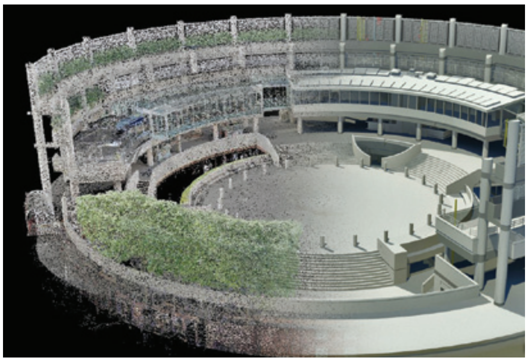
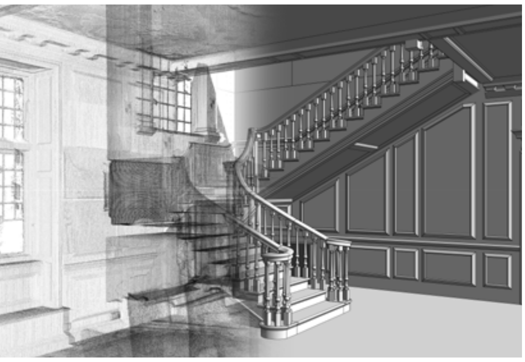
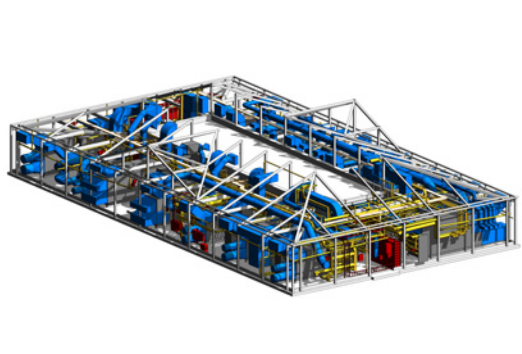
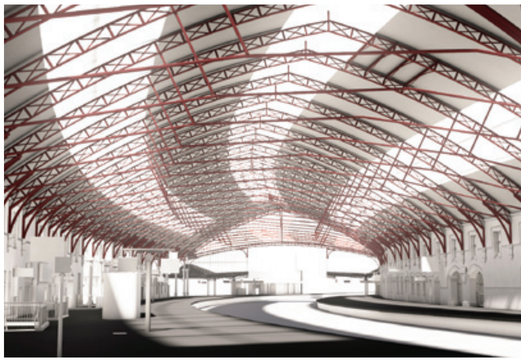
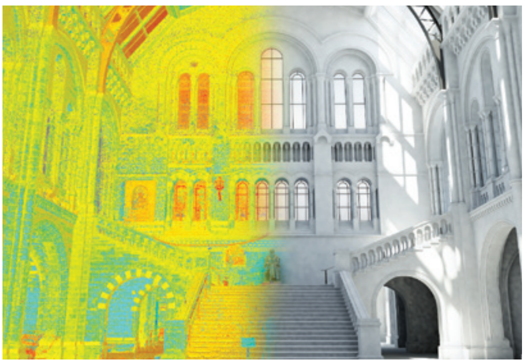
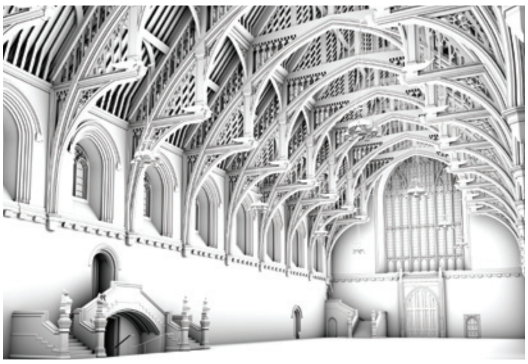
Plowman Craven

# BIM SURVEY SPECIFICATION
# AND
# REFERENCE GUIDE

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Plowman Craven

# Plowman Craven Profile

**Plowman Craven provides integrated measurement and consultancy services to the property and infrastructure markets, pioneering the use of technical innovation to deliver proven expertise and trusted results throughout the project lifecycle. With more than 50 years' experience, the company is built on honesty, integrity and a reputation for consistent delivery of quality service to customers who trust our expertise and professionalism.**

**Our access to skilled and specialist resource allows us to respond effectively, no matter the size of the project, or how challenging – turning spaces into places through superior understanding, technology and capabilities.**

**Driven by our commitment to continuous improvement and excellence, we aim to be the fastest growing innovator in the world of measurement.**

**For advice or clarification regarding this BIM Survey Specification and Reference Guide, please contact:**

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# Document Information

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## Revision History

| Version | Date | Description |
|---|---|---|
| 1.0.0 | 28/05/2012 | First issue |
| 2.0.0 | 04/07/2012 | Second edition. Major update and document consolidation |
| 2.0.1 | 01/08/2012 | Minor updates, front cover and enhancement to Appendix B |
| 2.0.2 | 02/08/2012 | Sign-off added to Check List |
| 2.0.3 | 12/11/2012 | MEP and FFE detail and check lists added. Levels of Detail renamed |
| 3.0.0 | 15/04/2014 | General update. Detailed Check List (Appendix B) updated and new Survey Model User Notes (Appendix C) included |
| 4.0.0 | 15/09/2015 | General update to whole document with major amendments to Appendix A, B and C |
| 4.0.1 | 02/01/2017 | Incorporation of new branding detail and minor updates |

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# Table of Contents







**Plowman Craven** Limited
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# 1 Introduction

**This document provides a specification for the survey of buildings, land and utility services which are to be incorporated into a Building Information Modelling (BIM) environment. It is intended to assist all those connected with the procurement and production of BIM related measurement services, enabling delivery of a successful project.**

**Whilst it is understood that BIM is a process and not a piece of software, this document specifically details the options for creating models of existing buildings or structures using the Autodesk Revit® application.**

## 1.1 How to Use This Document

This document is divided into four parts.

- **Body document** – The body of the document provides an outline description of the key factors to consider when commissioning a BIM-ready survey.
- **Check List** – Appendix A – Detail Check List is intended **to be completed and returned to Plowman Craven Ltd** to form the basis of understanding for the specification of a BIM survey. However, it is no substitute for a thorough and detailed discussion and agreement on the purpose and content of a survey.
- **Reference** – Appendix B – Detailed Modelling Methods and Considerations is a detailed description of modelling methods used in the creation of a BIM model. It is intended as a reference for a Client's BIM Manager and/or technical team. This section includes visual examples of how different features could appear in a model.
- **User Notes** – Appendix C – Survey Model User Notes highlights some additional features and guidance for users viewing and interrogating a survey model. This should be reviewed prior to opening a final model.

## 1.2 Reference Material

This document should be read in conjunction with a number of other publications related to surveying and the BIM process.

Recommended publications include:-

- Measured Surveys of Land, Buildings and Utilities[1]
- AEC (UK) BIM Protocol for Autodesk Revit[2]
- PAS 1192-2[3]
- PAS 1192-3[4]
- PAS 1192-5[5]
- RIBA Plan of Work 2013 Overview[6]

## 1.3 Critical Success Factors

Whilst this specification can cover much of the detail relating to a given project, other factors should also be considered which can affect a survey, such as:

- The purpose of an overall building project
- The nature of a building
- The extent of survey required
- The timescales available

Therefore, for a given project to succeed there is an obligation on both the Client and Plowman Craven to commit time and effort to ensure an appropriate level of communication is maintained throughout the project lifecycle. By their nature, the use of BIM models is much further reaching that traditional 2D or 3D CAD products. As such, it is far more important that every model is constructed in the correct manner from the outset.

With this in mind, Plowman Craven suggests the following approach is adopted:

- A pre-start up meeting to confirm the specification, clearly identify lines of communication for all stakeholders and identify any milestone deliveries
- Delivery and review of sample data at the earliest opportunity
- Regular progress meetings and communication throughout the life of the project
- Post-delivery review

1 *Measured Surveys of Land, Buildings and Utilities. 3rd Edition (2014) RICS Books*

2 *AEC (UK) BIM Protocol for Autodesk Revit®. Version 2.0 (2012)*

3 *PAS 1192-2:2013 Specification for information management for the capital/delivery phase of construction projects using building information modelling BSI Standards Limited (2013)*

4 *PAS 1192-3:2014 Specification for information management for the operational phase of assets using building information monitoring BSI Standards Limited (2014)*

5 *PAS 1192-5:2015 Specification for security-minded building information modelling, digital built environments and smart asset management BSI Standards Limited (2015)*

6 *RIBA Plan of Work 2013 Overview RIBA (2013)*



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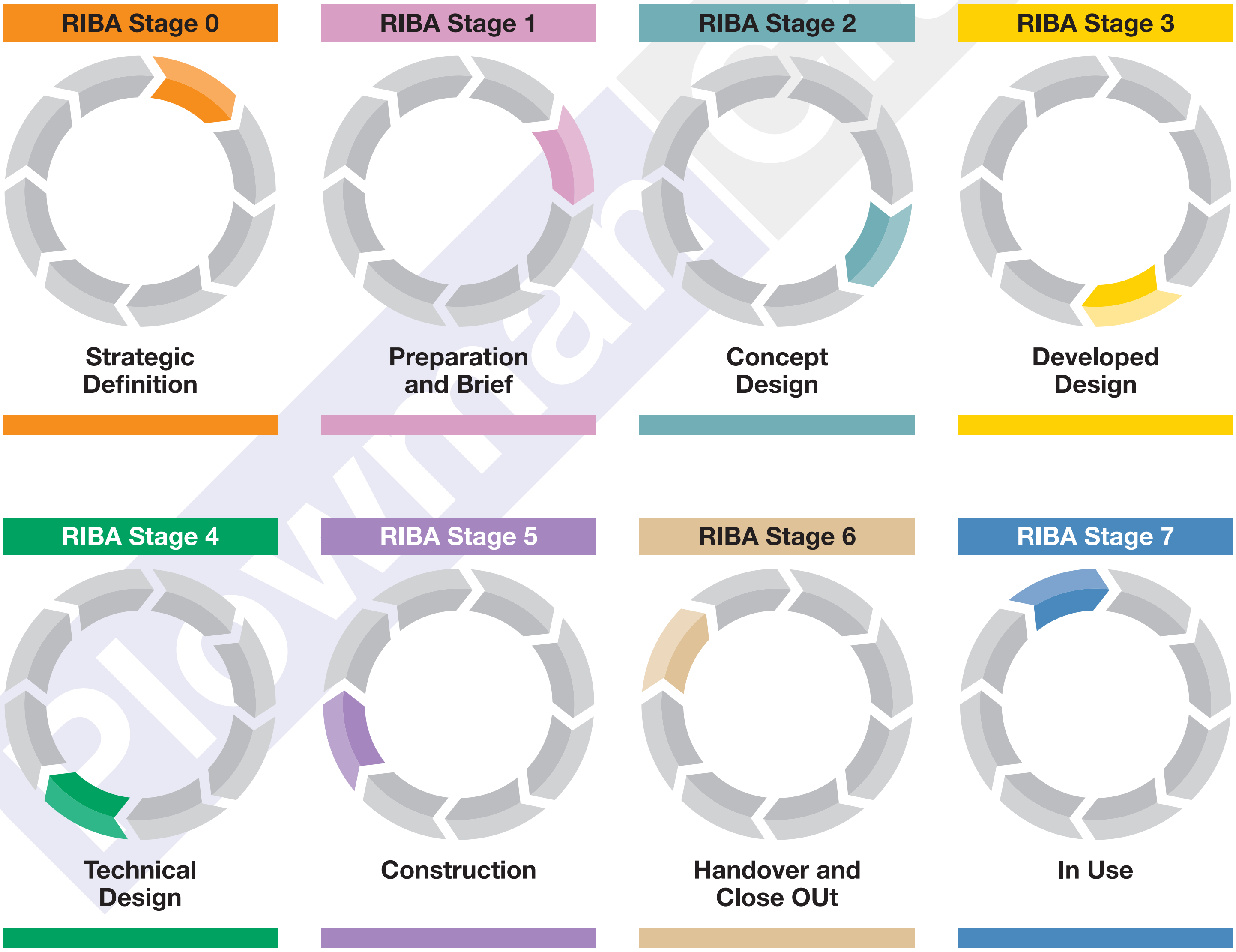
# 2 BIM Services through the project lifecycle

**The skills and experience Plowman Craven has gained over the last 50 years has enabled us to develop an in-depth understanding of the measured world. We are able to provide a huge variety of services at different stages of a project lifecycle, looking for innovative solutions and new approaches to every project.**

**We believe that our commitment to continuous improvement and excellence ensures that we will be able to provide a solution to any encounter within the measurement environment.**

**This section uses the RIBA Plan of Work 2013 as a base to expand upon some of the services Plowman Craven offers at different stages of the project lifecycle.**





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## 2.1 Strategy

### RIBA Stage 0 – Strategic Definition

**Plowman Craven can contribute to the Strategic Definition of a project by providing independent advice and consultancy in survey and BIM-related matters.**

Our established knowledge of survey, BIM and related technologies, alongside our commitment to innovation, enables us to suggest appropriate and cost-effective solutions throughout the project lifecycle.

We offer a variety of services which contribute to the success of the BIM process at all Stages of the project lifecycle. Some of these services are listed below and are expanded upon in the following pages.

- Geospatial BIM consultancy
  - Advisors on 'scan to BIM' approach
  - BIM-ready model specifications
  - Pre-tender advice and support,
  - Definition of measurement and modelling specifications
- Data management
  - Creation and maintenance of a Common Data Environment (CDE)
  - Set up and hosting data on a personalised Client Access Portal (CAP)
- Preparation of Employers Information Requirements (EIR)
- Production of detailed BIM Execution Plans (BEP)
- Construction verification
  - Retrospective (as-built data compared with existing site conditions)
  - Prospective (existing site conditions compared to proposed alterations)
- Model management, co-ordination and validation
  - Exploiting our expertise in survey to ensure accurate co-ordination
  - Employing our understanding of the built environment to guarantee integrity
  - Utilising the dataset we & others collect to enhance intelligence





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## 2.2 Feasibility and Planning

RIBA Stage 1 – Preparation and Brief

RIBA Stage 2 – Concept Design

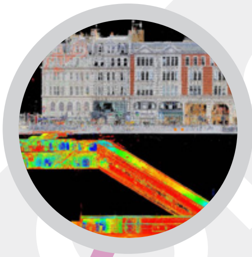
**With over 50 years' legacy in the geomatics industry, Plowman Craven has gained vast experience of working with different sectors, Standards, and environments. Alongside this, our ability to deliver a huge variety of services throughout the Design Programme will support the successful development of the initial and final project briefs.**

## Site Investigations

Using a wide range of data capture tools, vast amounts of data can be quickly captured from the outset, ensuring a 'right first time' approach, leading to:

- Reduced Health and Safety risks
- Minimizing site visits and carbon footprint
- Increased understanding of site
- Completeness of accurate and current information

## Correlation Surveys



Understanding what lies beneath the site is just as important as knowing what is above. Plowman Craven offers a wide range of utilities mapping solutions and is skilled at providing a comprehensive understanding of infrastructure below ground. Data can be accurately combined to guarantee a clear understanding of the whole site.

## Visualisations

Whether used for marketing a new development, communicating to investors or creating a complete walk-through experience, our visualisation solutions are a vital tool and can save time and money when engaging all stakeholders on design and planning proposals. Plowman Craven has a dedicated team skilled at creating 3D rendering, CGI still images, animated fly-through and interactive platforms.

## Hosted Sharing of Site Information

Effective collaboration and coordination is paramount in the BIM process. Ensuring all stakeholders have clear and easy access to the most up to date information is vital. Plowman Craven can provide all the necessary tools to ensure efficient project management through:

- Common Data Environments (see Section 3.7 for further detail)
- Information management
- Model hosting
- Virtual site visits

## Feasibility and Planning

Plowman Craven works closely with architects and developers to supply both the survey data and graphic information necessary to accurately illustrate the visual impact of a development proposal. We are experienced at producing Accurate Visual Representations (AVRs) – as photomontages, Verified Views or 3D Models – and will work with you to deliver the required output to relevant guidelines and frameworks.





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## 2.3 Design

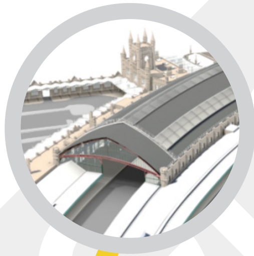
- RIBA Stage 3 – Developed Design
- RIBA Stage 4 – Technical Design

**Plowman Craven has years of experience providing the BIM-ready survey models that are essential to the success of RIBA Stages 3 and 4. Alongside this, validation and co-ordination of various disciplines' design models is vital to avoiding unforeseen costs and ensuring that the project is fully prepared to move on to the Construction Stage.**

### Comparison of Design to Existing Conditions

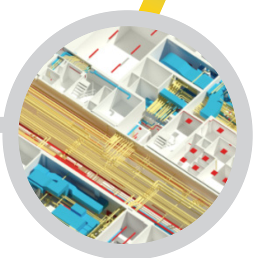
- Visualisation and clash analysis
- Bring proposed model into raw point cloud
- Risk reduction using scan data for pre-construction tender

### 'Scan to BIM' Modelling



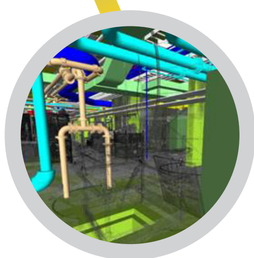
- Model as the project progresses
- Minimise rework – Ensuring design is based on accurate data
- Incorporate intelligence to the model
- Incorporate existing structural and MEP data

### MEP and Underground Service Mapping



- Fully incorporated and coordinated with the BIM survey model
- Ground Penetrating Radar and CCTV

### Model Coordination and Validation



- Spatial coordination
- Clash detection
- Model integrity/quality policing against protocols



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## 2.4 Construction

**RIBA Stage 5 – Construction**

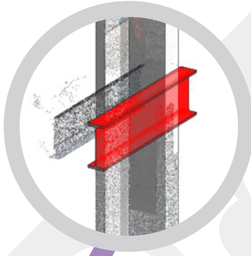
**Plowman Craven uses rapid data collection techniques to confirm the accuracy of structural features as they are exposed and verify the precision of the build during construction. This process helps to identify potential clashes throughout the process: reducing the risk of delays, helping to minimise cost and – if undertaken at the appropriate points in time - resulting in a true 'As-constructed' model.**

### Post Strip-Out Survey

Rapid data capture when the building has been stripped out can provide vital information for the design team.

- Coordinate the structure and services that are to be retained
- Verify existing as-built plans/ models with current conditions
- Validate proposed plans/models

### Construction Verification



Construction Verification is an accurate and independent measurement that provides assurance for stakeholders that the physical as-built condition matches the design and contractual expectations measured.

- Survey consulting and independent checking
- Verification of As built vs. Design
- Clash Detection and Quality Control
- Archive recording
- Location Verification directly from the BIM Model

### Pre Fit-Out Survey

Prior to site fit-out, rapid data capture can validate the installed services and any other critical elements prior to finishes being fitted, and therefore obstructed from view.

