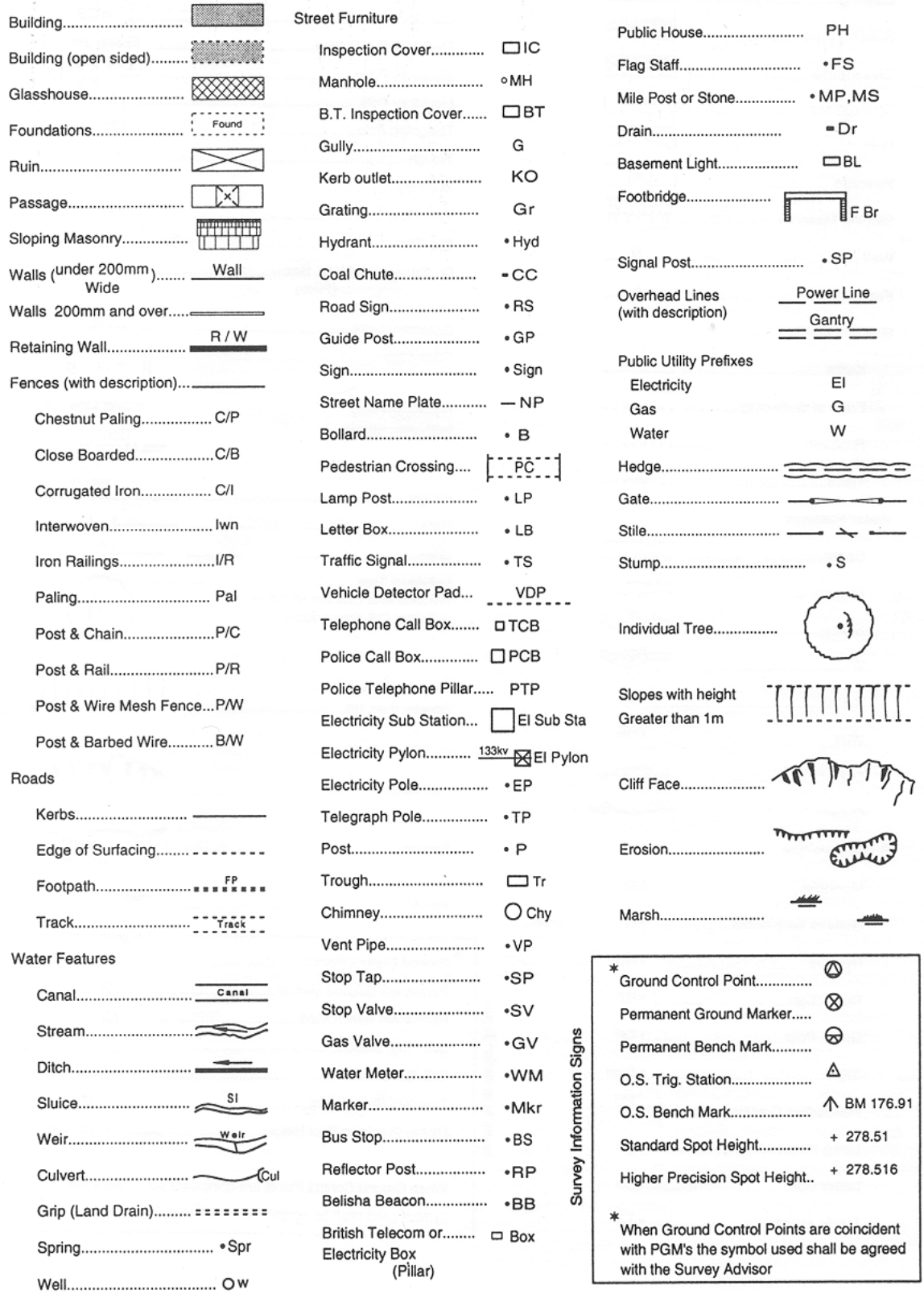
LOCATION OF PERMANENT GROUND MARKERS

PERMANENT GROUND MARKER RECORD SHEET			Page of
Location:			Contract No:
PGM No./ Name			
Description of PGM			
Arbitrary/ N.G. Coords	E	N	Ht
Detailed Location Diagram			
Marker Established by..... Date.....			
Record Prepared by ..... Date.....			
Revisited by ..... Date.....			
Remarks			

Appendix P - Mapping Symbols

Symbols to be used for mapping are given below, unless otherwise agreed with the Employer's Representative.

Conventional Feature Symbols to be used for 1:500 Scale mapping.



Appendix Q - H&S Risk Assessment