

Guidance Note

Principles of Geospatial Survey Data for Design



Executive summary

Geospatial survey data underpins critical design, construction, and asset management decisions. This guidance note explains how survey data should be planned, specified and governed to support confident decision making throughout the project lifecycle based on the following principles:

- Early involvement of qualified surveying professionals
- A single engineering-quality project coordinate system and datum
- A robust, well governed survey control network
- Survey specifications aligned with design stage and risk
- Clear documentation, reporting, and data governance
- Explicit understanding of survey accuracy, uncertainty and limitations.

By following these principles, clients and project teams can reduce risk, improve efficiency, and ensure that survey data is reliable, repeatable, and fit for purpose – supporting safe, timely, and high quality design and construction outcomes.

Clients play a critical role in ensuring survey success. Key early decisions – such as agreeing the project grid, defining accuracy requirements, confirming survey extent and appointing competent survey professionals – have a disproportionate influence on overall project outcomes. Failure to make these decisions early commonly results in abortive design, incorrect quantities, dimensional clashes, and construction misalignment.

Purpose

The effective use of geospatial survey data is critical to reducing design risk, avoiding rework, and ensuring successful project delivery. This Guidance Note is intended to support informed decision making by clients, designers, contractors, and practitioners, by explaining how geospatial survey data should be specified, governed, and relied upon at different stages of a project. It highlights the risks associated with inappropriate use of survey data and establishes principles to ensure that survey information is accurate, consistent, traceable, and fit for its intended purpose. The guidance is not a substitute for project specifications or professional advice, but is intended to inform their development.

The note is split into the following sections:

- Professional guidance
- Design stage and survey data
- Project coordinate system for survey, design, and construction
- Survey control network for project delivery
- Data for early design stages – project definition and option selection
- Data for later design stages – concept design and detailed design
- Types of data available
- Limitations and risks of using incorrect data for design
- Survey data capture and reporting
- Data for construction and handover
- Summary
- Relevant standards
- Associated CICES guidance

- Acronyms
- Appendix A - Generic survey report template

This guidance note has been prepared with a focus on the UK industry, but the principles apply globally.

Professional guidance

A suitably qualified geospatial surveying professional should be consulted and involved from an early stage and throughout the project lifecycle to advise on survey strategy, specification, accuracy requirements, methods, coordinate systems and survey control. Survey work should be undertaken by trained and competent practitioners under appropriate professional supervision. For further guidance consult with relevant professional bodies and trade associations, such as the Chartered Institution of Civil Engineering Surveyors (CICES), the Royal Institution of Chartered Surveyors (RICS) and The Geospatial Association (GSA).

Design stage and survey data

There are different types of survey which are suitable for the typical stages of design, as shown in Figure 1 below, however requirements will vary depending on the individual needs of a project, for example mobile mapping and UAV data may be appropriate for detailed design when appropriately coordinated to the project grid.

Project Definition	Option Selection	Concept Design	Detailed Design	Construction & Handover	Operation	Design Stage
National mapping / Terrain models / Satellite / Existing client data		Aerial Lidar/ UAV / Mobile mapping	Detail topo / Laser Scanning	Setting out As-built	Maintenance / monitoring	Survey Type
Low		Medium	High	High	As needed	Survey Accuracy
Mapping Grid			Engineering Grid		As needed	Coordinate System
As needed		Medium accuracy e.g. GNSS RTK	High accuracy Consistent across design & construction		As needed	Survey Control

Figure 1: Design stages and types of survey data.

The first tasks for the design team should be to:

- Establish what survey data is available
- Determine its currency and accuracy
- Undertake a gap analysis to determine further project survey data requirements
- Develop the comprehensive survey scope.

These activities should explicitly identify which design decisions will rely upon the available survey data, the level of confidence required to support those decisions, and the potential consequences of survey uncertainty. Where data is proposed to be used beyond its original purpose or specification, this should be treated as a project risk requiring formal review.