- Accurate recording of as-built information
- Validate design models for handover
- Party wall alignment
- Offsite fabrication and manufacture
- FM recording and visualisation

### Deformation Monitoring

Part of the Plowman Craven group, PC Monitoring provides fully integrated manual and automated monitoring services to construction projects. A large range of monitoring instrumentation and techniques are utilised to offer services including:

- Deformation monitoring
- Defect monitoring
- Settlement monitoring
- Convergence/divergence monitoring
- Structural monitoring – manual and/or automated
- Geotechnical monitoring
- Environmental monitoring



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## 2.5 Operation and Maintenance

**RIBA Stage 6 – Handover and Close out**

**RIBA Stage 7 – In use / Operation**

**During Handover, Close out and Use, Plowman Craven can revisit a site at critical stages to ensure that true ‘As-constructed’ data is gathered and incorporated into the model as soon as geospatial changes are made. Working with Facilities Managers to integrate such changes with the CAFM system will safeguard the successful and cost-effective operation of the building throughout its lifespan.**

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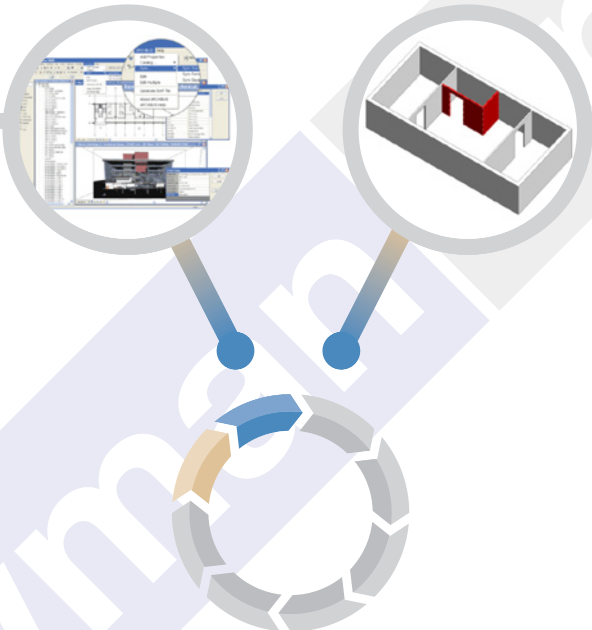
### Facilities Management Integration

- Integration of BIM, TruView™ and CAFM systems
- Conservation recording
- Asset management
- COBie integration and data drops



### On-Going Updates to the BIM Model During Operation and Maintenance

When carried out correctly, the BIM process greatly enhances the potential efficiencies during the life of a building. During its lifespan, multiple enhancements and modifications will be carried out and keeping track of changes is vital to ensure the BIM and CAFM system is accurate and in real time. Plowman Craven has various methods to ensure these changes are tracked and updated:

- Return visits to site to capture changes
- TruView™, BIM and CAFM system update
- Building analysis and efficiency studies

# 3 Scan to BIM: Technology and Workflow

**The most efficient method of producing a BIM model of an existing building or structure is to use terrestrial 3D laser scanning.**

However, laser scanning on its own is not sufficient to provide a complete geometric framework for the survey of a building or structure, or to provide the depth of information required for interpretation and creation of the BIM model.  The workflow for the accurate documentation and subsequent modelling should include the following stages:

1. Precise survey control framework
2. High definition 3D terrestrial laser scanning
3. High dynamic range 360° panoramic imagery
4. Consideration of other survey inputs
5. 3D parametric BIM modelling
6. Delivery
7. Creation of and hosting a Common Data Environment

## 3.1 Survey Control Framework

Traditional survey techniques, such as GPS and traversing using robotic total stations, are used to establish primary control and to provide the accurate geometrical framework for a project. This control is permanent and available for future works and setting out and control defines the primary grid for the project, which could be Ordnance Survey National Grid or a local project grid.  All height information will use either Ordnance Datum Newlyn or a local arbitrary datum.  See Section 7.26 Coordinate Systems and Units for more information.

Although Revit® works on a local coordinate system, a project base point can be used to link the model to a known project coordinate system.  It is imperative to define this at the outset of a project to ensure that all survey data including traverse, point cloud and BIM model are related to the same coordinate system. Plowman Craven's default process for establishing this base point is described further in section 7.26.


*Figure 1 - Scan to BIM workflow summary*

## 3.2 Laser Scanning Data Capture

Laser Scanning instruments collect high accuracy (+/- 3mm) data at up to 1 million points per second, providing a rich and accurate set of measurements in three dimensions called point clouds.

The result is an organised digital representation of a building or structure which is delivered quickly, efficiently and accurately. The resulting point cloud data provides an immediate 'point in time' database of information from which a 3D parametric BIM model can be constructed. The database provides an archive and record which can be accessed at any time throughout a project or for future proposals by all relevant stakeholders. Laser scanning is the preferred method of data collection for subsequent modelling as it provides:

- Rapid site data collection and minimal disruption
- Completeness of data – reducing return visits to site
- Immediate asset archive
- Improved safety and non-contamination
- Assistance with off-site manufacture in complicated and limited access environments

*Figure 2 – Scan data capture*

### 3.2.1 Point Cloud Density

The physical process of capturing laser scan data has many variables. One important consideration is the point spacing at which the scanning will be carried out.

Laser scanning data capture must take into consideration a balance between:

- Scan density required to enable suitable identification for modelling purposes
- Site time available for data capture
- Resultant file sizes, and the Client's ability to handle large data sets
- Potential future uses of the data by all stakeholders
- Amount of coverage required. It should be noted that 100% laser scan coverage is not required for creation of the BIM model (and will not be possible), but minimising obscured areas may be important for other stakeholders or subsequent users of the scan data

As a general guideline, point spacing should be considered at the following intervals, but should be discussed and agreed prior to a survey taking place:

| | |
|---|---|
| Mass model, Rights to Light or LOD 1 / 2 models: | Point spacing 20mm |
| Typical building or LOD 3 models: | Point spacing 10mm |
| Heritage buildings or LOD 4 models: | Point spacing 5mm |

### 3.2.2 Inaccessible Areas

Survey measurement is a line of sight technique, dependent on site conditions, access, safety, etc. As such a survey and subsequent BIM model will not be able to accurately measure and portray every wall line or detail. This may include inaccessible areas such as ceiling voids, lift shafts, electrical substations, etc.

Whilst it may be possible for Plowman Craven to devise a workflow for collecting such data, this must be addressed on a case by case basis and agreed with the Client prior to quotation. Safe and visible access must also be arranged by the Client prior to the survey.

Undefined lines and surfaces, such as wall, floor, roof and ceiling thicknesses will be clearly identified in a model as such. For example, the outer side of a basement wall.

In areas of restricted or no access, this will impact on what can be modelled. This means that there may be vital elements of a building not captured and therefore not modelled.

Refer to Section 7.23 Inaccessible Areas and Wall Lines for more information on how such areas will be addressed.

## 3.3 Panoramic Imagery Data Capture

On its own, laser scanning provides only the accurate geometric information required for the BIM modelling process. An equally essential element in the process is the collection of high quality, high dynamic range, 360° panoramic photography to enhance the appearance and aid interpretation of the point cloud data.

Specification of the panoramic imagery must include:

- Minimum 12 megapixel photography
- Parallax-free imagery, with the optical centre of the camera precisely located at the same point as the laser origin of the scanner
- Full 360° x 270° coverage
- High dynamic range imagery, colour balanced to ensure that dark areas are lightened and bright areas are darkened
- Imagery accurately aligned to the point cloud





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## 3.4 Consideration of Other Survey Inputs

Base information may be provided by the Client, such as existing 2D CAD drawings or existing M&E services information. Such information can be used as a basis or an aid in a BIM model under certain circumstances. However, the accuracies and completeness of the information cannot be guaranteed by Plowman Craven.

Additional measurements, particularly height information, may be required to enable modelling to take place. This information may also be supplemented with laser scan data for completeness.

## 3.5 3D Parametric BIM Modelling

This section provides a brief overview of some key considerations relating to parametric BIM modelling. The detailed processes and methods which Plowman Craven employs are discussed in depth in subsequent sections of this document, specifically in Appendix A, B and C.

### 3.5.1 Liability

Where possible, Plowman Craven should be tasked with the creation of the base BIM model, thus ensuring that the professional liability for the survey model rests with Plowman Craven.

Plowman Craven shall be responsible and liable for:

- The geometry of the model, including coordinate system, origin and units

Plowman Craven shall NOT be liable for and will not warrant:

- Any base drawings provided by the Client, or model information based upon them
- Any meta-data provided by third parties
- Identification of structural / non-structural walls, or wall / floor construction

Should Plowman Craven produce the final BIM-ready survey model, the liability for the geometric accuracy rests in one place, rather than split between the Client and Plowman Craven. This eliminates an extra stage in the process, thereby reducing time and cost.

### 3.5.2 Creation of the BIM Model

There are many considerations to be given to the specification of the final parametric BIM model.

The key elements to consider are:

- General level of development – i.e. What to include and exclude from the model (see section 4 and Appendix A – Detail Check List)
- Level of Detail (LOD) and Level of Information (LOI) – i.e. For each component to be included in the model, how it will be visually portrayed and what information is to be incorporated (see Appendix B – Detailed Modelling Methods and Considerations)
- Accuracy of the model in relation to the survey point cloud data (see Section 5 Accuracy and Modelling Tolerances)

### 3.5.3 Quality Checking Procedures

Plowman Craven ensures that the services provided to its customers are professional, good value and of the highest quality and adheres to statutory, regulatory and legal requirements. These services are effectively controlled through a Business Management System which is certified to the ISO 9001:2008 standard.

The quality checking of the survey BIM model is a 4-stage process:

- **Stage 1** – Computational check of control survey and point cloud registration
- **Stage 2** – Geometric check of the final BIM model against point cloud and base data
- **Stage 3** – Integrity check of BIM model construction, to ensure efficient and consistent construction of families and objects
- **Stage 4** – Presentation check to ensure that extracted 2D plans, sections and elevations meet required standards of presentation

Refer to Section 7.29 to view our QA Check List.





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## 3.6 Delivery

Final deliverables to the Client can include combinations of the following:

### Building Information Model

It is essential that the version of software to be used on a project is defined at the outset, and that all stakeholders and contributors to the project work in that same software version. Plowman Craven primarily provides models in Revit® software and can deliver in any version from 2009 to 2015, but 2012 onwards is recommended when using point cloud surveys.

The BIM survey model can be delivered in a number of other formats including RVT, iFC, NWF, DGN, DWG and VWX. Should any of these formats be required, this should be specified at the outset. Refer to section 8.3 for more information.

### Scan Data

The raw scan data can be provided to the Client in a number of formats so that it can be used natively in applications such as Revit®, AutoCAD, MicroStation and Navisworks. Supported formats include RCS, PTS, PTX, PCG, E57, POD, IMP and many other formats. Please check with Plowman Craven for a current list of supported formats.

Before requesting point cloud data, consideration should be given to:

- The level of decimation (i.e. reduction or controlled degradation) required
- Accommodation of potentially large file sizes
- Data transfer method, commonly FTP

### Collaborative Point Cloud Viewing

The laser scan data can be combined with 360° high dynamic range photography in a web environment to provide all stakeholders access to point cloud data in real time. TruView™ is a free web-based portal which enables a user to undertake a visual tour of the scanned site. Its real time measurement tools allow each user to pan, zoom, measure, and investigate a site using a workstation or mobile device. Proposed design models can be incorporated at this stage to enable a visual analysis. TruView™ is a major contributor towards reducing carbon footprint and cost reduction through avoiding multiple visits to site.

TruView™ should be specified as a deliverable as it provides:

- A measurement and site investigation tool to allow early decision making without the need for expensive software or highly skilled operators
- High dynamic range photography of every scanned location
- A reduction in site visits and carbon footprint
- The ability to compare 'Design' versus 'As-built'
- Asset management capabilities, assisting planned maintenance and condition assessment
- The ability to incorporate proposed CAD and Revit® designs into the point cloud data without the need to model the existing environment

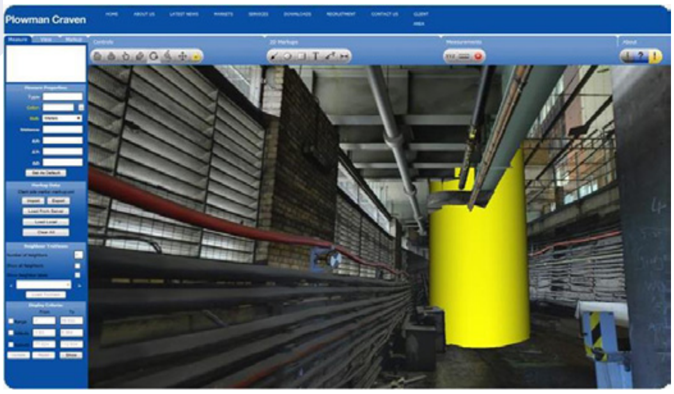


*Figure 3 - TruView™ with embedded design model*

## 3.7 Common Data Environment

PAS 1192-2:2013 describes the shared use of individually authored models in a Common Data Environment (CDE). A CDE is a shared digital space providing a single source of project information which is used to collect, share, manage and disseminate project documents across the team. Creating this single source of information facilitates collaboration between project team members and maximises efficiency by enforcing a structured approach to the management of project data.

Plowman Craven is able to setup, host and manage your CDE within industry-leading collaborative systems. We can provide a single, digital environment for your project data based on the Employer's Information Requirements (EIRs) and its required controls and approval mechanisms at key stages. This will ensure that all parties utilise the most up-to-date project data to inform their specialities, maximising efficiency and reducing risk and cost in producing co-ordinated information.

The ownership of information within the CDE remains with the originator of that information, but the use of a CDE manages the distribution of that information and contributes to a 'right first time' delivery.

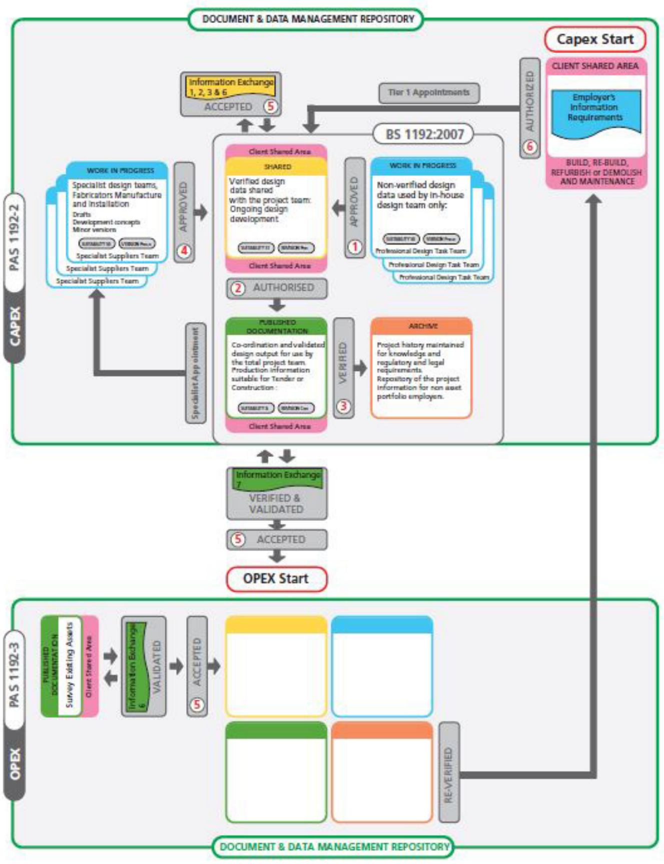


*Figure 4 – The extended CDE taken from PAS 1192-2:2013*

If TruView™ is required as a deliverable, then consideration must be given regarding the location, or hosting of this data. Plowman Craven can host these large datasets on a client-specific, secure, web-based Client Access Portal which can be customised and maintained to your exact need. Alternatively TruView™ data will be delivered in its entirety for the client to host.

## 3.8 Data Exchange and Interoperability

Understanding the required data exchanges and interoperability between softwares used on the project is critical. Communication protocols are key and need to be agreed at the beginning of a project. Plowman Craven adheres to the latest standards/specifications such as COBie or IFC, or can assist in setting out an agreed project specific data exchange.

Awareness of the different softwares being used on a project will assist in the increased ability to provide greater control of the data exchange and set rules to compensate for interoperability issues.

Plowman Craven has devised its own survey specific Revit® template where basic families, views and naming conventions are defined. Unless specified and agreed prior to commencement of the survey, this template will be used by default. This template can be modified to suit certain Client or project requirements.

## 3.9 Ownership

Prior to project commencement, agreement must be made regarding the ownership of a final model. Unless requested otherwise, ownership of raw survey data, including point cloud data and TruView™ will remain with Plowman Craven. Ownership of the final model will reside with the Client.



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# 4 Levels of Model Detail and Model Information

**This section discusses what is shown, and what is omitted from the BIM model.**

Traditionally, a surveyor creating a 2D drawing or 3D model would be responsible for identifying a type of building element and its accurate geometry only. A BIM survey encourages the surveyor to provide much more information about the building due to the parametric tools of the software and a basic understanding of how the model is physically built.

When specifying the requirements for a BIM survey, it is essential to define (for each area of a project if necessary) the level of model detail and model information to be shown. Therefore a consideration when commissioning a BIM survey is to understand the difference between model detail and model information. BSI PAS 1192-2:2013 defines the following abbreviations:

> ***A.77 Levels Of model Detail (LOD)***
>
> Description of graphical content of models at each of the stages defined for example in the CIC Scope of Services.
>
> ***A.78 Levels Of model Information (LOI)***
>
> Description of non-graphical content of models at each of the stages defined for example in the CIC Scope of Services.

The resultant survey model will be a combination of detail and information and this will be considered as the overall **Level of Development**. Plowman Craven ranks differing Levels of Detail as incrementing through LOD 1, LOD 2, LOD 3 and LOD 4 and Levels of Information as LOI 100, LOI 200, LOI 300, LOI 400 and LOI 500.

***LOD + LOI = Level of Development***

## 4.1 Level of Detail (LOD)

When extracting elements such as walls and columns from the point cloud data, we must consider the nature of the building, for example heritage or modern office. It is important to agree on the level of interpretation and simplification to represent the structure and components of the building, e.g. whether it is necessary to model detailed architrave around a door frame. The amount of visual simplification applied to these different components in any given project is called their Level of Detail (LOD).

One of the significant benefits of laser scanning is that the point cloud data can be revisited at any time to extract further information as and when required. Additionally, variable levels of detail can be provided in different parts of the site or during different stages of the project, thus ensuring maximum cost efficiency.

In terms of the survey model LOD, there are four generic levels that can be provided, each building progressively over its predecessor. These Levels are described in this section. A more comprehensive breakdown of the Level of Detail to be shown in a model is described in Appendix A – Detail Check List with visual examples provided in Appendix B. Customised Levels of Detail can also be provided, up to and including the provision of separate structural, architectural and MEP models.





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### 4.1.1 LOD 1 – Mass Model

LOD 1 will be an outline overall mass model of the building, site or structure. It will contain no window or door openings, services or architectural detailing. In most instances, the Level of Information (LOI) can be no higher than LOI 100 as this type of model is primarily surface modelling.

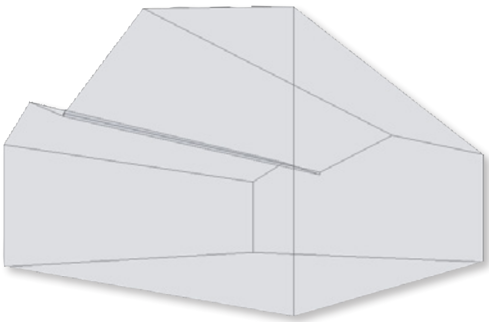

*Figure 5 – LOD 1 (Mass Model)*

### 4.1.2 LOD 2 – Shell and Core Model

An LOD 2 model will contain major structural components and openings in the building including floor slabs, columns, beams and structural openings of doors and windows in a basic form.

No services, architectural detailing or furnishings will be modelled, and no families will be built, although 2D symbols (LOI 100) can be placed in for some elements.

LOD 2 is intended as a base model with detailing as typically shown on a 1:200 survey.

The LOI applicable will only be to structural elements depending on the exposure of required elements on site.

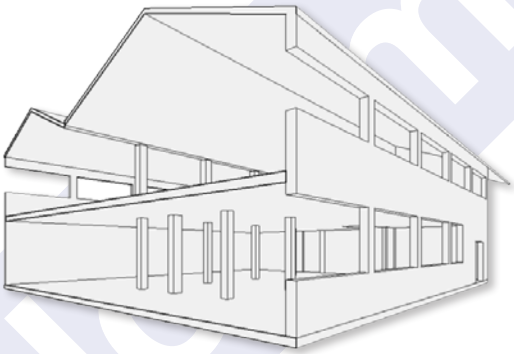

*Figure 6 – LOD 2 (Shell and Core Model)*

### 4.1.3 LOD 3 – Standard Survey Model

An LOD 3 model will additionally contain primary architectural details.

Basic families can be created for doors and windows, whilst major services can be modelled in outline form. Fixed furnishings and fittings can be modelled in simplified form if requested.

In general terms, the model will be developed sufficiently to show enough detail to generate 1:50 or 1:100 scale survey plans, sections and elevations, subject to discussion and agreement with the Client.

*Figure 7 - LOD 3 (Standard Survey model)*

*Note that LOD 3 is deemed to be the "typical" level of detail which will be provided by the survey in the absence of an instruction to the contrary.*

### 4.1.4 LOD 4 – Detailed Survey Model

An LOD 4 model will additionally contain detailed architectural and structural elements. Major and minor services can be modelled and there can be a higher level of detail in families and fixed furnishings.

Additional details could include skirting, architraves, rails and heaters or significant surface finishes.

If required, an investigative survey may be carried out above false ceilings. LOD 4 is akin to the detailing typically shown on a 1:50 or even 1:20 survey where specified in places. If required, and agreed prior to commencement of the project, individual structural, architectural and MEP Revit® models can be produced and coordinated.

*Figure 8 – LOD 4 (Detailed Survey model)*





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## 4.2 Level of Information (LOI)

For every element created in the BIM survey model, there is a requirement to attain and input certain information to each and every element.

As a survey is responsible for providing accurate information of the building, a minimum level of information must be acquired and input in to the model.

The table below shows what will be captured and input at the various Levels of Information:

| | |
|---|---|
| LOI 100 | Model Category and Position (2D symbol only) |
| LOI 200 | Model Category, Position + Size |
| LOI 300 | Model Category, Position, Size + Type |
| LOI 400 | Model Category, Position, Size, Type + Visual Observations* |
| LOI 500 | Model Category, Position, Size, Type, Visual Observation and/or FM Data |

**Visual observations refer to specific characteristics of the element that can be identified using plain sight (non-intrusive) methods. These will be noted as a family text parameter and will require prior clarification and understanding before confirming deliverables.*

LOI 100, LOI 200 and LOI 300 are all geometry based inputs. LOI 400 can be achieved in the model from visual observations taken on site if feasible. LOI 500 would require access to third-party information supplied by the Client or others. Examples of such inputs are provided in Appendix B.





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# 5 Accuracy and Modelling Tolerances

**Prior to commencement of a survey, a clear understanding of accuracy requirements must be understood by all parties. In addition to outright accuracy, the level of interpretation and modelling tolerances required by the project must also be agreed and understood.**

It is important to understand the differences between survey accuracy and modelling tolerances in the context of laser scanning and subsequent modelling of a building or structure.

## 5.1 Survey Accuracy

This section discusses the accuracy of the underlying point cloud survey.

Accuracy refers to the closeness of the survey measurements and point cloud to their real world position.

In relation to a laser scan survey for BIM purposes, accuracy of the laser scan survey can be influenced by a number of underlying factors, such as the accuracy of the survey control network, the accuracy of the individual instrumentation being used, or the accuracy of registering the individual laser scans onto the control framework.

In the context of this document it is inappropriate to examine the subject of survey accuracy in more detail, other than to relate the accuracy to the traditional presentation scale of a 2D representation of the building.

In general terms, the absolute plan position of well-defined detail extracted from fully controlled surveys shall be correct to within 0.3 mm r.m.s.e. (root-mean-square error) at the plan scale when checked from the nearest survey control station on that floor.

For example, survey accuracy of 15mm for an equivalent presentation scale of 1:50

**(0.3 mm x 50 = 15mm).**





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## 5.2 Modelling Tolerances

This section discusses the level of interpretation and simplification of the point cloud data into parametric Revit® objects, considering the deviation of walls from the horizontal or vertical plane.

### 5.2.1 Interpretation of Data

Having determined the underlying accuracy of the point cloud, we then consider the interpretation of walls and other building components from the point cloud data. Due to the nature of the dataset Plowman Craven will always create structure and components as best fit to the point cloud and will round any measurements to the nearest 5mm.

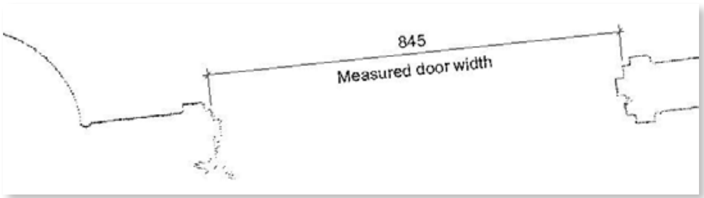


*Figure 9 - Rounding of scan data measurements*

### 5.2.2 Deviations

Thought must then be given to the deviation of walls, floors, ceilings and other planar surfaces, by considering the degree to which their modelled alignment relates to the scan data in all X, Y and Z axes.

For example, a wall which is bowing:

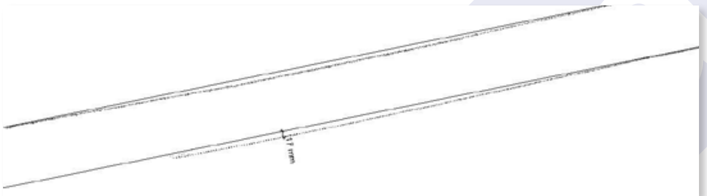

*Figure 10 – Horizontal deviation between model and point cloud*

or a failed ceiling which is sagging:

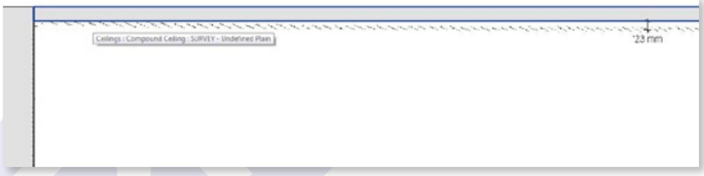


*Figure 11 – Vertical deviation between model and point cloud*

The most effective method of dealing with such deviations is to define the maximum tolerance by which the point cloud data will be allowed to deviate from the interpreted finish face before taking further action.

Plowman Craven defines the maximum allowable deviation for each project against one of the following tolerance levels:

**Low-level tolerance** - model data constructed to a tolerance of 60mm of the point cloud

**Mid-level tolerance** - model data constructed to a tolerance of 30mm of the point cloud

**High-level tolerance** - model data constructed to a tolerance of 15mm of the point cloud

Should the model and point cloud deviate by more than the tolerance allows, a lateral and/or vertical deviation will be recorded as a shared parameter in the Revit® model. Refer to Section 7.19 Plowman Craven Parameters for more detailed information on how these can be viewed within the delivered model.

In order to represent the uneven features of a building in a modelled form, it may be necessary to use more complex tools such as In-Place families and mass modelling rather than a straightforward planar wall element. This must be agreed with the Client prior to undertaking the survey.

### 5.2.3 Families and Repeating Details

To prevent a model containing vast amounts of Family Types with only slight dimensional differences, consideration will be given to repeating elements, such as windows and doors, that are similar in size and design. These will be modelled as families with as few varying types as possible.

For example, it is assumed that most buildings are designed to have a set number of door and window types when constructed. When surveyed however, small differences can be identified in structural opening heights and widths. Rather than creating a family type for each small variation in size, an average measurement will be taken across all these similar elements and applied to the family type. Because of this there may be some families that appear not to be as accurate to the point cloud as others. The modelling tolerance will be considered before creating a new family type.

Due to the varying sizes of brick and blockwork such as imperial or metric, they will be considered but not accounted for when sizing structural openings. Plowman Craven will model families to exactly what is measured and rounded to the nearest 5mm.


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# 6 Appendix A – Detail Check List

**This Appendix provides a check list to be completed by the Client to form the basis of a specification of requirements for a BIM survey and model.**

The Client is requested to complete the check boxes according to requirements, whilst referring to relevant sections of the BIM Survey Specification and Reference Guide for further information. The submitted form will be used in conjunction with discussions and site meetings to provide an agreement on the survey specification.

## 6.1 Check List – Level of Development Matrix

The table below gives a summary of how each building element is visually represented within the model at different Levels of Detail (LOD) corresponding with the Level of Information (LOI) required. The red box indicates typical combination choices for LOD and LOI.

Refer to Appendix B – Detailed Modelling Methods and Considerations for visual examples of how each element will be modelled.

| | |
|---|---|
| **Name of Project:** | |
| **Client:** | |
| **Form Completed by:** | |
| **Date:** | |

| **FLOOR/SLAB** | | | **LEVEL OF INFORMATION** | | | | |
|---|---|---|---|---|---|---|---|
| **LEVEL OF DETAIL** | **Not Required** | ☐ | **LOI 100** | **LOI 200** | **LOI 300** | **LOI 400** | **LOI 500** |
| | **LOD 1** | Modelled as mass floor | ☐ | | | | |
| | **LOD 2** | Floor modelled from FFL to U/S of finish below (including ceiling void) | | ☐ | | | |
| | **LOD 3** | Floor modelled showing overall thickness of floor structure (excluding ceiling void) | | | ☐ | ☐ | ☐ |
| | **LOD 4** | As LOD 3 showing additional details such as joists, penetrations and access panels | | | ☐ | ☐ | ☐ |

**Comments:**

| **WALLS** | | | **LEVEL OF INFORMATION** | | | | |
|---|---|---|---|---|---|---|---|
| **LEVEL OF DETAIL** | **Not Required** | ☐ | **LOI 100** | **LOI 200** | **LOI 300** | **LOI 400** | **LOI 500** |
| | **LOD 1** | External wall faces modelled as massing object | ☐ | | | | |
| | **LOD 2** | Structural walls modelled indicating overall thickness | | ☐ | ☐ | ☐ | ☐ |
| | **LOD 3** | All walls modelled indicating overall thickness | | ☐ | ☐ | ☐ | ☐ |
| | **LOD 4** | All walls modelled indicating overall thickness and ornate details | | ☐ | ☐ | ☐ | ☐ |

**Comments:**



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| STRUCTURE | | | LEVEL OF INFORMATION | | | | |
|---|---|---|---|---|---|---|---|
| LEVEL OF DETAIL | Not Required | ☐ | LOI 100 | LOI 200 | LOI 300 | LOI 400 | LOI 500 |
| | LOD 1 | N/A | | | | | |
| | LOD 2 | Primary beams, trusses and columns modelled in simple form | | ☐ | ☐ | ☐ | ☐ |
| | LOD 3 | As LOD 2 showing column/beam profiles and lightening/service penetrations | | ☐ | ☐ | ☐ | ☐ |
| | LOD 4 | As LOD 3 showing additional secondary structure, supports and plinths | | ☐ | ☐ | ☐ | ☐ |

**Comments:**

| CEILINGS/BULKHEADS | | | LEVEL OF INFORMATION | | | | |
|---|---|---|---|---|---|---|---|
| LEVEL OF DETAIL | Not Required | ☐ | LOI 100 | LOI 200 | LOI 300 | LOI 400 | LOI 500 |
| | LOD 1 | N/A | | | | | |
| | LOD 2 | As LOD 1 floor | ☐ | | | | |
| | LOD 3 | Modelled as ‘basic ceiling’ with ceiling void identified | | ☐ | ☐ | ☐ | ☐ |
| | LOD 4 | Ornate ceilings modelled as In-Place families. Ceiling tiles shown if requested | | ☐ | ☐ | ☐ | ☐ |

**Comments:**

| ROOF | | | LEVEL OF INFORMATION | | | | |
|---|---|---|---|---|---|---|---|
| LEVEL OF DETAIL | Not Required | ☐ | LOI 100 | LOI 200 | LOI 300 | LOI 400 | LOI 500 |
| | LOD 1 | Roof faces modelled as massing object | ☐ | | | | |
| | LOD 2 | Modelled as system roof showing overall thickness of construction | | ☐ | ☐ | ☐ | ☐ |
| | LOD 3 | Modelled as system roof showing detail such as trusses, joists and purlins | | ☐ | ☐ | ☐ | ☐ |
| | LOD 4 | Modelled as LOD 3 showing additional detail such as coping and flashing | | ☐ | ☐ | ☐ | ☐ |

**Comments:**



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| GUTTERS/DOWNPIPES | | | LEVEL OF INFORMATION | | | | |
|---|---|---|---|---|---|---|---|
| LEVEL OF DETAIL | Not Required | ☐ | LOI 100 | LOI 200 | LOI 300 | LOI 400 | LOI 500 |
| | LOD 1 | N/A | | | | | |
| | LOD 2 | N/A | | | | | |
| | LOD 3 | Gutters and downpipes modelled in overall size and shape | | ☐ | ☐ | ☐ | ☐ |
| | LOD 4 | Gutters and downpipes modelled with profile of fittings | | ☐ | ☐ | ☐ | ☐ |

**Comments:**

| LIFTS | | | LEVEL OF INFORMATION | | | | |
|---|---|---|---|---|---|---|---|
| LEVEL OF DETAIL | Not Required | ☐ | LOI 100 | LOI 200 | LOI 300 | LOI 400 | LOI 500 |
| | LOD 1 | N/A | | | | | |
| | LOD 2 | Modelled using default lift family showing core and lift opening | | ☐ | | | |
| | LOD 3 | Modelled using default lift family showing core, door and generic lift object | | | ☐ | ☐ | ☐ |
| | LOD 4 | Modelled using default lift family showing core, door and internal lift dimensions | | | ☐ | ☐ | ☐ |

**Comments:**

| STAIRS | | | LEVEL OF INFORMATION | | | | |
|---|---|---|---|---|---|---|---|
| LEVEL OF DETAIL | Not Required | ☐ | LOI 100 | LOI 200 | LOI 300 | LOI 400 | LOI 500 |
| | LOD 1 | N/A | | | | | |
| | LOD 2 | Stairs typically modelled as monolithic stair | | ☐ | ☐ | ☐ | ☐ |
| | LOD 3 | As LOD 2 showing hand rails and stair type | | ☐ | ☐ | ☐ | ☐ |
| | LOD 4 | As LOD 3 showing additional detail such as stair nosing and railings | | ☐ | ☐ | ☐ | ☐ |

**Comments:**



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| DOORS AND WINDOWS | | | LEVEL OF INFORMATION | | | | |
|---|---|---|---|---|---|---|---|
| LEVEL OF DETAIL | Not Required | ☐ | LOI 100 | LOI 200 | LOI 300 | LOI 400 | LOI 500 |
| | LOD 1 | N/A | | | | | |
| | LOD 2 | Structural openings shown only | | ☐ | | | |
| | LOD 3 | Modelled using generic families with basic detail | | | ☐ | ☐ | ☐ |
| | LOD 4 | Modelled using generic families showing detail such as sills, frames and architraves | | | ☐ | ☐ | ☐ |

**Comments:**

| SITE TOPOGRAPHY | | | | LEVEL OF INFORMATION | | | | |
|---|---|---|---|---|---|---|---|---|
| LEVEL OF DETAIL | Not Required | ☐ | Linked AutoCAD ☐ | LOI 100 | LOI 200 | LOI 300 | LOI 400 | LOI 500 |
| | LOD 1 | Topography shown as simplified contour Revit® surface | | ☐ | | | | |
| | LOD 2 | As LOD 1, with roads shown as sub-regions | | ☐ | | | | |
| | LOD 3 | As LOD 2, with all hard surfaces identified, including car parks and pavements | | ☐ | | | | |
| | LOD 4 | As LOD 3, with street furniture, lighting and surface evidence of underground services modelled in basic form | | | ☐ | | | |

**Comments:**

| UNDERGROUND SERVICES | | | LEVEL OF INFORMATION | | | | |
|---|---|---|---|---|---|---|---|
| LEVEL OF DETAIL | Not Required | ☐ | LOI 100 | LOI 200 | LOI 300 | LOI 400 | LOI 500 |
| | LOD 1 | N/A | | | | | |
| | LOD 2 | 3D CAD underground services and topographic survey as linked AutoCAD DWG | | ☐ | ☐ | | |
| | LOD 3 | Underground services modelled as intelligent Revit® objects | | ☐ | ☐ | | |
| | LOD 4 | N/A | | | | | |

**Comments:**


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| SERVICES MEP, HVAC AND PLANT | | | LEVEL OF INFORMATION | | | | |
|---|---|---|---|---|---|---|---|
| LEVEL OF DETAIL | Not Required | ☐ | LOI 100 | LOI 200 | LOI 300 | LOI 400 | LOI 500 |
| | LOD 1 | N/A | | | | | |
| | LOD 2 | Major plant items modelled to show overall size and position | | ☐ | ☐ | ☐ | ☐ |
| | LOD 3 | Major service runs modelled to show profile shape and position, and overall volume of large clusters | | ☐ | ☐ | ☐ | ☐ |
| | LOD 4 | Major and minor services modelled individually to show shape, size and position | | ☐ | ☐ | ☐ | ☐ |

Comments:

If LOD 3 or LOD 4 has been selected from the table above, please identify the specific services required in the table below:

| INDIVIDUAL SERVICES: MECHANICAL | | LEVEL OF INFORMATION | | | | |
|---|---|---|---|---|---|---|
| Not Required | ☐ | LOI 100 | LOI 200 | LOI 300 | LOI 400 | LOI 500 |
| Air Handling Units | | | ☐ | ☐ | ☐ | ☐ |
| Air Terminals | | | ☐ | ☐ | ☐ | ☐ |
| Ducts | | | ☐ | ☐ | ☐ | ☐ |
| Duct Fittings | | | ☐ | ☐ | ☐ | ☐ |
| Exhaust Flu | | | ☐ | ☐ | ☐ | ☐ |

Comments:

| INDIVIDUAL SERVICES: ELECTRICAL | | LEVEL OF INFORMATION | | | | |
|---|---|---|---|---|---|---|
| Not Required | ☐ | LOI 100 | LOI 200 | LOI 300 | LOI 400 | LOI 500 |
| Cable Trays | | | ☐ | ☐ | ☐ | ☐ |
| Conduit | | | ☐ | ☐ | ☐ | ☐ |
| Electrical Equipment | | | ☐ | ☐ | ☐ | ☐ |
| Electrical Fixtures | | | ☐ | ☐ | ☐ | ☐ |
| Fire Alarms | | | ☐ | ☐ | ☐ | ☐ |

Comments:



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| INDIVIDUAL SERVICES: PLUMBING | | LEVEL OF INFORMATION | | | | |
|---|---|---|---|---|---|---|
| Not Required | ☐ | LOI 100 | LOI 200 | LOI 300 | LOI 400 | LOI 500 |
| Drainage | | | ☐ | ☐ | ☐ | ☐ |
| Pipes | | | ☐ | ☐ | ☐ | ☐ |
| Pipe Fittings | | | ☐ | ☐ | ☐ | ☐ |
| Sprinkler Systems | | | ☐ | ☐ | ☐ | ☐ |
| Rainwater Pipes/Tanks | | | ☐ | ☐ | ☐ | ☐ |

**Comments:**

| FIXTURES, FURNISHINGS AND EQUIPMENT (FFE) | | | LEVEL OF INFORMATION | | | | |
|---|---|---|---|---|---|---|---|
| LEVEL OF DETAIL | Not Required | ☐ | LOI 100 | LOI 200 | LOI 300 | LOI 400 | LOI 500 |
| | LOD 1 | N/A | | | | | |
| | LOD 2 | Fixed cabinets and major equipment shown in 2D | ☐ | | | | |
| | LOD 3 | Fixed cabinets and major equipment modelled in overall volume to show size and position | | ☐ | ☐ | ☐ | ☐ |
| | LOD 4 | Fixed fixtures modelled in higher detail | | ☐ | ☐ | ☐ | ☐ |

**Comments:**





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**If LOD 2 , LOD 3 or LOD 4 has been selected from the previous table, please identify the specific services required in the table below:**

| INDIVIDUAL FFE | | LEVEL OF INFORMATION | | | | |
|---|---|---|---|---|---|---|
| Not Required | ☐ | LOI 100 | LOI 200 | LOI 300 | LOI 400 | LOI 500 |
| Storage Units/Cupboards | | ☐ | ☐ | ☐ | ☐ | ☐ |
| Soft Furnishings | | ☐ | ☐ | ☐ | ☐ | ☐ |
| Plumbing Fixtures | | ☐ | ☐ | ☐ | ☐ | ☐ |
| Toilet Cubicles | | ☐ | ☐ | ☐ | ☐ | ☐ |
| Retail Gondolas | | ☐ | ☐ | ☐ | ☐ | ☐ |
| Refrigeration/Mechanical Units | | ☐ | ☐ | ☐ | ☐ | ☐ |
| Display/Merchandising Units | | ☐ | ☐ | ☐ | ☐ | ☐ |
| Radiators | | ☐ | ☐ | ☐ | ☐ | ☐ |

**Comments:**

## 6.2 Check List – Modelling Tolerance

Specify the acceptable level of deviation the modelled objects can be from the point cloud data before having to alert the user. Refer to Section 5.2 Modelling Tolerances.