The currency of geospatial survey data should be regularly reviewed to ensure it is appropriate to the task, and this should include future survey requirements. There will be many situations where higher accuracy and more detailed topographical information at early stages will reduce costs and rework by enabling better decision making and mitigating design risk. Consideration should be made to capturing data for as many disciplines and purposes as possible – ‘survey once use many times’.

Project coordinate system for survey, design, and construction

The project coordinate system (survey grid and vertical datum) is the 3-dimensional reference framework used for design, construction, and maintenance. It is important to understand the hierarchy of reference frameworks, and how the correct application of such grids will provide efficiency and mitigate project risk and cost. Common examples include, but are not limited to:

- Global frameworks such as WGS84, UTM, and Web Mercator
- Regional geodetic systems such as ETRS89
- National mapping coordinates systems such as the Ordnance Survey British National Grid
- Low distortion engineering grids for specific projects, such as London Survey Grid or tailored SnakeGrids

The selection of grids and the derivation of transformations between grids, is a complex subject and can be a significant cause of error, rework, cost and spatial misalignment. For each project, a single authoritative definition of the project coordinate system should be established, including the horizontal and vertical datums, projection parameters, and approved transformation parameters to and from other relevant systems. These definitions should be documented, version controlled, and agreed by relevant stakeholders. Undocumented or ad hoc transformations, including software default transformations, introduce significant project risk and should be avoided.

A qualified survey professional should be consulted to advise the appropriate approach.

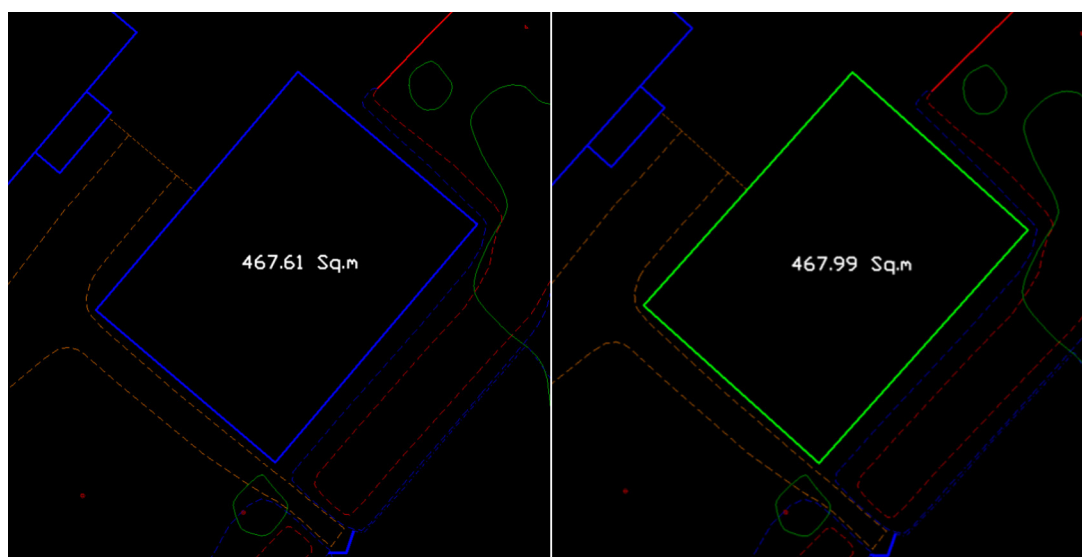


Figure 2: Area measurement examples between (a) national mapping grid and (b) increased accuracy near-unity-scale engineering grid.

Optioneering design stages

At early design stages, such as option selection, most available topographic data will be in a national mapping grid and vertical datum, or similar regional coordinate system such as Universal Transverse Mercator. It is therefore common for optioneering design stages to use the national mapping grid and datum.

Transition into concept, detailed design and construction

As design progresses and optioneering concludes, reliance on a national mapping grid becomes a significant risk. Such grids are not suited to engineering applications because scale factor variation can cause notable differences between grid distances and true ground distances, as shown in the 0.38 m² area difference example in Figure 2.