**Low-level tolerance** - model data constructed to a tolerance of 60mm of the point cloud ☐

**Mid-level tolerance** - model data constructed to a tolerance of 30mm of the point cloud ☐

**High-level tolerance** - model data constructed to a tolerance of 15mm of the point cloud ☐

## 6.3 Check List – Client Supplied Data

Specify whether existing base information is to be provided to assist the construction of the BIM model. Refer to Section 3.4 Other Survey Inputs.

Base drawing information to be provided by the Client: ☐

Please provide a brief description of the base data and/or drawings to be provided:

Please enter text:





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## 6.4 Check List – Point Cloud Density

Specify the required average point spacing, bearing in mind current and future potential uses for the scan data. Refer to Section 3.2.1 Point Cloud Density.

- Mass model, Rights of Light or level 1 / 2 models: Point spacing 20mm ☐
- Typical building or level 3 models: Point spacing 10mm ☐
- Heritage buildings or level 4 / 5 models: Point spacing 5mm ☐

## 6.5 Check List – Deliverables

Specify the key digital deliverables for the survey. Refer to Section 3.6 Delivery.

### Scan data

- Delivery of scan data not required: ☐
- Scan data to be delivered as PTS: ☐
- Scan data to be delivered as PCG: ☐
- Scan data to be delivered as E57: ☐
- Scan data to be delivered as POD: ☐
- Scan data to be delivered as IMP: ☐
- Scan data to be delivered as RCS: ☐

### TruView™

- TruView™ not required: ☐
- Greyscale TruView™ required: ☐
- Colour flash-panorama imagery required: ☐
- Colour TruView™ required: ☐

### Revit® Model

- Revit® Architecture: ☐
- Revit® Structure: ☐
- Revit® MEP: ☐

## 6.6 Check List – Common Data Environment (CDE)

Specify whether the project will be PAS 1192-2:2013 compliant thus requiring a CDE to be hosted and managed by Plowman Craven, or simply created and delivered to the Client. Refer to Section 3.7.

- CDE to be created hosted and managed by Plowman Craven: ☐
- CDE to be created for Client to manage: ☐

## 6.7 Check List – TruView™ Hosting

Specify whether the TruView™ virtual site investigation tool is to be hosted by Plowman Craven, or delivered in its entirety to the Client. Refer to Section 3.6.

- TruView™ to be hosted on Plowman Craven web server: ☐
- TruView™ to be hosted by Client: ☐

## 6.8 Check List – Coordinate Systems and Units

Specify the planimetric coordinate system and height datum to be used for the project. Refer to Section 3.1 Survey Control Framework.

- Plan Control: OS National Grid: ☐
- Plan Control: Local Project Grid: ☐
- Height Control: Ordnance Datum Newlyn: ☐
- Height Control: Local Datum: ☐

## 6.9 Check List – Project North

Specify the rotation of Project North from True North:

| |
|---|
| Please enter text: |

## 6.10 Check List – Templates

Specify whether a Client template will be provided. Refer to section 7.17 Templates.

- Client supplied template to be used: ☐
- COBie template to be integrated: ☐



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## 6.11 Check List – 2D Views and Sheets

Specify whether 2D Views and Sheets are required for plans, elevations and sections. Refer to Appendix B 2D Views and Sheets.

Basic (no annotation) 2D views required for plans, elevations and sections: ☐

Detailed, fully annotated 2D drawings required for plans, elevations and sections: ☐

Please provide a brief description of the 2D Views required:

Please enter text:

## 6.12 Check List – Software Version

Specify the software version for delivery of the BIM model. Refer to Section 8.3 Exporting the Revit Model.

Required Revit® version:

2012: ☐ 2013: ☐ 2014: ☐ 2015: ☐ 2016: ☐

Conversion required:

IFC: ☐ NWF: ☐ DGN: ☐ DWG: ☐ VWX: ☐

## 6.13 Sign-Off

Specification signed and agreed:

| |
|---|
| Name: |
| Company: |
| Email: |
| Telephone: |
| Date: |





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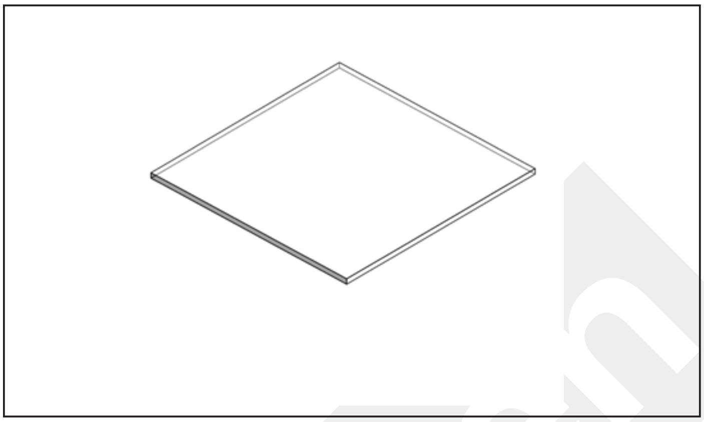
# 7 Appendix B – Detailed Modelling Methods and Considerations

**This Appendix provides a more detailed description of the modelling techniques used for the primary surveyed building components specified in the LOD or otherwise agreed with the Client. It also contains a description of more detailed aspects of BIM modelling that need to be considered as part of the BIM Survey Specification. Examples are also given for typical parameters which would be included at each LOI.**

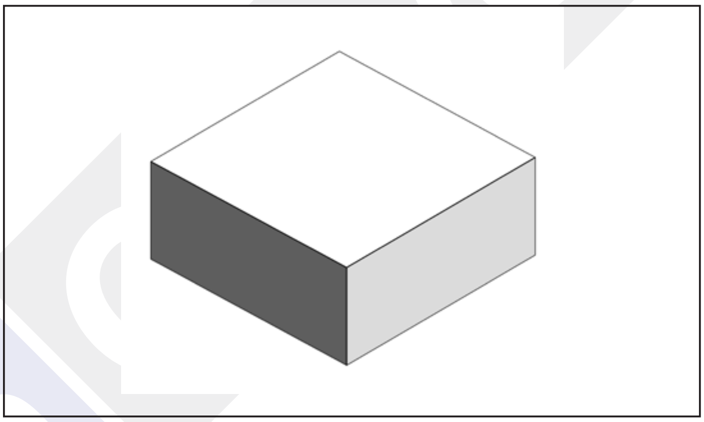
This section should be used for reference by the Client's BIM Manager or Technical Team in order to agree and understand the precise method used to model the building. It is imperative to agree modelling methods prior to a survey being taken as re-work of the model can incur significant costs and delays.

## 7.1 Floors/Slab

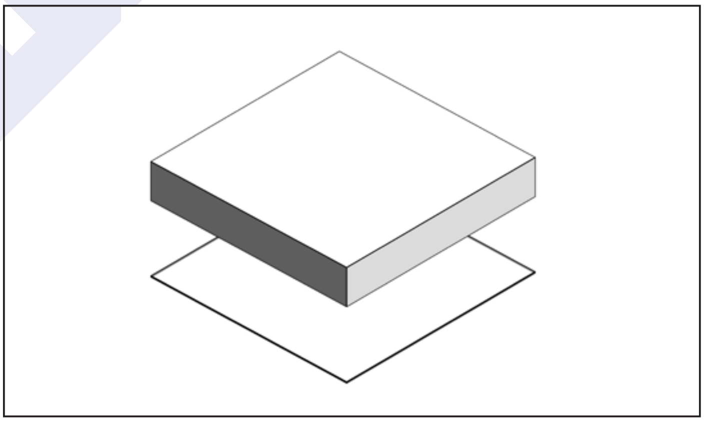
All floors and slabs will be modelled using the Revit® System Family: Floors. In some instances, or where appropriate, floors may have to be modelled In-Place. The floor will be referenced to the appropriate Level and given an overall thickness from Finished Floor Level (FFL) to Underside of Slab - or to that which was measured or visible at the time of survey. In many instances floor thicknesses cannot be ascertained from a survey due to finishes, etc., therefore a floor will be given a nominal thickness and named as 'undefined'.



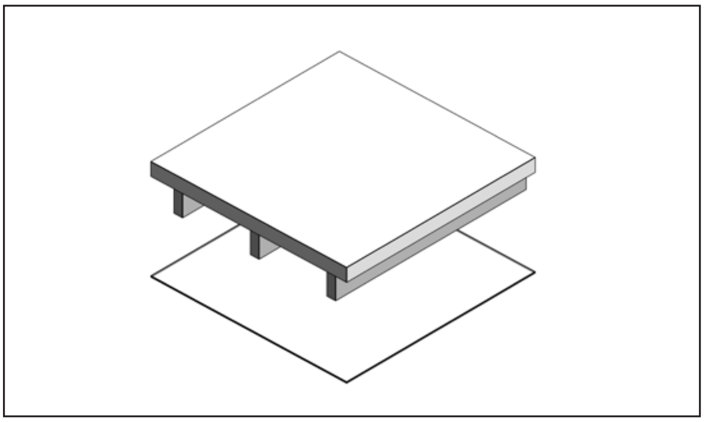
LOD 1



LOD 2



LOD 3



LOD 4

## Typical Levels of Information

| | |
|---|---|
| LOI 100 | Conceptual Mass |
| LOI 200 | Floor: SURVEY 180mm |
| LOI 300 | Floor: SURVEY STRUCTURAL 180mm |
| LOI 400 | Floor: SURVEY STRUCTURAL 180mm [Carpet] |
| LOI 500 | Floor: SURVEY STRUCTURAL 180mm [75mm Sand/Cement Screed] |



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Floors will be modelled such that they finish to the inside of external or core walls where possible.

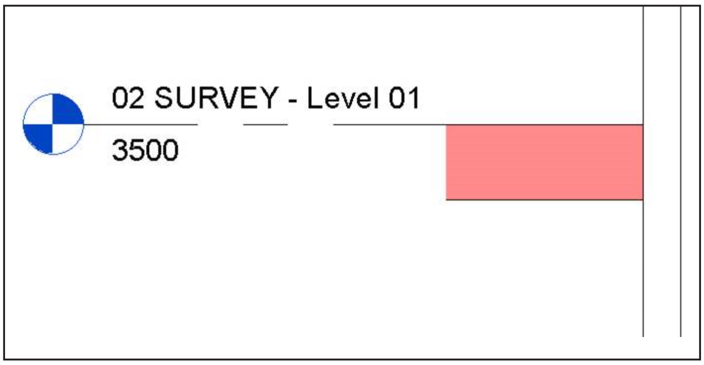


*Figure 12 - Floor construction to inside of core walls*

To ensure all walls sit on a base, floors will finish to the external face of undefined walls.

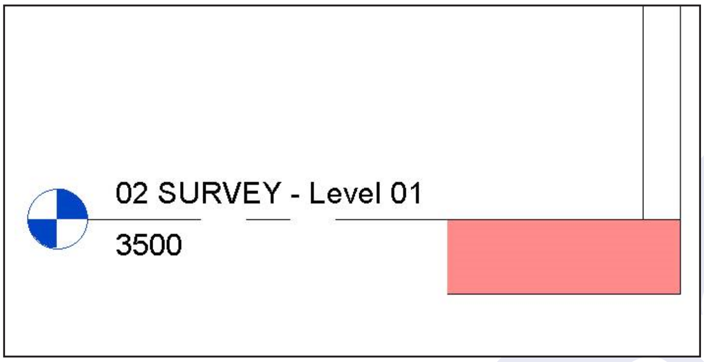


*Figure 13 - Floor construction to external face of undefined walls*

## Architectural

Generally floors will be modelled as architectural floors. If specified and ascertainable, the floor slabs can be split into architectural and structural slabs.

## Structural

A structural floor will only be modelled when it is easily identifiable or indicated by the Client as a structural floor slab (such as concrete).

## Floor Boundaries

Floors will be modelled in a zone format as per the measured height. The sketch lines for the floor boundary will be defined by the internal face of the bounding walls.

## Sub-Elements

Falls and slopes can be modelled into the floor slabs by modifying its sub-elements. This is not usually recommended as it can severely reduce the performance of the model. However, with careful consideration to the project and Client requirements, it can be decided prior to commencement of the survey.

## Visual Observations

Some of the typical visual observations that can be made with floors include materials, finishes and any specific corresponding condition report. There may also be unique identifiers or requirements specific to a project that can be visually observed during the survey.  These can be applied subject to a clear understanding of the scope from the outset.





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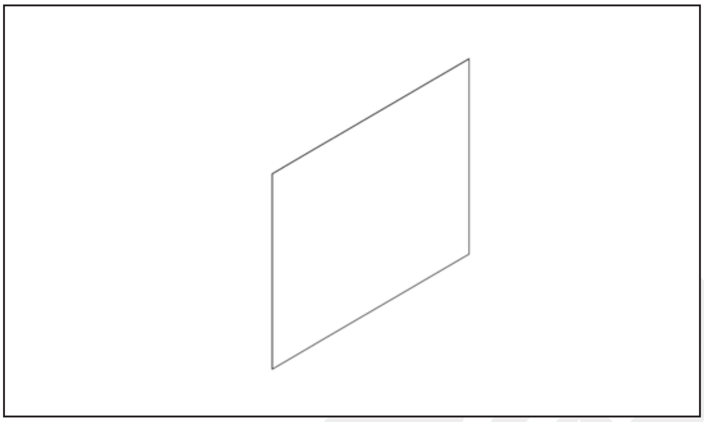
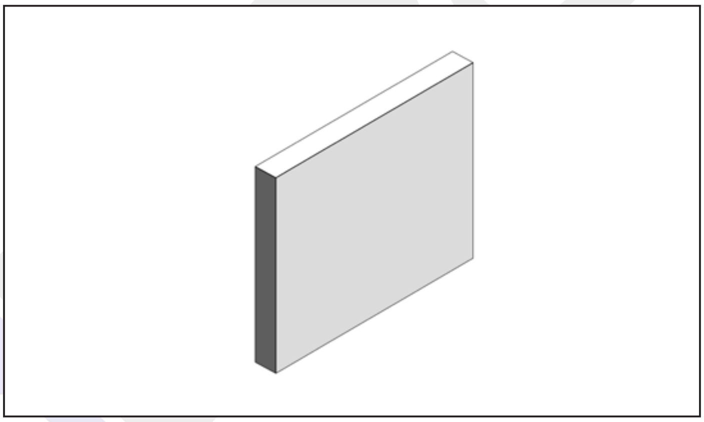
## 7.2 Walls

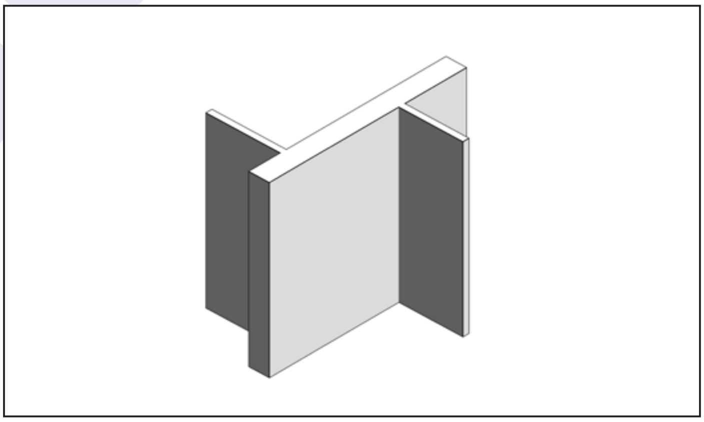
Walls will be referenced to the appropriate Levels and given an overall thickness based on the measured data. In many instances wall thicknesses cannot be ascertained from the measurement survey due to finishes, obstructions, access restrictions, etc. In instances where it is not possible to measure or locate both sides of a wall, the hidden wall line will be clearly identified. Depending on the location and purpose of the wall, it will be given a nominal thickness and named as 'undefined thick' or 'undefined thin'.



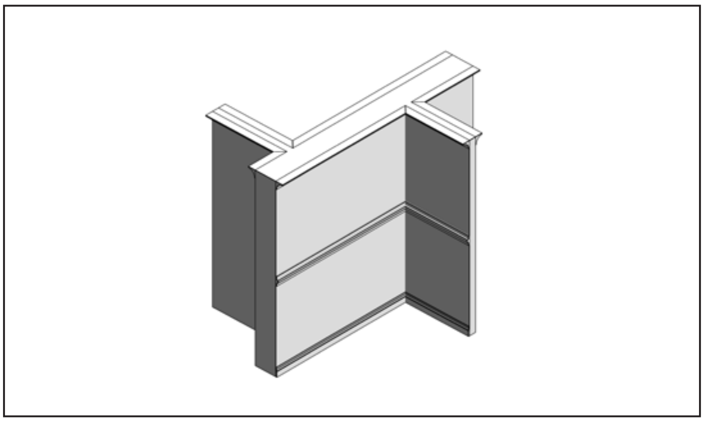
LOD 1



LOD 2



LOD 3



LOD 4

## Typical Levels of Information

| | |
|---|---|
| LOI 100 | Conceptual Mass |
| LOI 200 | Basic Wall: SURVEY 140mm |
| LOI 300 | Basic Wall: SURVEY INTERNAL 140mm |
| LOI 400 | Basic Wall: SURVEY INTERNAL 140mm [Plaster] |
| LOI 500 | Basic Wall: SURVEY INTERNAL 140mm [90mm Stud Acoustic] |





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## Architectural

Generally most walls will be modelled as architectural walls. All partitions will be modelled from the Revit® level to either the underside of the ceiling or as far as measurement is achieved.

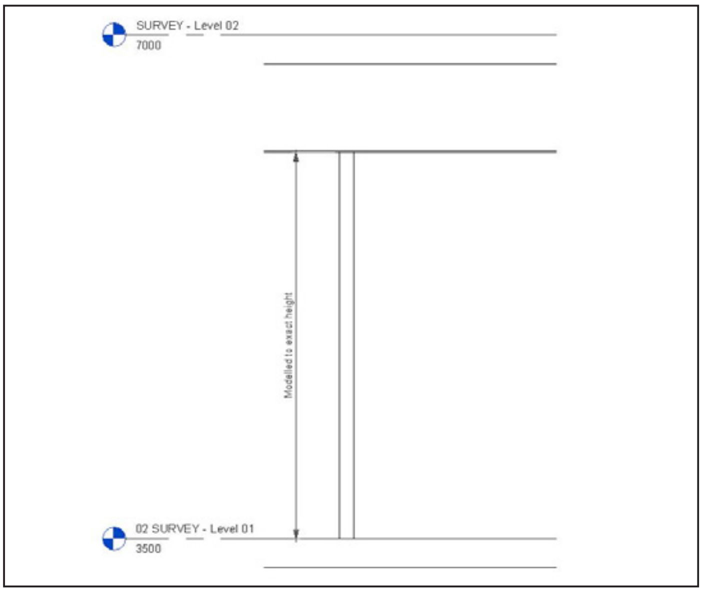


*Figure 14 - Partition wall to false ceiling*

## Structural / Core

To ensure model integrity, walls that are obviously core walls or riser walls (such as lift shafts) will be modelled from the Revit® level to the underside of the above floor slab, even if it is not possible to confirm this at time of survey. Walls will not be attached to the slab or floor.

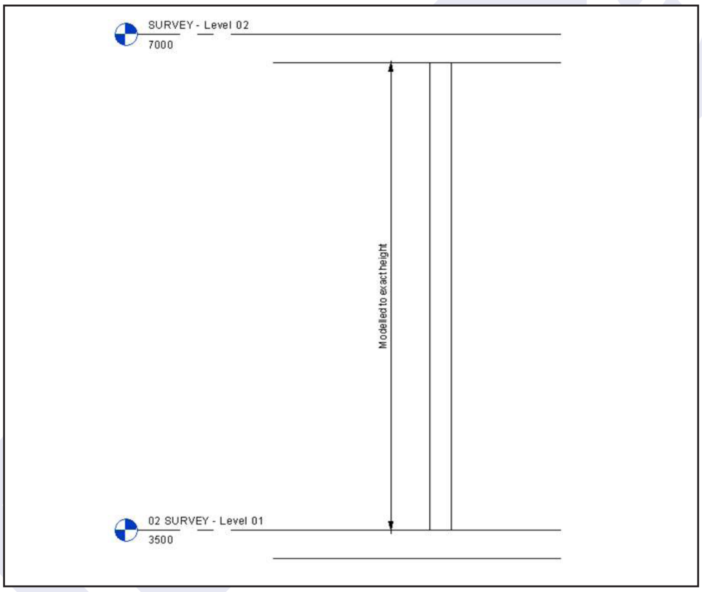


*Figure 15 - Structural wall slab to slab*

## External

External walls will be modelled as sheer walls as much as possible to suit the building façade. Every attempt will be made to make the build-up of the façade to suit the assumed construction of the building. The use of stacked walls will be generally avoided.

## Location Line

The location line of any wall will either be external or internal face as appropriate. The wall face with greatest point cloud coverage will be used for this.

## Wall Profile

There will be instances where a wall must have its profile modified to suit the situation. This can hinder performance of the model and modification will be applied as a last resort.

## Special Conditions

Walls are generally modelled as flat and upright but if required specified walls can be modelled to their true form showing leaning or warping. This can incur greater modelling time and must be agreed prior to commencement of survey. Refer to Section 5.2 Modelling Tolerances for more information.

## Visual Observations

Some of the typical visual observations that can be made with walls include materials, finishes and any specific corresponding condition report. There may also be unique identifiers or requirements specific to a project that can be visually observed during the survey. These can be applied subject to a clear understanding of the scope from the outset.



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## 7.3 Curtain Walls

The curtain wall feature is a powerful tool and quick to manipulate. The use of curtain walls will be carefully considered beforehand to ensure it appropriately reflects the construction of the built element.

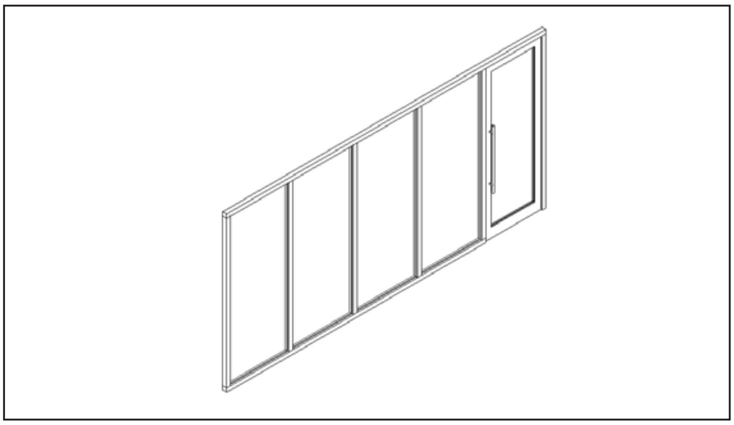

*Figure 16 - Simple curtain wall*

### Grids and Mullions

Curtain grids will be positioned to match a consistent spacing as much as possible. Mullions placed on these grids will be set to the nearest 10mm overall dimensions. Generally, one mullion size will be used per curtain wall unless a substantial variation is measured.

### Panels

Curtain panels will usually be a single glass panel at a nominal thickness. Where appropriate, in-fill or spandrel panels will be used to match the depth of the mullions, depending on what is measured.

### Location Line

The location line of a curtain wall can play a very important role in determining areas and offsets for all elements embedded in the curtain wall. Usually the location line will be set to the centre of the curtain wall but this may vary due to the nature of the model. It is up to the Client to check this before modifying and calculating areas.

### Embedding

Curtain walls will be automatically set to embed into basic walls.





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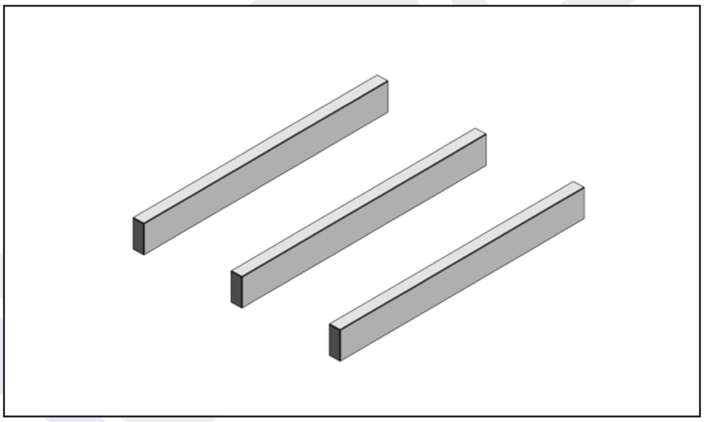
## 7.4 Structure

Unless the building is completely stripped-out prior to survey, the structure is often completely or partially obstructed by architectural finishes. Plowman Craven will endeavour to capture all structural elements of the building during survey. However, structural elements cannot be modelled if completely hidden from view and therefore will not be modelled. If structural elements can be identified but they are encased in finishes or fireproofing, the overall geometry as measured will be modelled.

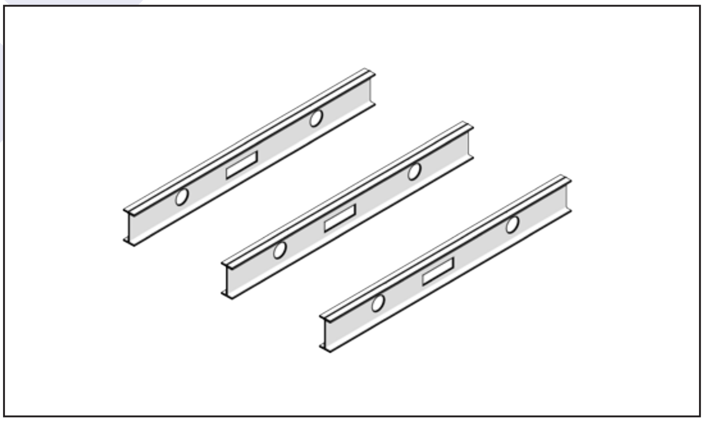
Where false ceilings partially obstruct visibility to a structure, a basic ceiling will be added to a model to highlight that structural features might not be visible in the scan.

N/A

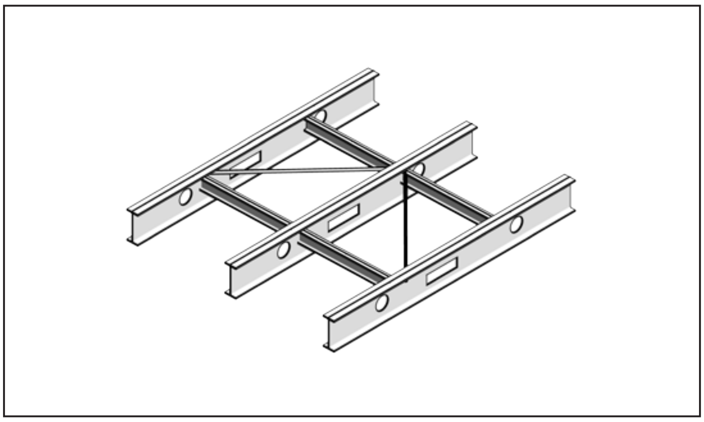
*LOD 1*



*LOD 2*



*LOD 3*



*LOD 4*

## Typical Levels of Information

| | |
|---|---|
| LOI 100 | N/A |
| LOI 200 | Structural Framing: SURVEY Beam: 300 x 400mm |
| LOI 300 | Structural Framing: SURVEY Universal Beam: 300 x 400mm |
| LOI 400 | Structural Framing: SURVEY Universal Beam: 300 x 400mm [Steel] |
| LOI 500 | Structural Framing: SURVEY Universal Beam: 300 x 400mm [283lb/$ft^3$] |

### Beams

Structural beams will be modelled using the most appropriate profile from the standard Revit® library. In many cases the entire length of a beam is not visible and cannot be measured, therefore Plowman Craven will always connect beams from one structural element to another. The automatic join condition will be used in most cases. Service penetrations will be modelled as structural openings.

### Columns

Structural columns will be modelled in a similar fashion to beams. All columns will be modelled from the associated reference level to the level above, even if not visible at the time of survey. Repeating column details will be modelled as a single column family type if feasible and applied to the most appropriate that Plowman Craven can determine.

### Visual Observations

Some of the typical visual observations that can be made with structure include materials, finishes, fire-proofing and any specific corresponding condition report. There may also be unique identifiers or requirements specific to a project that can be visually observed during the survey. These can be applied subject to a clear understanding of the scope from the outset.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## 7.5 Ceilings and Bulkheads

False ceilings will generally be modelled as a ‘plain - undefined’ System Family: Ceiling with a nominal thickness of 10mm. Complex ornate ceilings may be modelled as an In-Place family. All partition walls will connect to the underside of false ceilings except for core or riser walls. Columns will be joined to ceilings to create the penetration outline of the ceiling.

## Typical Levels of Information

| | |
|---|---|
| LOI 100 | Basic Ceiling: Generic |
| LOI 200 | Compound Ceiling: SURVEY - 50mm |
| LOI 300 | Compound Ceiling: SURVEY - 50mm [600 x 600mm Grid] |
| LOI 400 | Compound Ceiling: SURVEY - 50mm [600 x 600mm Grid]_[Metal] |
| LOI 500 | Compound Ceiling: SURVEY - 50mm [600 x 600mm Grid]_[Acoustic] |

Ornate ceilings with high level of detail (LOD 4) will usually be modelled In-Place.

### Ceiling Boundaries

Ceilings will be modelled in a zone format as per the measured height rather than as a per room basis. The sketch lines for the ceiling boundary will be defined by the internal face of the bounding walls.

### Ceiling Tiles

Ceiling tiles or patterns can be measured and shown as a surface pattern on a ceiling. Ceiling tiles will not be lifted, and ceiling void surveys are not carried out unless specifically requested and agreed.

### Ceiling Fixtures

Ceiling fixtures such as lighting, AC, sprinklers, fans and so on can be shown as simple families or 2D line work. Basic families will be used showing overall dimensions.

### Bulkheads

Bulkheads can be modelled in two ways depending on the circumstances and assumptions of the building. If a bulkhead is assumed to be casing a beam or a structural member such as a truss, it will be modelled as a structural beam element with its reference point at the highest point measured such as undersides of slabs, ceilings or roof above. In all other cases, bulkheads will be modelled as joined walls and ceilings.

### Visual Observations

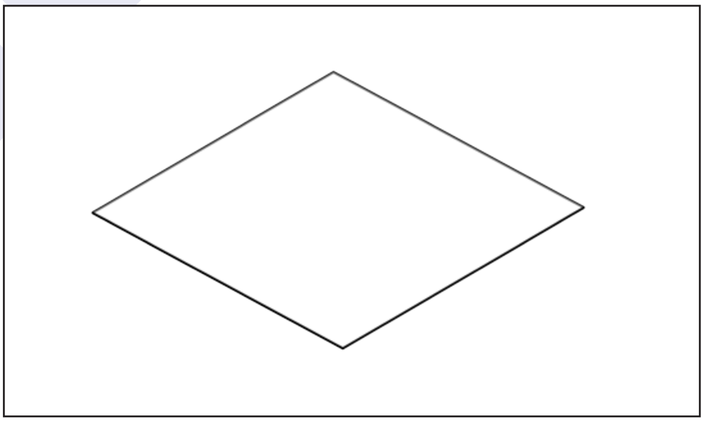
Some of the typical visual observations that can be made with ceilings include materials, finishes and any specific corresponding condition report. There may also be unique identifiers or requirements specific to a project that can be visually observed during the survey. These can be applied subject to a clear understanding of the scope from the outset.

N/A

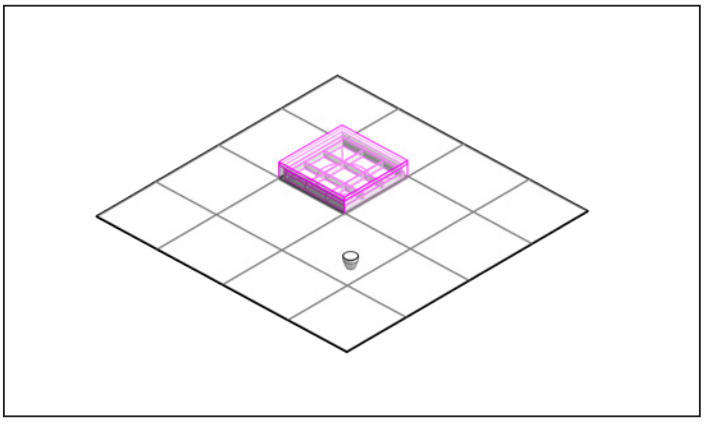
*LOD 1*

N/A

*LOD 2*



*LOD 3*



*LOD 4*



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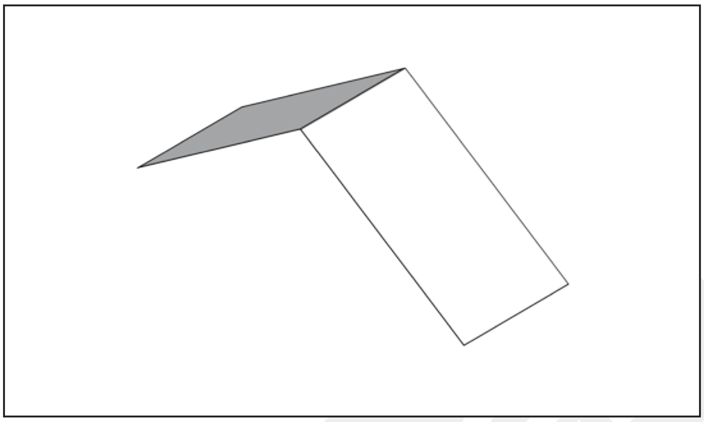
## 7.6 Roofs

Roofs will be modelled as a System Family: Basic Roof or Sloped Glazing modelled to the overall measured thickness (usually from the outer finish to the underside of steel or timber rafters).

In higher detail (LOD 4 and 5) rafters and trusses can be modelled if requested and if accessible at the time of survey.

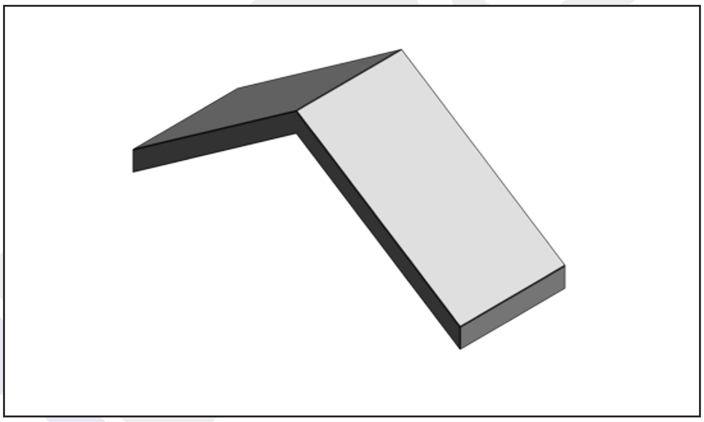
In many cases, a roof thickness may not be measurable and will be given a nominal thickness and named as 'undefined'. Complex roof structures will be modelled as In-Place to achieve the desired geometry.



*LOD 1*

### Typical Levels of Information

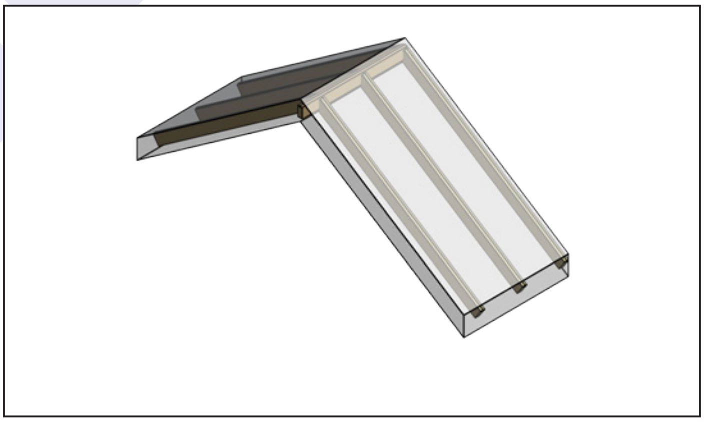
| | |
|---|---|
| LOI 100 | Conceptual Mass |
| LOI 200 | Roofs: Basic Roof: SURVEY - 150mm |
| LOI 300 | Roofs: Basic Roof: SURVEY Gable - 150mm |
| LOI 400 | Roofs: Basic Roof: SURVEY Gable - 150mm [Tiled] |
| LOI 500 | Roofs: Basic Roof: SURVEY Gable - 150mm [Live load = 0.57 kN/m²] |



*LOD 2*

### Roof Footprint/Extrusion and Defining Slopes

Depending on the complexity of the roof, it may be modelled as an extrusion, a footprint with defining slopes, modelled In-Place, or a combination of all three. The defining slope will be rounded to the nearest 0.5° as per the point cloud or measured ridge height shows.