At an early stage in the design process, stakeholders should agree on a project grid and vertical datum suitable for engineering use. This may be a tailored low-distortion projection (examples include SnakeGrids or London Survey Grid), a local site grid, or a quasi-mapping grid adjusted for the site.

Early transition to the agreed project grid and datum is essential. Any design undertaken prior to formal agreement and documentation of the project coordinate system is exposed to an increased risk of rework, redesign, incorrect quantities, and dimensional inconsistency at construction.

A rigorously defined engineering grid allows existing data to be converted reliably, and all subsequent survey and design activities, such as topographic capture and setting-out, should use the agreed project grid and datum.

The project grid and datum should be confirmed with the client and clearly documented within the works information/scope, BIM execution plan, survey strategy and relevant survey control reports.

Survey control network for project delivery

Survey control is a system of permanent markers used to provide a positional framework for the dimensional control of construction projects. Such points are used for activities such as capturing topographic data, construction setting-out, as-built verification, infrastructure maintenance and deformation monitoring. Survey control networks should be designed with an appropriate hierarchy (for example, primary, secondary and working control), with defined accuracy requirements linked to their intended use. Control accuracy should be verified through redundant observations and reported in statistically meaningful terms.

The survey control network may not be established at the early design stages, such as option selection. Even if it exists there may be no direct linkage between most national mapping and LiDAR data and the control network. This can cause spatial mis-alignment issues when moving from concept to detailed design. As a project progresses, the specification, installation and maintenance of survey control is critical to provide dimensional continuity between design, construction and as-built verification. The control network needs to fully cover the maximum project extents and may include sections of overlap to existing control networks on proximate projects. Validated conversion parameters between all relevant coordinate systems should be agreed amongst relevant stakeholders, published and maintained for use on the project. Responsibility for the establishment, maintenance, revalidation, and coordination of survey control should be clearly defined. Any changes to survey control or transformation parameters should be formally communicated and assessed for impact on design and construction activities.

Installation of a robust, accurate, project wide control network should be undertaken and documented as early as practicable, at minimum in time for detailed design. Any design undertaken prior to control network establishment is at risk of rework due to spatial misalignment. The survey control should be maintained, updated, and documented, through the construction phase and into handover, to mitigate the risk of rework and redesign. CICES guidance note 'Guidance Note Survey Control Reports' should be consulted for more detail on this subject.

Data for early design stages – project definition and option selection

For early design stages national mapping and LiDAR may be the first data to be sourced for the project. This data may be free to obtain via open source or public sector licencing arrangements. Further sources should be investigated as needed for the project, such as existing client data.

The types of data available may include:

- Elevation models, including surface and terrain, and LiDAR point clouds such as the National LIDAR Programme, run by the UK Environment Agency
- Raster orthoimagery (aerial or satellite)
- Vector topography/mapping such as Ordnance Survey data via PSGA licencing
- Underground mapping data available through local statutory undertakers and NUAR
- Bathymetry data available from port authorities and national hydrographic organisations.

Due diligence is required to ensure the survey accuracy, coordinate system, and currency is fit for purpose. National mapping, LiDAR and other open or third party datasets are typically suitable only for optioneering and strategic assessment. Such data is rarely suitable for detailed design or construction without validation against a robust project control framework. Reliance on these datasets beyond early design stages should be treated as a significant project risk.