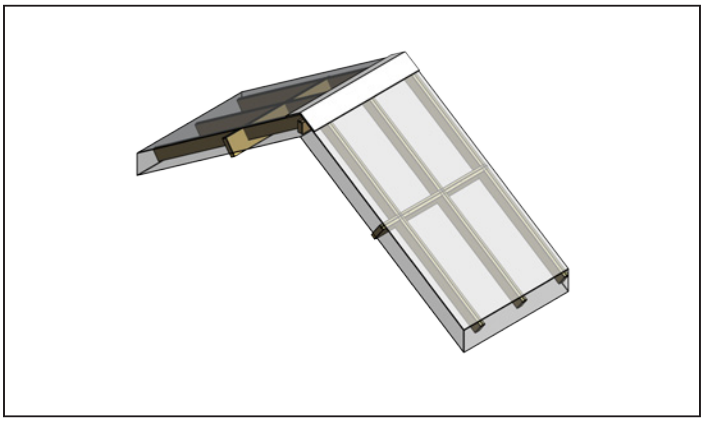
*LOD 3*

### Dormers

Dormers will be modelled using the dormer tool where possible. Depending on roof void access, roof dormers may be modelled to suit measured external dimensions, but may not reflect internal geometry correctly.

### Visual Observations

Some of the typical visual observations that can be made with roofs include materials, finishes, health & safety/access issues and any specific corresponding condition report. There may also be unique identifiers or requirements specific to a project: these can be applied subject to a clear understanding of the scope from the outset.



*LOD 4*



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## 7.7 Gutters and Downpipes

In many cases, gutters are concealed and generally difficult to capture due to the constraints of roof access. All measured gutters will be modelled using the roof gutter tool and the profiles will be an overall dimension. Falls in gutters and drainage will not be modelled. Downpipes will be modelled as In-Place families showing over path and profile.

### Typical Levels of Information

| | |
|---|---|
| LOI 100 | N/A |
| LOI 200 | Gutter: SURVEY Gutter - 125 x 125mm |
| LOI 300 | Gutter: SURVEY Gutter Bevel - 125 x 125mm |
| LOI 400 | Gutter: SURVEY Gutter Bevel - 125 x 125mm [Zinc] |
| LOI 500 | Gutter: SURVEY Gutter Bevel - 125 x 125mm [Max area = 124m²] |

N/A

*LOD 1*

N/A

*LOD 2*

*LOD 3*

*LOD 4*



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## 7.8 Lifts

Unless specified by the Client, the internal of lift cores and risers are not scanned or measured during a survey. Therefore these spaces or shafts will be enclosed by undefined walls. However, lift doors and riser access panels will generally be modelled.

Lift doors will be modelled using the generic Lift Family, simplified to show a dashed notional line in plan. If a lift car is measured internally, it will be displayed to the measured dimensions in plan as a solid line. Door trim can be shown to the correct size but call points will not be shown unless requested.

All attempts will be made to ensure lift and riser walls rise vertically from lift pit to lift overrun but due to various build-ups of shaft walls, this may not be possible, hence the creation of separate walls on a floor-by-floor basis.

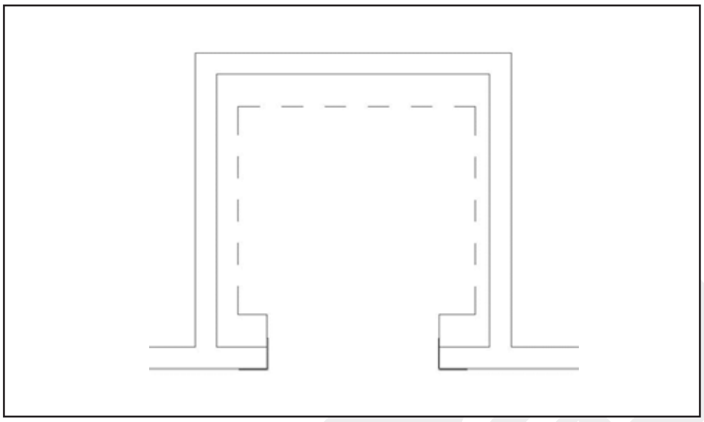

*Figure 17 - Lift core and car*

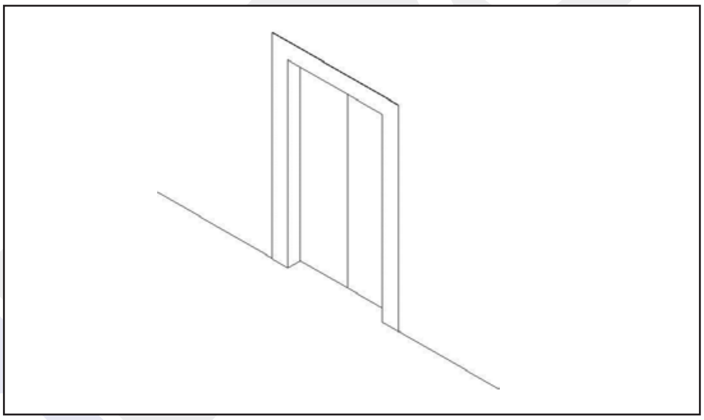

*Figure 18 - Lift doors*





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## 7.9 Stairs

Generally, simple stairs will be modelled using the stair tool within Revit®. Depending on the complexity of the stairs, they may have to be modelled as In-Place and these will be placed under the category of floors.

### Typical Levels of Information

| | |
|---|---|
| LOI 100 | N/A |
| LOI 200 | Stair: Cast In-Place stair:<br>SURVEY MONOLITHIC - 150mm |
| LOI 300 | Stair: Assembled stair: SURVEY OPEN - 150mm |
| LOI 400 | Stair: Assembled stair:<br>SURVEY OPEN - 150mm_[Fire escape] |
| LOI 500 | Stair: Assembled stair:<br>SURVEY OPEN - 150mm _[UDL 3 kN/m²] |

### Monolithic

Unless otherwise easily identifiable from the survey, all stairs will be modelled as monolithic stairs. The thickness of the stairs will be adjusted to best fit but should not be relied upon. Refer to the point cloud or 2D drawings for more accurate data.

### Open

Steel or timber stairs (with stringers) can be modelled as such, so long as this is specified prior to scanning, and subject to capture of suitable scan data at time of survey. The dimensions of the stringers and tread depths will be adjusted to best fit but should not be relied upon. Refer to the point cloud or 2D drawings for more accurate data.

### Stair Sketch

Modelling stairs in Revit® is restrictive but attempts will always be made to use the sketch tool as Revit® intended. The boundary sketch will be aligned to the extent of where the tread is visible. The risers will be positioned as measured, not evenly spaced out.

### Handrails

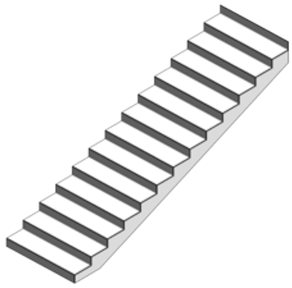
Generally railings will be modelled showing only handrails at correct height and profile. Modelling all balusters, especially ornate ones, will need to be agreed upon prior to survey.

### Visual Observations

Some of the typical visual observations that can be made with stairs include materials, finishes, access and any specific corresponding condition report. There may also be unique identifiers or requirements specific to a project that can be visually observed during the survey. These can be applied subject to a clear understanding of the scope from the outset.

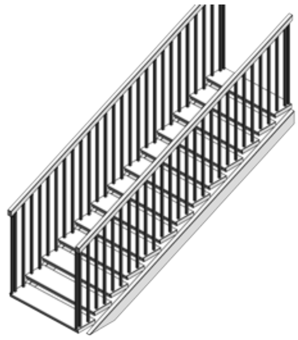
N/A

*LOD 1*



*LOD 2*

*LOD 3*



*LOD 4*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## 7.10 Ramps

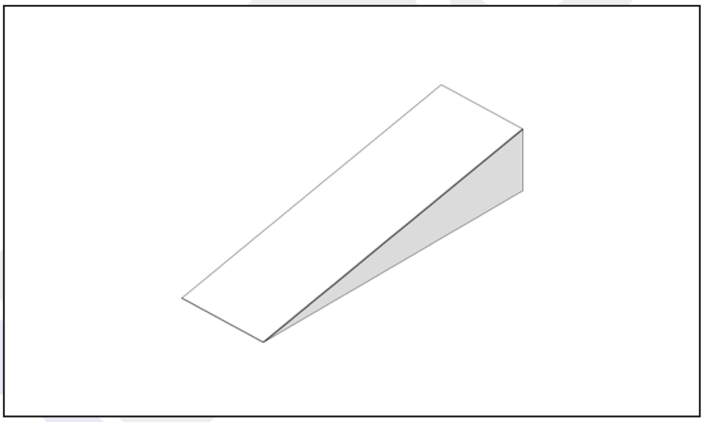
Where shown, simple ramps will be modelled using the ramp tool within Revit®. Depending on the complexity of the ramp, they may have to be modelled as In-Place and these will be placed under the category of floors.

## Typical Levels of Information

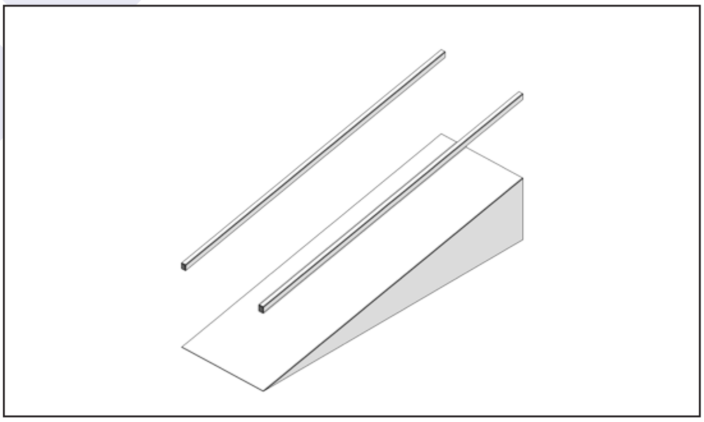
| | |
|---|---|
| LOI 100 | N/A |
| LOI 200 | Ramps: Ramp: SURVEY - SOLID 150mm |
| LOI 300 | Ramps: Ramp: SURVEY Pedestrian - 150mm |
| LOI 400 | Ramps: Ramp: SURVEY Pedestrian - 150mm [Concrete] |
| LOI 500 | Ramps: Ramp: SURVEY Pedestrian - 150mm [Part M Compliant = yes] |

N/A

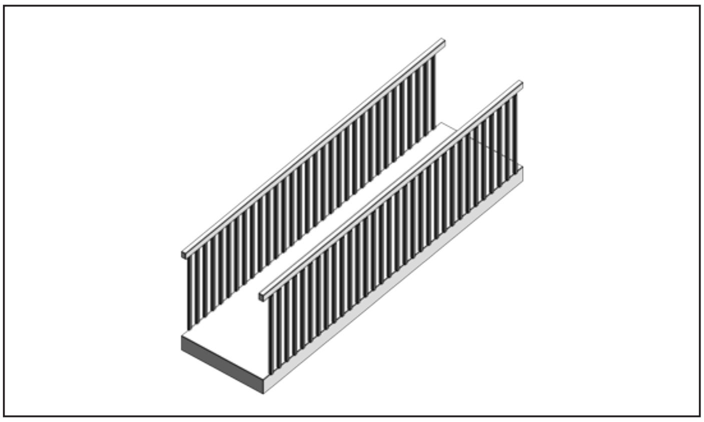
*LOD 1*



*LOD 2*



*LOD 3*



*LOD 4*



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## 7.11 Doors

The determining factor if either a door family or a wall opening will be used, is if it has a door frame. Where door leaves have been removed, a door family will be used with the door leaf not shown. The same applies for cased openings. All other openings in walls will be modelled using the wall opening tool within Revit®. Door swings will be shown as determined during survey. Where door swings can not be identified, they will be given a comment such as 'assumed door swing'.

### Typical Levels of Information

| | |
|---|---|
| LOI 100 | N/A |
| LOI 200 | Doors: SURVEY - Door Opening: 850 x 2000mm |
| LOI 300 | Doors: SURVEY – Int.Single: 850 x 2000mm |
| LOI 400 | Doors: SURVEY – Int.Single: 850 x 2000mm [Fire Door] |
| LOI 500 | Doors: SURVEY – Int.Single: 850 x 2000mm [Fire Rating = 60mins] |

### Modelled Geometry

Generally doors will be modelled as a simplified family showing door leaf, swing and opening only. Higher detail (LOD 3 or 4) can show door frame and, if specified, ironmongery, vision panels, kick plates and surface features.

### Measured Dimensions

Doors will be dimensioned to the largest opening width and height measured (usually to the inner face of the architrave).

### Visibility Settings

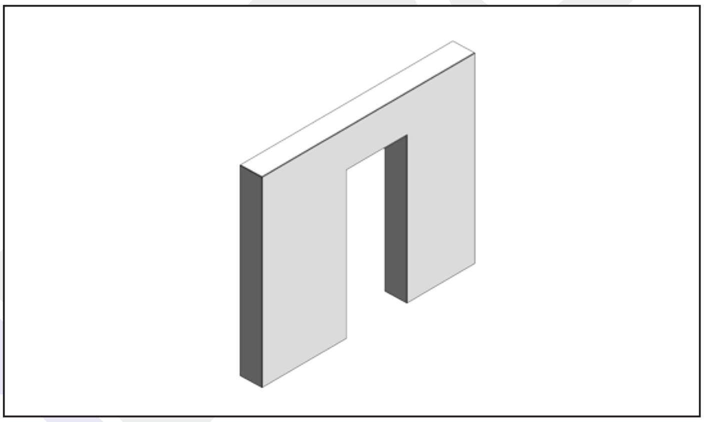
Basic Door Families will have a visibility setting for 2D door swings. Higher detail doors will have visibility settings for the extra geometry and will only be visible in Revit® Medium and Fine detail levels.

### Visual Observations

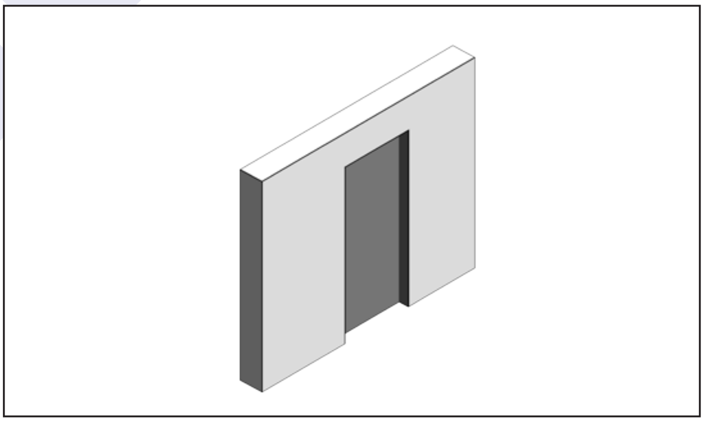
Some of the typical visual observations that can be made with doors include materials, finishes, access type, ironmongery, vision panels, kick plates and any specific corresponding condition report. There may also be unique identifiers or requirements specific to a project that can be visually observed during the survey. These can be applied subject to a clear understanding of the scope from the outset.

N/A

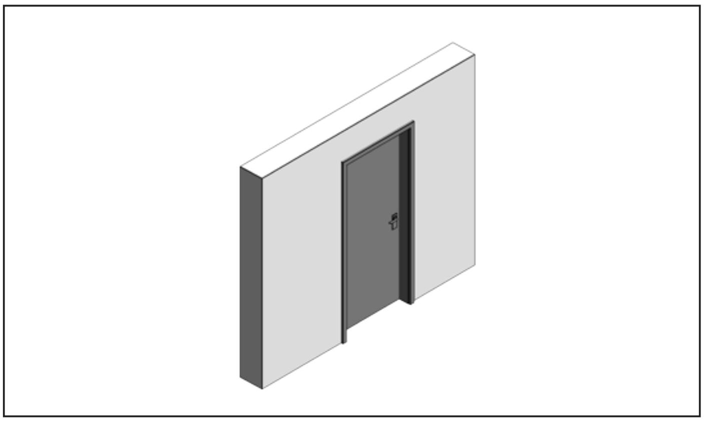
*LOD 1*



*LOD 2*



*LOD 3*



*LOD 4*

## 7.12 Windows

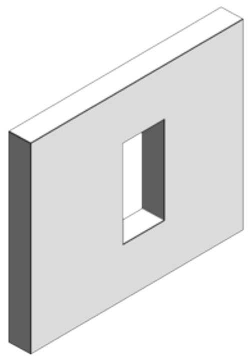
Windows can be modelled as simplified families or as curtain walls. Depending on the complexity, functionality and repetitiveness of the window, an assumption will be made as to the best method of modelling to use. Deciding which method to model windows must be set out and agreed prior to quotation as this can greatly affect timings and therefore costs. Window families can take longer to manipulate and build but have far more functionality within the BIM environment.

N/A

LOD 1

## Typical Levels of Information

| | |
|---|---|
| LOI 100 | N/A |
| LOI 200 | Windows: SURVEY - Window Opening: 1200 x 1400mm |
| LOI 300 | Windows: SURVEY - Arch Type 01: 1200 x 1400mm |
| LOI 400 | Windows: SURVEY - Arch Type 01: 1200 x 1400mm_[Side Hung] |
| LOI 500 | Windows: SURVEY - Arch Type 01: 1200 x 1400mm_[U-V = 1.5 W/m²k] |



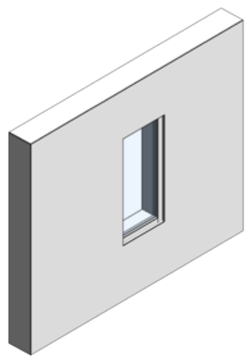
LOD 2

### Modelled Geometry

Generally, windows will be modelled as a simplified family showing frame/panels, glass and opening only. Higher detail (LOD 3 or 4) can show swings, sills, ironmongery and glass features.

### Measured Dimensions

Windows will be dimensioned to the largest opening width and height measured (usually to the inner face of the structural opening). Any panelling will also be measured and modelled.



LOD 3

### Parameters

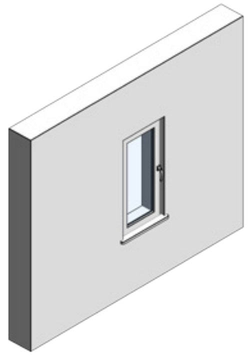
Basic type parameters will be used for window families such as overall width and height and of each panel. Higher detail windows will have instance parameters controlling the geometry of ironmongery, sills, features, etc.

### Visibility Settings

Basic window families will have a visibility setting for 2D window swings and cut lines. Higher detail windows will have visibility settings for the extra geometry and will only be visible in Revit® Medium and Fine detail levels.

### Visual Observations

Some of the typical visual observations that can be made with windows include materials, finishes, opening type, sills, special features and any specific corresponding condition report. There may also be unique identifiers or requirements specific to a project. These can be applied subject to a clear understanding of the scope from the outset.



LOD 4



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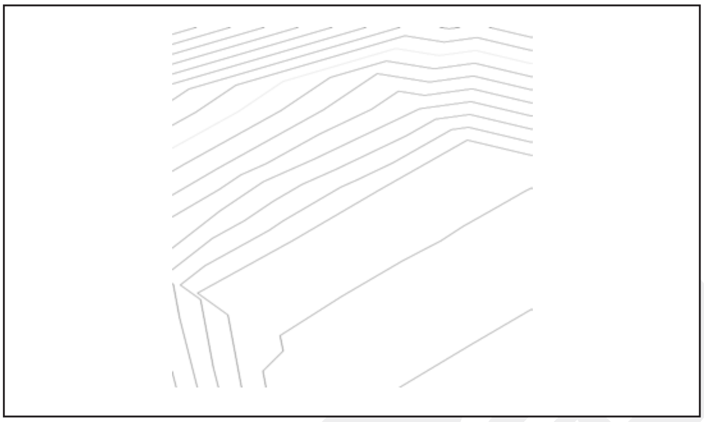
## 7.13 Topographic Surfaces

Revit® has known limitations in handling topographic surfaces, so there are a number of options to be considered for representing surrounding topography.

In the simplest form, a 2D topographic survey can be undertaken and drawn as a linked 2D AutoCAD DWG. Where specified, a simplified topographic surface can be created from contours or by a traditional 3D AutoCAD site survey with levels linked into the Revit® model.

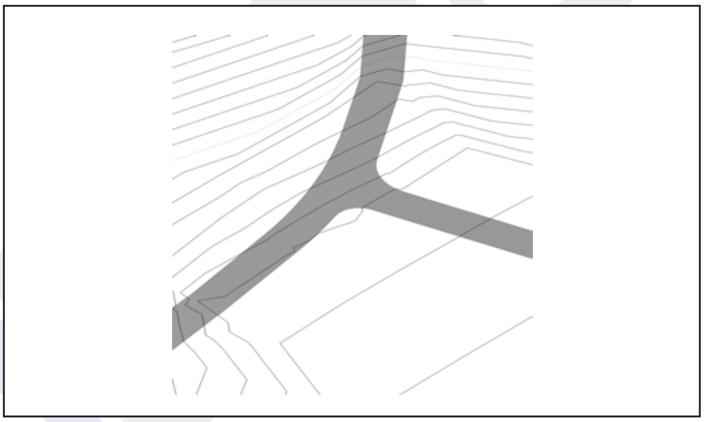
The specification needs to define whether retaining walls, roads, paths, car parks and street furniture should also be included.



LOD 1

### Typical Levels of Information

| | |
|---|---|
| LOI 100 | Topography: Surface |
| LOI 200 | N/A |
| LOI 300 | N/A |
| LOI 400 | N/A |
| LOI 500 | N/A |



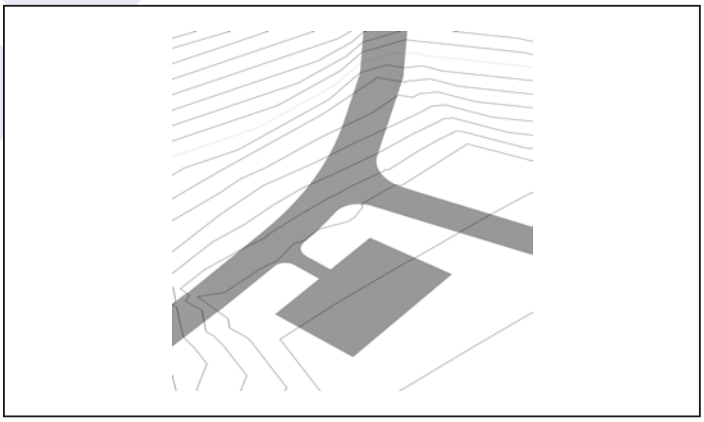
LOD 2

#### Topographic Sub-regions

Roads and pavements and any other surface feature requested by the Client can be modelled onto the surface of the topography using sub-regions.

#### Parking Spaces

If requested, parking spaces can be modelled. Parking space families can be hosted to the surface but will not follow the exact contours of the topography.



LOD 3

#### Planting

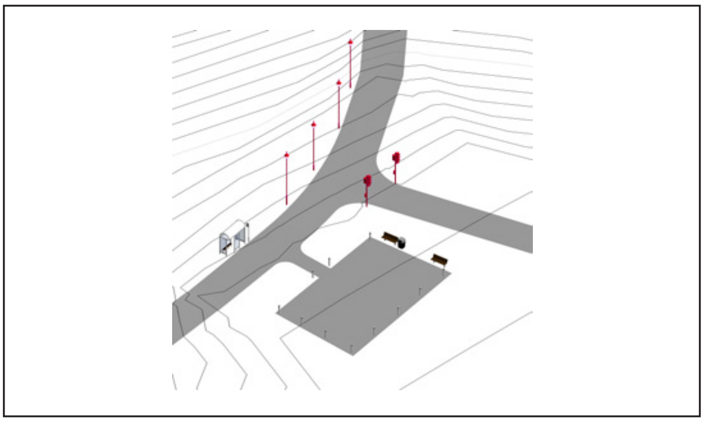
Trees and planting can also be added for indicative purposes. If a tree survey is carried out, the data collected can be represented in the model.

#### Site Furniture

Any site furniture, such as benches, lamp posts, signage, etc. which are measured in the survey can be represented in the model.

## 7.14 Underground Services

Where requested, underground services can be represented in a number of ways, as detailed in Appendix A – Detail Check List. This can vary from a 2D or 3D linked AutoCAD DWG, right through to intelligent Revit® objects. Identification of foul, storm, water, gas, electric and telecommunication services can also be provided.



LOD 4



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## 7.15 MEP Services

Plowman Craven can model mechanical, electrical and plumbing services that are captured during a survey.  These services can be modelled and delivered as a separate Revit® MEP file or modelled as In-Place families within the architectural model. A clear scope of services to be modelled and delivery format must be understood prior to quotation.

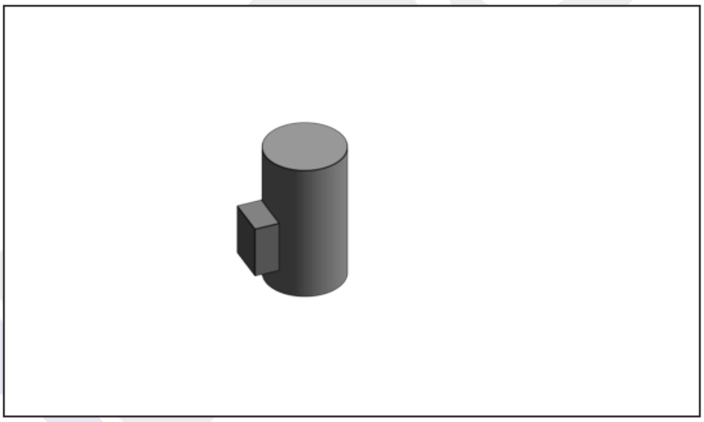
As summarised in Appendix A – Detail Check List, main MEP services can be modelled depending on the Level of Detail of the model.  This can vary from modelling the profile and overall volume of pipe clusters, right up to modelling individual service runs.

N/A

LOD 1

## Typical Levels of Information

| | |
|---|---|
| LOI 100 | N/A |
| LOI 200 | Pipes: Pipe Type: SURVEY - Generic [150mm] |
| LOI 300 | Pipes: Pipe Type: SURVEY - Generic Plastic [150mm] |
| LOI 400 | Pipes: Pipe Type: SURVEY - Generic Plastic [150mm][Lagged] |
| LOI 500 | Pipes: Pipe Type: SURVEY - Generic Plastic [150mm][Lagged][2.3 GPM] |

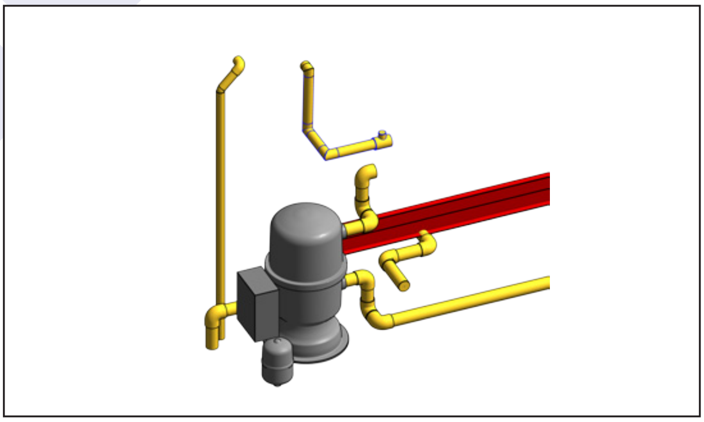


LOD 2

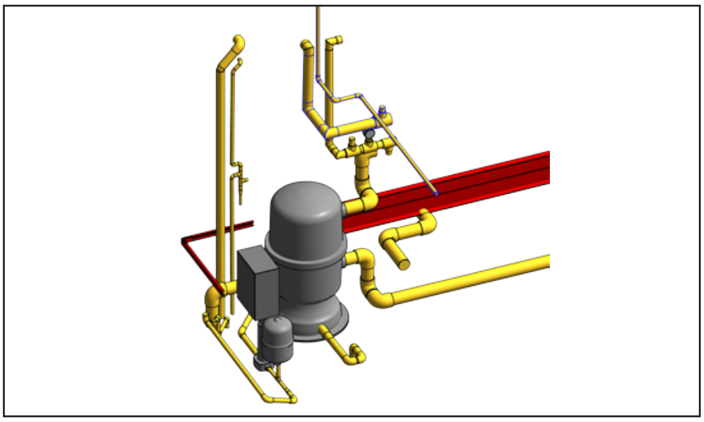
Plowman Craven will only model MEP elements that are fixed to the building and in a rigid state. Cable trays/runs will be modelled as one element. All loose elements such as cables, wires, loose/temporary fittings and so on will not be modelled. Fixtures and fittings (taps, sprinkler heads, etc.) will not generally be modelled.

MEP elements will not be connected into systems.  However, service runs will be correctly assembled so that all elements within a particular service run are connected.  Service identification can be provided but this may require additional client supplied information. No additional parametric data will be added to model elements (e.g. plant capacity) unless specified.

There are limitations when surveying MEP elements in a building and the Client should be aware of these to ensure that cost effectiveness and expectations are met.



LOD 3



LOD 4





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The following issues should be understood before commissioning an MEP survey:

## Visibility and Access

Building services are intended to be hidden behind architectural finishes and this is the main restriction when surveying services in an existing building. Plowman Craven will not be responsible for the removal of architectural finishes, such as ceiling tiles, in order to capture the data behind them. If no access is given during the survey then Plowman Craven will capture as much visible data as possible at that time.

In plant rooms and service corridors where MEP is exposed and more visible, capturing elements at high level, for example stacked services, can be limited. Plowman Craven is unable to guarantee 100% data capture in these areas.

## Software

Revit® MEP is a systems design tool and comes with certain rules that are necessary for engineering. It does not allow for modelling of imperfections or damaged services where brackets and fastenings have failed causing the pipe or ducting to sag or warp. In these instances the MEP model will be connected at 'best fit.' Plowman Craven will supply the point cloud with the model so accurate measurements of the current situation can be directly attained by the Client.

## Materials and Insulation

Much of the existing piping within a building will have varying degrees of insulation and lagging. This will cause the profiles of the pipework to be varied in size and may not necessarily be its true size. Best efforts will be taken to model the true diameter of pipework but Plowman Craven is not able to guarantee this level of accuracy unless lagging is removed prior to survey.

## Data Capture

Usually, laser scanning will capture much more data than required for a typical survey model. However, scanning technology does have limitations that can affect data quality. Different types of scanners have varying degrees of data acquisition capability – certain types are more suited for long range scanning whilst others are more suited for higher detail. Dark/black materials can absorb the laser whilst extremely reflective surfaces, such as insulation, can reflect and create a lot of "noise" in the scan data. Good surveying practice and equipment choice will reduce this undesirable effect but Plowman Craven is unable to guarantee 100% data capture where these surfaces are present in the MEP environment.

Due to the varying noise that laser scanning records, Plowman Craven will tend not to model any element (pipe, conduit, cable, etc.) with a diameter less than 30mm.

## Visual Observations

Some of the typical visual observations that can be made with MEP include materials, service type, flow directions, lagging and any specific corresponding condition report. There may also be unique identifiers or requirements specific to a project that can be visually observed during the survey. These can be applied subject to a clear understanding of the scope from the outset.





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## 7.16 Fixtures, Furnishings and Equipment

Showing the fixtures, furnishings and equipment (FFE) in the model can be done in a variety of methods.

In most circumstances loose furniture and equipment would not be modelled, however, if they are required for FM purposes and/or visualisations, they can be modelled in a basic form to keep the model from being too heavy.

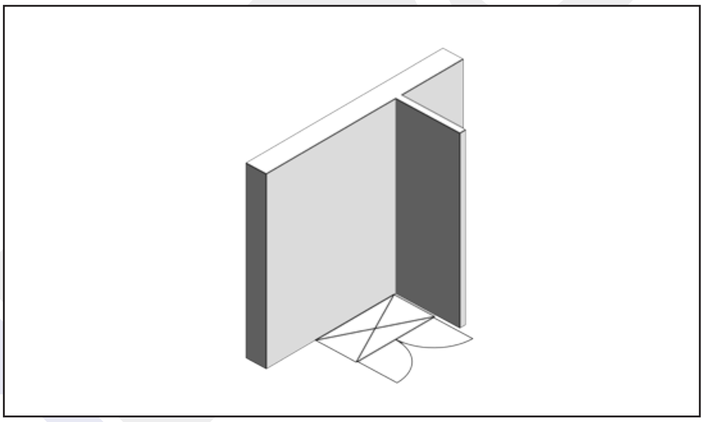
In its most simplistic form, FFE can be shown as 2D symbols or as an inserted 2D CAD drawing. Higher LOD would be in 3D form and LOD 4 would only be suitable if high detail visualisations were required.

## Typical Levels of Information

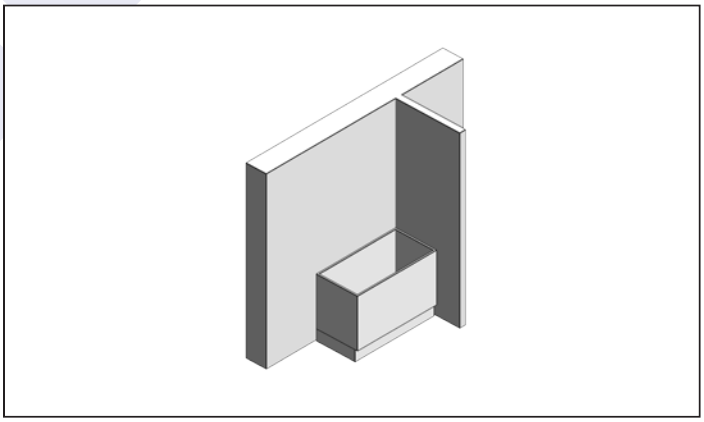
| | |
|---|---|
| LOI 100 | Casework: SURVEY - Cabinet: 600 x 1200mm |
| LOI 200 | Casework: SURVEY - Cabinet: 600 x 1200 x 700mm |
| LOI 300 | Casework: SURVEY - Kitchen Cabinet: 600 x 1200 x 700mm |
| LOI 400 | Casework: SURVEY - Kitchen Cabinet: 600 x 1200 x 700mm_[Granit] |
| LOI 500 | Casework: SURVEY - Kitchen Cabinet: 600 x 1200 x 700mm_[ID1234] |

N/A

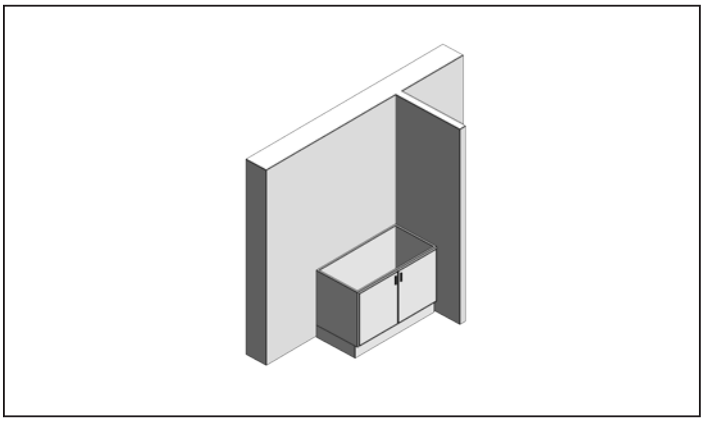
*LOD 1*



*LOD 2*



*LOD 3*



*LOD 4*





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Plowman Craven

## 7.17 Project Browser, Views and Sheets

The Project Browser is where all views, schedules, sheets, families, and so on, are managed and organised. How this is managed is essential to a well organised Revit® model and Plowman Craven aims to keep it as clear and as simple as possible.

Consideration should be given as to whether 2D Views are required for plans, sections and elevations. One of the many advantages of adopting the BIM model approach is that the production of plans, sections and elevations is a dynamic and automated process. However, the presentation of such 2D drawings does need discussion and agreement.

### Views

Depending on the requirements of the Client, Plowman Craven can set up views to suit the project. Similar to traditional 2D deliverables, views can be annotated and placed into sheets if so desired.

- Floor Plans – Generally a floor plan for each referenced level will be created. Unless specified the default settings will be used with no annotations. Plan view naming convention is: SURVEY – 'level name'. Level tags can be added to each room and corridor to indicate typical heights.
- Elevations – If requested, elevations will be created for North, South, East and West. Unless specified the default settings will be used with no annotations. Elevation naming convention is: SURVEY – 'direction' elevation
- Sections – Unless specified, sections will not be created within the Revit® model. Prior agreement to the production of sections is required before commencement of the model.
- 3D View – A default 3D view will be created showing the completed model. If required or applicable, extra 3D views can be created with filters, etc.
- Annotation – No annotations are created in the default views mentioned above. If required, annotations can be created in selected views and will adhere to the Plowman Craven standards for 2D drawings.
- Export Settings – If required, any views can be exported out to 2D CAD format. Unless the Client supplies its own export layer settings, Plowman Craven will use its own, and these can be provided prior to commencing the survey.

### View Filters

Depending on the nature of the building and Client requirements, views can be created that have filters applied to them. These filtered views will highlight specific elements where Plowman Craven has applied certain parameters that need considering when using the model. For example, a filter can be applied to a 3D view to highlight elements that have tolerance deviations or to show elements which have comments added.

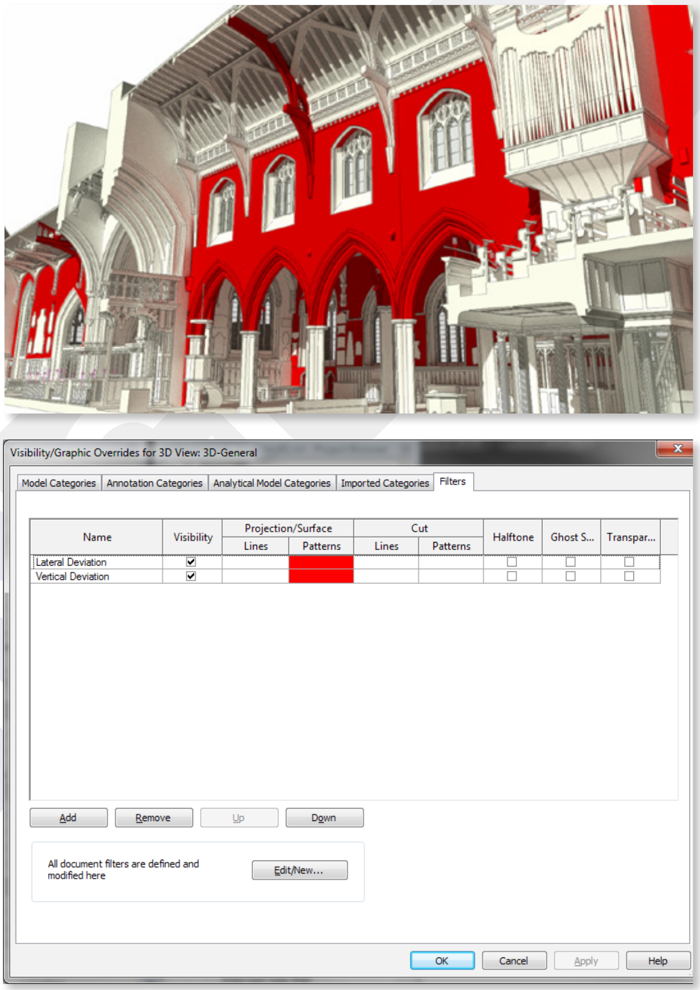


*Figure 20 – Using view filters to show deviation*

### Schedules

Plowman Craven will not create schedules within Revit®. However, if required a schedule could be created to list and easily identify certain elements. Prior agreement to the production of schedules is required before commencement of the survey.