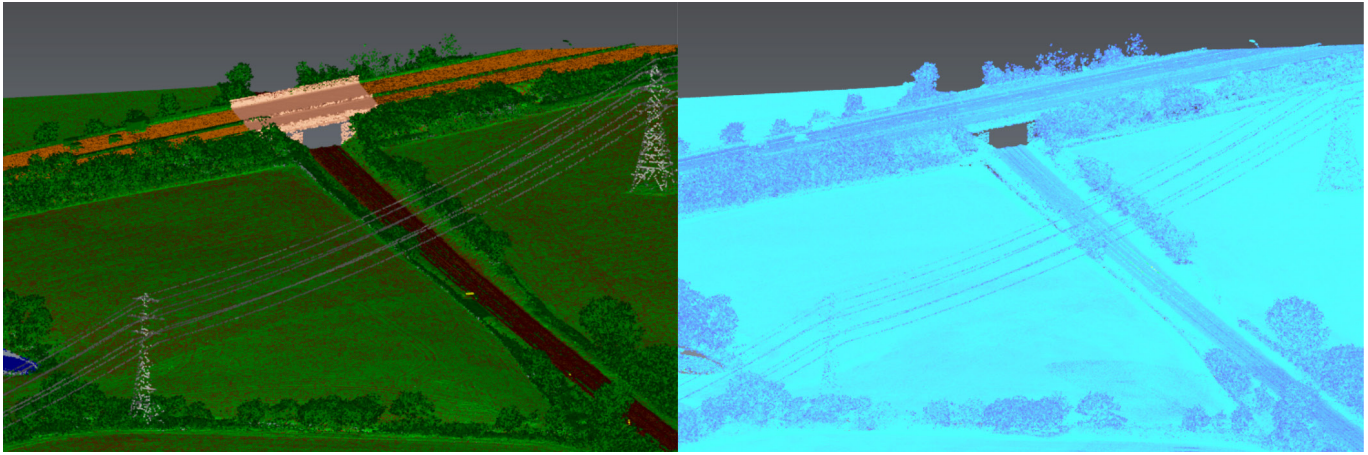


Figure 3: Example of a point cloud from aerial LiDAR (a) classified and (b) intensity.

Data for later design stages – concept design and detailed design

For later design stages, including concept and detailed design, the currency and accuracy of existing survey data needs to be assessed for fitness of use. To ensure the survey data is accurate and contemporary, and derisks the design process, appropriate detailed survey specifications should be developed in collaboration with relevant stakeholders such as discipline design leads and their customers. This should be based upon the principle of minimisation of design rework.

The scope should consider the purpose of the survey, and survey requirements should be defined in a specification for each project. This should be tailored to the specific project and include survey data for all relevant design disciplines. The following can be used as guidance for the minimal requirements:

- Project scope and purpose
- The survey grid and height datum
- Survey control requirements, including the monumentation and accuracy. Further information on this is available in the survey control network for project delivery section above
- Survey extents in a readable format that clearly defines the area of interest
- Spatial accuracy (absolute and relative) and resolution
- Specific features and detail to be included
- Survey deliverables including data formats, meta-data and reports
- Example data and standardised templates, shared and agreed with design team
- Method of delivery, storage, data ownership, legal constraints (including GDPR), quality control and timescales
- Project specific considerations.

For more detail on the above refer to relevant industry standards and guidance such as those listed in the relevant standards section below.

Limitations and risks of using incorrect data for design

Survey data always carries limits on accuracy, resolution and repeatability and its relevance decreases over time as site conditions change. Uncoordinated or misaligned surveys can introduce significant geospatial uncertainty. Establishing a standardised, project-wide survey approach – guided by a clear survey strategy updated at key milestones – reduces risk and ensures consistent, integrated survey data for design.

Survey data and reporting

Survey reports should be delivered to provide a clear audit trail, demonstrate quality and state the purpose of the survey, any limitations or exclusions, to support effective risk management. Reports should be proportionate to the works undertaken and relative to the complexity of the project.

Documenting survey data capture and processing builds stakeholder confidence ensuring its uses and limitations are transparent, while a detailed methodology enables repeatability on site. CICES publish relevant

guidance, including the 'Guidance Note Survey Control Reports'. For general topographic survey capture, a minimum level of expected report headings may be found in appendix A. Further best practice documents may be found in the relevant standards section below.

Survey data should be stored using robust data management procedures, with appropriate naming conventions, that is accessible to all relevant stakeholders. Metadata should be used to provide information about each dataset, to enable re-use and understanding of the lineage.

Data for construction and handover

Survey procedures for construction and setting out verification should achieve sufficient accuracy to demonstrate compliance with specified construction tolerances. Projects should define a clear responsibility matrix for progressive and final as-built survey verification deliverables, supported by quality procedures governing submission, review, and approval of the works. CICES has published further guidance, the 'Guidance Note Survey Control Reports' and 'Guidance Note As-Built Survey Reporting'. Survey control is an essential part of project handover, to provide design continuity for maintenance and future works.

Summary

The effective use of geospatial survey data is critical to reducing design risk, avoiding rework and ensuring successful project delivery. By engaging qualified surveying professionals from the outset, establishing an appropriate project coordinate system, and planning survey requirements in line with design-stage needs, project teams can ensure that all spatial information is accurate, consistent and fit for purpose.

The use of national mapping data can support optioneering, but timely transition to a rigorously defined engineering coordinate system – supported by a well-designed survey control network – is essential to maintain dimensional data integrity as the project progresses. Clearly defined survey specifications, robust data management, and comprehensive reporting further strengthen confidence in the data and enable repeatability, transparency, and integration across all disciplines.

In an environment where inaccurate or outdated survey data can lead to significant cost, delay, and safety risks, a coordinated, project-wide approach to geospatial data capture, management and validation is fundamental. By applying the principles and best practices outlined in this guidance note, clients and practitioners can ensure that survey data is used effectively to support high-quality, efficient and resilient design and construction outcomes.



Figure 4: Example Network Rail project UAV photogrammetry data.

Relevant standards

- UK Highways – GG951
- UK HS2 - Railway Survey Standard HS2-HS2-GL-STD-000-000001
- UK Network Rail - NR/L2/TRK/3100
- UK RICS - Measured surveys of land, buildings and utilities
- UK RICS – Use of GNSS in surveying and mapping
- UK RICS – Aerial imagery (UAV, Aerial, EO)
- UK RIBA – Plan of Work 2020
- UK Network Rail – Design Advice Panel Project Guidance
- UK AGI Gemini
- UK MCA – Civil Hydrography Programme Survey Specification
- UK Environment Agency - National Standard Technical Specifications for Surveying Services

Associated CICES guidance

- Guidance Note Survey Control Reports
- Guidance Note AsBuilt Survey Reporting

Acronyms

- CICES Chartered Institution of Civil Engineering Surveyors
- ETRS89 European Terrestrial Reference System 1989
- GDPR General Data Protection Regulation
- GNSS Global Navigation Satellite Systems
- GSA Geospatial Survey Association
- LIDAR Light Detection and Ranging
- MCA Maritime and Coastguard Agency
- NUAR National Underground Asset Register
- PGM Permanent Ground Marker
- PSGA Public Sector Geospatial Agreement
- RICS Royal Institution of Chartered Surveyors
- RTK Real Time Kinematic
- UAV Uncrewed Aerial Vehicle
- UTM Universal Transverse Mercator
- WGS84 World Geodetic System 1984

Appendix A – Generic survey report template

- Front sheet including:
 - Company details
 - Project and client details
 - Document number and report date
- Prepared by/Checked by/Approved by
- Scope and extent of survey works
- Applicable standards/specifications
- Equipment, including checks and calibration
- Software (both capture and processing, including version numbers)
- Personnel and responsibilities
- All relevant survey grids and level datums
- Survey control utilised
- A full description of technical principles, methods and workflows used to satisfy the requirements

- Contextual mapping of the area of interest including existing and proposed works (such as PGM locations)
- Dates and periods of data capture
- Environmental observations
- Independent and redundant observations, including check points utilised with residuals
- Survey accuracy, including thorough quantification and comparison against what is required
- Confirmation of compliance with the agreed specification, including any deviations
- Summary of residual risks and assumptions
- Description of the quality assurance process utilised for all datasets
- List of deliverables
- Conclusions, including comments on the specification, results, and lessons learnt for future work.

This guide has been produced by the Geospatial Engineering Practices Committee of the Chartered Institution of Civil Engineering Surveyors

Endorsed by



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