### Sheets

Plowman Craven will not create sheets within the model unless specifically requested. If sheets are required then Plowman Craven will adhere to its traditional 2D deliverable standards and title block. Client supplied sheets can be provided and incorporated with prior agreement.



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## 7.18 Plowman Craven Parameters

The survey Revit® model comes with several survey specific parameters and families. These will be used for various conditions relating to the survey data and the model itself. To ensure the user is referring to the most accurate information, care must be taken when measuring from the model, especially for areas where high accuracy is paramount.

Shared parameters can be used to identify specific attributes to certain elements. If required, it can be agreed to use certain shared parameters bespoke to the project. As a general rule, Plowman Craven utilises two shared parameters:

### Survey Notes Parameter

All elements within the model have the Survey Notes parameter. Plowman Craven will use this parameter to note any issues, assumptions, restrictions and so on, that affect the model's integrity or accuracy.

### Deviation Parameters

To address any elements deformity such as warping, bowing or leaning, Lateral Deviation and Vertical Deviation parameters can be used to record the maximum deviation of the modelled element from the point cloud data. View filters can then be used to indicate components which are outside of tolerance.

Basic Wall
SURVEY EXTERNAL - 340mm

Walls (1) | Edit Type

| | |
|---|---|
| **Constraints** | |
| Location Line | Finish Face: Interior |
| Base Constraint | 08 SURVEY - Tower Roof |
| Base Offset | 0.0 |
| Base is Attached | ☐ |
| Base Extension Distance | 0.0 |
| Top Constraint | Up to level: 08 SURVEY - Tow... |
| Unconnected Height | 1330.0 |
| Top Offset | 1330.0 |
| Top is Attached | ☐ |
| Top Extension Distance | 0.0 |
| Room Bounding | ☑ |
| Related to Mass | ☐ |
| **Structural** | |
| Structural | ☐ |
| Enable Analytical Model | ☐ |
| Structural Usage | Non-bearing |
| **Dimensions** | |
| Length | 5965.7 |
| Area | 8.241 $m^2$ |
| Volume | 2.802 $m^3$ |
| **Identity Data** | |
| Comments | |
| Mark | |
| **Phasing** | |
| Phase Created | Existing |
| Phase Demolished | None |
| **General** | |
| Survey Notes | |
| Lateral Deviation | |
| Vertical Deviation | |

*Figure 21 – Plowman Craven custom parameters*

### Point of Interest Family

When a large area has a deviation parameter, e.g. there is a particular anomaly or a specific area that was obstructed during survey, a Point of Interest (POI) family showing its location and rough size will be placed and populated with the relevant information. It is strongly advised to refer to the point cloud for clarity.

It is important to note that this family is only to identify an area for review and does not represent any part of the model. You can check this in its type properties to confirm. To check if an element has any special considerations or deviations in any view, just click on the element and check its properties.

| Parameter | Value |
|---|---|
| **Materials and Finishes** | |
| Material Finish | Floor Deviation |
| **Structural** | |
| Important | THIS IS NOT A STRUCTURAL ELEMENT - ANNOTATION ONLY |
| **Identity Data** | |
| Version | 1 |
| URL | www.plowmancraven.co.uk |
| Model | Floor Deviation Location |
| Manufacturer | Plowman Craven |
| File Location | F:\Library\Revit\Families\Detail Items |
| Description | Location of floor deviation |

*Figure 22 – POI family properties*

## 7.19 Naming Conventions

It is important to agree on fundamental naming conventions for individual components of the BIM. Naming conventions should, in principle, follow PAS 1192-2:2013 naming standards, but are open to discussion and agreement with the Client. In the absence of any guidance or requests from the Client, component and family names will begin with the prefix “SURVEY” where possible.

Consideration should be given to naming conventions for the following components:

- Project browser structure and naming
- Component and family naming
- Workset naming
- View naming
- Reference level naming
- Sheet naming

## 7.20 Families, System Families and In-Place Models

A Revit® model is entirely constructed using families and system families. There will be instances where the use of a system family is not feasible and an In-Place Model will have to be created. The production of parametric families can increase modelling times significantly, and therefore careful consideration should be given to family requirements.

### System Families

To maintain model integrity and to make the model as BIM-ready as possible, Plowman Craven will aim to use and manipulate the appropriate system family (floors, walls, roofs, ceilings, stairs, etc) as a priority during construction of the survey model.

### In-Place Models

Where it is inappropriate or unsuitable to model more complex shapes or objects using standard Revit® system based elements, these will be modelled using In-Place or family-based mass instances. Families will be given the correct Revit® category, parameters and naming.

### Families

Family production can have a large impact on the modelling timeline and so the use and specifications for families within the model must be agreed upon prior to commencement of the survey. Client supplied families, such as retail gondolas, can also be used with prior agreement.

### Categories

Typical families such as doors, windows, columns, beams, etc. will use the default family template from the metric library but modified to suit survey specification. Parameters and flexibility will remain minimal and only measured geometry will be modelled in the family.

### Visibility Settings

Visibility control can be given to a family depending detail level and view type. Generally, all families will display simplified line work in conjunction with Plowman Craven’s 2D output.

### Dimensions

Locked and parametric dimensions within a family will be kept as clear and concise as possible. Parametric dimensions will only be applied to geometry that may alter between different types or instances within the survey model. All other geometry that remains constant will have locked dimensions applied.

### Family Naming Convention

As mentioned in Section 7.20, all families will be named with the prefix SURVEY. To identify the family type the name will also contain the overall dimensions. Any special parameter added to the family will usually be an instance parameter and not picked up in the name. If, however, it has to be a type parameter it will be abbreviated and noted at the end of the family name. The following convention will generally be applied:

**SURVEY – [family type]: [length] x [width]mm**

*For example a 910 x 2110mm single door will be called:*

**SURVEY – Single: 910 x 2110mm**

## 7.21 Phasing

As a general rule, ALL models produced from survey data by Plowman Craven will be produced in the “Existing” phase. The Client may have a certain phasing structure that they require to be implemented and this must be agreed upon before commencement. Depending on the nature of the project, other phases such as Pre-Demolition, Post-Construction, Survey Phase 1/2/3, and so on, could also be considered.

## 7.22 Inaccessible Areas and Wall Lines

Areas or wall lines which are inaccessible at the time of survey will be annotated in the model as such. Undefined lines and surfaces such as wall, floor, roof and ceiling thicknesses will be clearly identified in the model. False ceilings will not be removed and ceiling voids will be appropriately labelled. If measurements above false ceilings are required, then it is the responsibility of the Client to arrange removal of the ceiling material prior to the survey.

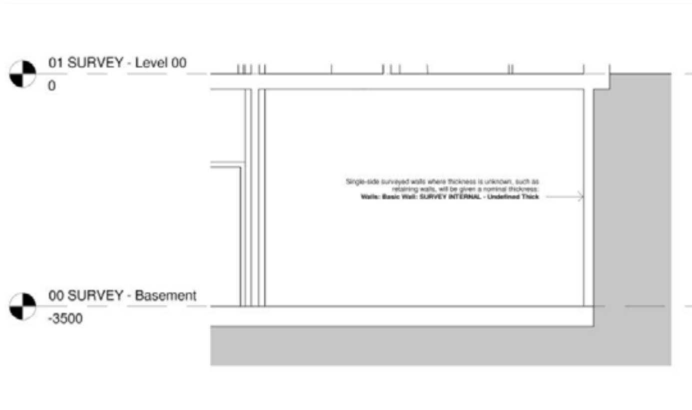


*Figure 23 - Inaccessible wall line*

## 7.23 Reference Levels

Defining the reference levels for each floor of the building is the first and foremost integral exercise in the modelling process. These reference levels will be set in relation to Ordnance Survey or Local Datum as defined in Section 7.25 Coordinate Systems and Units. The preferred modelling technique is to minimise the amount of reference levels by defining only one reference level per storey or mezzanine.

### Finished Floor Level (FFL) and Structural Slab Level (SSL)

The reference levels will be set up to the majority finished floor level (FFL) of each floor level, usually at stair or lift core. If the structural slab can be identified and measured, Plowman Craven can set the reference levels to the SSL at the Client's request. All other floors and landings that deviate from the majority FFL will be offset from the nearest reference level.

### Naming Convention

All reference levels are named with a prefix of SURVEY. A typical reference level will be named as follows:

SURVEY – Level 03.

If requested and agreed, Plowman Craven can name the reference levels as per the Client's specifications, however this convention must identify that the level is the surveyed level.

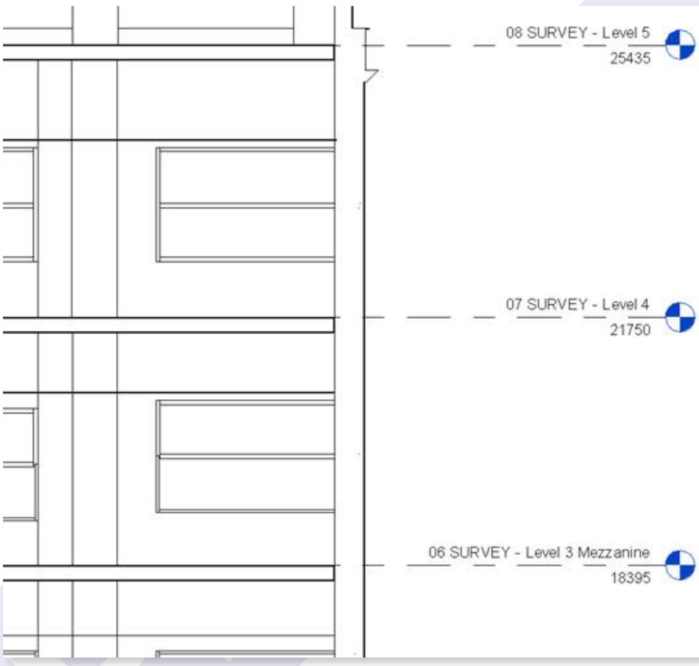


*Figure 24 - Floor levels*

## 7.24 Structural Column Grids

Grids are typically not set up unless requested by the client and agreed with Plowman Craven prior to commencement of the survey. Whilst all effort is taken to keep within a structural grid, columns can only be modelled as per the survey data. Where grids are required to be defined within the survey model, it will need to be clarified and confirmed in the initial technical meeting with the Client.

## 7.25 Coordinate Systems and Units

Where requested, a shared coordinate system will be created linking the Revit® local coordinate system to Ordnance Survey National Grid, or to the project site grid as appropriate. Height control can be related to Ordnance Datum Newlyn, or to a locally established site datum.

### Project Base Point

Unless specified the Project Base Point will be set to a defined location on the site and set at 0.00m Datum.

### Project/True North

Unless specified the Project North will be set to True North upon final delivery. If the Client requests a Project North be defined, then this must be agreed upon prior to commencement of the model.

### Shared Coordinates

If the final deliverable is to be split into separate models, a shared coordinate system will be set up. On larger sites where several buildings are modelled, a coordination SITE file will be created to host the link models.

Project units, unless otherwise specified, shall be millimetres.


*Figure 25 - Project base point*

## 7.26 Worksets

Any worksets created during the construction of the model will be removed prior to final delivery. However, worksets can be defined and incorporated if required by the Client.

## 7.27 Materials

All elements will be given a default material of SURVEY – White, except for glass which will be the default Glass material within Revit®. If requested, Plowman Craven can identify materials depicted from the survey and implement them into the model by either painting surfaces or modifying the build-up of the element. Modifying the build-up will require construction information and assumptive modelling, therefore the best method must be agreed upon prior to quotation.


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## 7.28 Project Quality / Check List for BIM Surveys

At Plowman Craven, we believe our superior understanding, technology and capabilities enable us to give Clients products which meet their requirements in a way which surpasses expectation. We are dedicated to providing a quality product and implement a number of robust Quality Assurance practices to ensure a successful, high quality deliverable through a project lifecycle. The checklist below gives an overview of these processes, for a further information please contact us.

| **Project No. and Name:** | |
|---|---|
| **Stage 1 – Project briefing and data collection** | |
| Check that the project team is fully briefed and data is collected in an appropriate manner | ☐ |
| Lead Person(s) and project team fully briefed | ☐ |
| Health & Safety issues, Risk Assessment and Method Statements reviewed and signed off by all relevant parties | ☐ |
| Data measured/collected in accordance with the procedures set out in Plowman Craven's methods of operation and the content and accuracies meet the requirement of the project specification | ☐ |
| **Stage 2 – Data processing** | |
| Check that the survey data is processed and checked prior to commencement of modelling | ☐ |
| Measured data processed in accordance with the procedures set out in Plowman Craven's methods of operation and content and accuracies meet the requirement of the project specification | ☐ |
| Independent Quality Audit of measured data prior to commencement of modelling | ☐ |
| **Stage 3 - Independent geometry check of final model** | |
| Check that the final Revit® model has the correct geometry and is in the right place in relation to the point cloud and independent polar observations | ☐ |
| Modelled Level of Detail meets project requirements | ☐ |
| Model accuracy is within project tolerance, and deviations have been applied in instances where tolerance is not met | ☐ |
| Model walkthrough – Model checked against photography for completeness | ☐ |
| **Stage 4 – Independent integrity check of final model** | |
| Check that the final Revit® model is constructed in a consistent manner | ☐ |
| Naming conventions are to Plowman Craven's or other agreed convention, e.g. family naming, Levels | ☐ |
| Warnings are fixed and reduced to as close to nil as possible | ☐ |
| All geometry is joined as far as possible | ☐ |
| **Stage 5 – Delivery of final model** | |
| Check that the final deliverable is presented correctly | ☐ |
| Any unnecessary Grids, Levels, Views or other project parameters are deleted and project is purged | ☐ |
| Project is disconnected from the central file | ☐ |
| Project Information and Landing Page are completed with the correct information | ☐ |
| Confirm that 2D views and/or sheets meet the required standards of presentation | ☐ |

| | |
|---|---|
| ***Date:*** | ***Signed (Survey Lead):***<br>***Print Name:*** |
| ***Date:*** | ***Signed (BIM Lead):***<br>***Print Name:*** |


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# 8 Appendix C – Survey Model User Notes

**This section provides guidance to the recipient or user of the BIM-ready survey model supplied by Plowman Craven. It provides guidance on key topics such as the project browser, landing page and links to point cloud data.**

**Upon receiving the final Revit® model from Plowman Craven, please ensure that all accompanying point cloud and/or CAD data linked into the model is also available.**

## 8.1 Project Browser and Views

Opening the .rvt file will take you to the landing page, which will have the project information, revision, date and reason for issue. Any specific notes may be added as well as the reminder to "Please refer to deviation parameters." It is recommended that you now "Save_As" a copy for your team to edit and demolish, etc. to then be linked into the proposed design models.

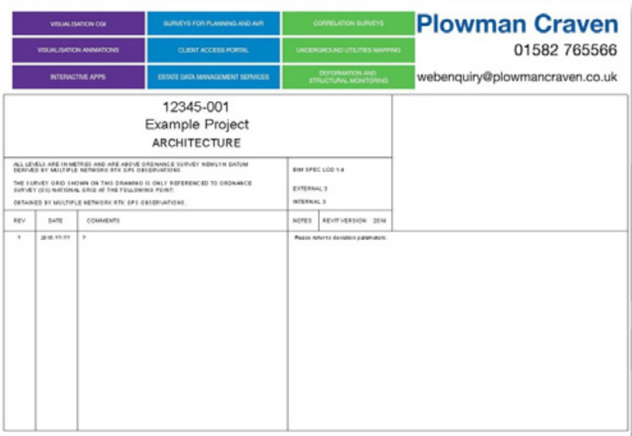


*Figure 26 - Landing page*

The project browser will only have the relevant views present and any schedules or sheets if required. There will be a 3D view called 3D-Deviations. This view has a view filter applied that highlights all elements with a deviation parameter associated to it. A view filter can be applied to any view created within the model and it is highly recommended to apply them when interrogating areas where tolerance is critical.

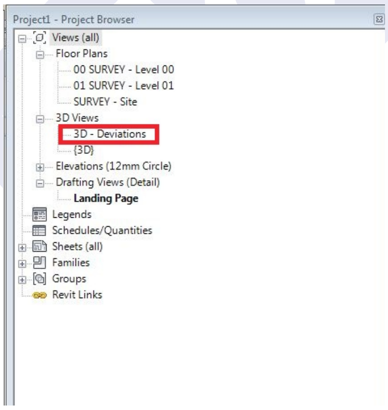


*Figure 27 - 3D deviation view*

Please refer to section 7.19 for further information about deviation parameters.

## 8.2 Point Clouds and Links

The Revit® model will have a series of point clouds and/or 2D CAD drawings linked to it and these can be unloaded or reloaded from the Manage Links tab. The point clouds are referenced regularly in the Revit® model, such as deviation parameters, and enable the user to see an element's true and complete condition when required. Point clouds are substantial in size and can slow performance of the model significantly if not utilised correctly. Plowman Craven breaks the point cloud data into smaller chunks (<5 GB) to assist with software performance management.

Below are some tips for viewing point clouds in the Revit® model:

- Only load the required point cloud 'chunks' for each area for review. Do not load all point clouds together if not necessary
- Close views/windows in the background that are not required
- Set up relative views and control visibility prior to loading point clouds. Ensure point clouds are turned off by default in visibility graphics
- Control view depth/range to shallow slices (approx. 200mm) to ensure clarity of points
- Set graphics display to fine and either wireframe or increase transparency to see points inside elements
- When finished reviewing point cloud data, unload it from Manage Links

## 8.3 Exporting the Revit® Model

It is very important to understand that the survey model is a 'BIM-ready' model, and as such has certain parametric data associated within it that may be lost when exporting to other formats. Care and consideration is essential when issuing the exported survey model. IFC and FBX are the only known export formats that export the parametric information with it, but it cannot be guaranteed and needs to be checked thoroughly.

If it is required to export 2D plans, elevations and sections or a 3D solid/surface model to other formats such as DXF, DWG, DGN, SAT, etc., then all the parametric information will be lost. Please note that walls identified as 'undefined thick' in the model will simply represent two lines or surfaces. This will not notify the user in the exported format that the thickness is unknown. It is recommended to clean the 2D drawings in Revit® first before exporting to other CAD versions. This ensures all linework will be relevant and not cause inaccurate referencing. Plowman Craven also offers the service of creating export-ready views in the model.


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# About Plowman Craven

Plowman Craven is an established Chartered Surveying company, offering a wide range of measurement services across a variety of sectors. We are experienced in producing BIM-ready models and can also supply a range of additional BIM-related products and services across the project lifecycle. This document has described those services, and has gone into depth concerning the scan to BIM methodology which we employ.

Plowman Craven believes that it is our innovation that sets us apart, and that the thorough understanding of the built environment gained through over 50 years of experience enables us to offer a solution to any problem in the world of measurement.



**For advice or clarification regarding this BIM Survey Specification and Reference Guide, please contact:**

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To download further copies of this BIM Specification and Reference Guide, scan here: