

# MINIMUM STANDARD Z/16 – SURVEY SPECIFICATIONS

## 1. GENERAL

This specification sets out the Consultant’s requirements for topographical survey (ground and aerial) for the Detailed Business Case (DBC) and Pre-Implementation (PI) phases of Transport Agency projects.

The Consultant shall select the most appropriate survey method (unless already specified in the Contract Scope) from the flow diagram in Figure 1 below. The Consultant shall ensure that each phase of survey is complimentary to the previous phase(s).

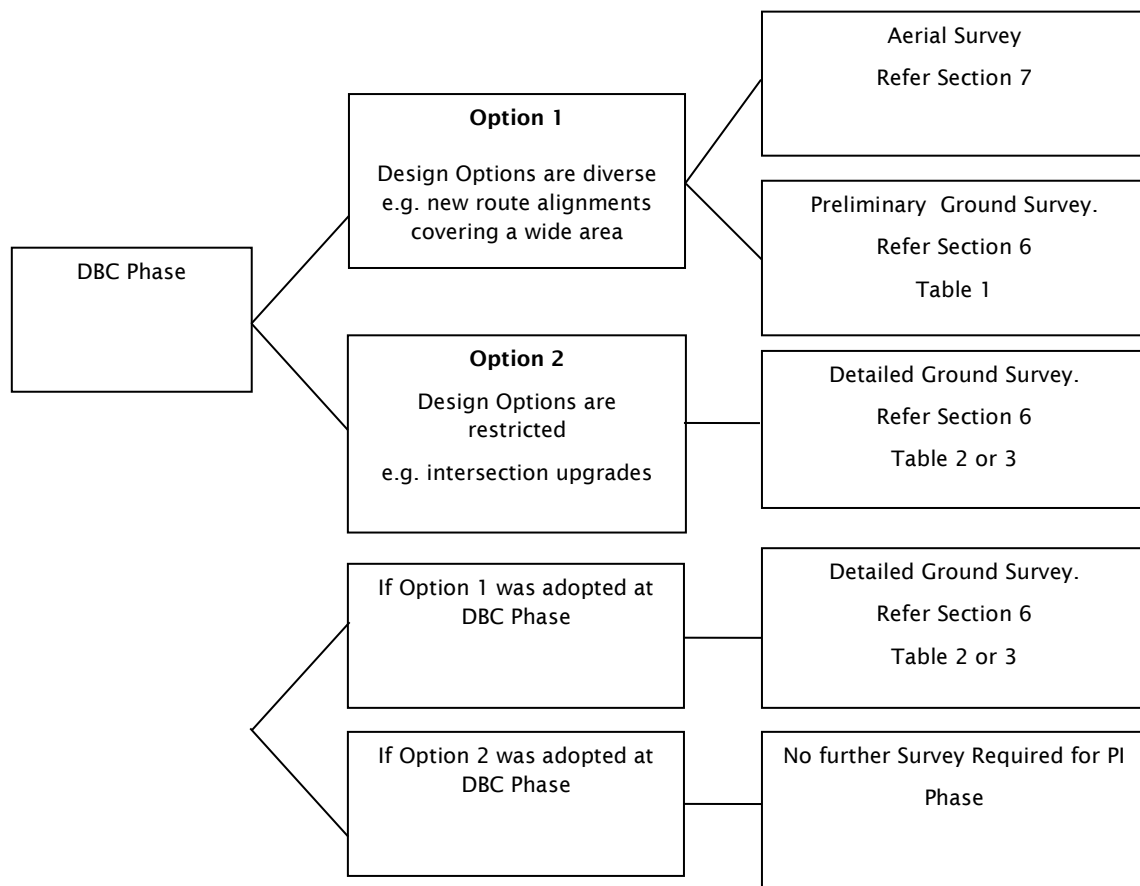


Figure 1: Survey Method Selection

## 2. CONSULTANT REQUIREMENTS

The Consultant shall undertake the required survey for each phase of the project to the appropriate level of accuracy as defined above. All Consultants’ survey output shall be fit for purpose.

Aerial survey may be used where the Consultant can demonstrate to the satisfaction of the Client that the method is appropriate to the project and significant benefits may be obtained (e.g. time and cost savings). Where possible this should be determined prior to calling for tenders.

Where available and advised in the Contract Scope, the Client may make photography (photogrammetry) or LiDAR data available for the Consultant's use.

The Consultant is expected to exercise their professional judgment based on expertise and experience in the interpretation and application of this specification.

### 3. REPORTING

The Consultant's Programme shall include the survey programme requirements and be included in the Consultant's Monthly Report in accordance with the Contract Scope *Contract Management*.

### 4. SURVEY CONTROL

The Consultant shall establish appropriate survey control throughout the project. The control survey shall be suitable for future use by other parties including construction set out. The Consultant shall ensure that the control survey is tied to the local datum and origin so that it can be related to cadastral boundaries.

The Consultant shall locate any new marks clear of future construction works and on public land where possible. The Consultant shall install all new survey marks using materials of a standard sufficient to ensure that it is stable, durable and appropriate for the precision and the purpose of the survey.

Where total stations are used the Consultant shall ensure control marks are no further than 200 metres apart and shall retain a clear line of sight between adjacent marks. Where Global Positioning Systems (GPS) is used the Consultant shall ensure that sufficient marks are installed to allow verification of the reliability of the installed marks and to enable the works to be set out without undue additional control having to be established by a contractor.

The Consultant shall ensure any existing Land Information New Zealand (LINZ) marks adopted for control are undisturbed and remain easily identifiable and stable, or that the LINZ requirements for relocating survey control marks are followed.

The required accuracy for the control survey is:

X and Y co-ordinates:  $\pm 20$  millimetres in plan in any direction.

Z co-ordinate:  $\pm 10$  millimetres in level.

### 5. ORIGIN OF COORDINATES AND LEVELS

Because each region in New Zealand has a different origin of coordinates, the Consultant shall ensure that the survey is in terms of the applicable local coordinate system. The Consultant shall ensure that the Geodetic Datum 2000 or later is used for the control survey. The Consultant shall express levels relative to mean sea level in terms of the applicable local height datum. Where GPS equipment is used to complete the survey, the Consultant shall use the appropriate regional orthometric height origin. ([www.linz.govt.nz/geodetic/datums-projections-heights/vertical-datums/mean-sea-level-datums](http://www.linz.govt.nz/geodetic/datums-projections-heights/vertical-datums/mean-sea-level-datums)).

The Consultant shall ensure that any existing survey marks used to provide origins for the survey are proven to be reliable and shall be clearly identify any such marks in the final survey data output. The Consultant shall supply the data to the Client in terms of the local coordinate system and also in terms of New Zealand Transverse Mercator (for Global Information Systems (GIS) Mapping purposes).

## 6. GROUND SURVEY

The Consultant shall carry out sufficient engineering survey for field investigation, preliminary design and final design purposes, as applicable. The Consultant shall ensure that the survey, regardless of the data collection and production method, incorporates all topographical features required to define the terrain in its entirety to the specified accuracy.

The Consultant’s presentation of the detailed survey data shall be made using the library as set out in the Transport Agency’s guideline *PSG/10 Guideline for Coding, Symbols and Line Types for Presentation of Detailed Survey Data*. This is considered to be the Client’s minimum standard for presentation of such data. Any additional symbols and line-styles used should be detailed as part of the report and drawing output.

The Consultant’s required accuracy relative to the Control for the ground survey is given in Tables 1 to 3, depending on the type of survey selected and undertaken in accordance with Section 1 “General” above. Individual points shall be within the accuracies given below, with the density of points appropriate for the uniformity of the ground:

**TABLE 1: PRELIMINARY SURVEY**

DESCRIPTION	NORTHING / EASTING	HEIGHT
Carriageways and solid surfaces, culvert inverts, drainage system water levels and inverts	± 50mm	± 50mm
Spot heights on grassed areas, garden or expansive areas etc	± 150mm	± 200mm
All other features	± 100mm	± 80mm

The purpose of this survey is for the Consultant to provide sufficient detail of the existing ground to facilitate the assessment of options and the feasibility of the proposed scheme(s). This detail shall include as a minimum:

- Location and level of the edge of the existing roading;
- Location and level of waterways;
- General levels of the ground so that earthwork quantities can be calculated;
- Location of significant services;
- Significant drainage details.
- Location of features that may represent a constraint to the design.

There is no requirement for the Consultant to lift manhole and catchpit lids unless it is required to confirm type of service and assess the impact of the proposed option(s).

**TABLE 2: DETAILED SURVEY (RURAL)**

DESCRIPTION	NORTHING / EASTING	HEIGHT
Carriageways and solid surfaces	± 20mm	± 20mm
Culvert/pipe and manhole inverts; drainage system water levels and inverts	± 30mm	± 30mm
Spot heights on grassed areas, garden or expansive areas etc	± 30mm	± 50mm
All other features	± 50mm	± 50mm

The intent of this survey is for the Consultant to provide sufficient detail of the topography to carry out detailed design and produce reliable construction drawings and quantities. This detail shall include as a minimum; Table 1 plus those features listed in the symbols and features tables sections 1.1.1 to 1.1.4 of the Transport Agency Guideline *PSG/10*.

**TABLE 3: DETAILED SURVEY (URBAN)**

DESCRIPTION	NORTHING / EASTING	HEIGHT
Carriageways and solid surfaces	± 20mm	± 20mm
Culvert/pipe and manhole inverts; drainage system water levels and inverts	± 20mm	± 20mm
Spot heights on grassed areas, garden or expansive areas etc	± 30mm	± 40mm
All other features	± 30mm	± 30mm

The intent of this survey is for the Consultant to provide sufficient detail of the topography to carry out detailed design and produce reliable construction drawings and quantities. This detail would include as a minimum Table 1 above plus those features listed in the symbols and features tables, Sections 1.1.1 to 1.1.4 of the Transport Agency Guideline *PSG/10*. In urban locations the emphasis on capturing underground services is much

greater.

The accuracy specified is the minimum requirement acceptable to the Client. The Client may require more accuracy from time to time to reflect the needs of each project or part thereof, and this will be specified in the Contract Scope.

Where the survey includes both a bridge and topographical information below the bridge (e.g. stream), the Consultant shall separate the bridge from the main survey model.

The Consultant shall ensure that all captured topographical survey information is appropriately contoured and shall produce associated 2-D and 3-D drawings and digital terrain model (DTM). See Clauses 11 and 12 for the required formats.

The Consultant shall record details of how the DTM was formed in the survey report inclusive of, but not limited to, any specific break lines and inclusion or exclusion of specific points.

## 7. AERIAL SURVEY

Aerial survey may consist of products resulting from aerial photography (photogrammetry) and LiDAR surveys.

### 7.1 Aerial Photography

The Consultant shall arrange and manage the supply of aerial photography. The aerial photography shall be:

- 1:1000 plan scale orthorectified colour aerial photography on photographic medium.
- Flown at a height suitable to enable the mapping of data to an accuracy of +/- 0.25 metres for both horizontal co-ordinates and vertical level information (90%) where the ground surface is not obscured by vegetation.
- Produce images electronically on compact disk in 24-bit colour TIFF format of sufficient quality to allow use as a background plotted at 1:500 scale to the local survey origin (600dpi).
- Include an agreed buffer area outside the project limits.

The Consultant shall supply survey control of sufficient accuracy to facilitate the following DTM requirements. The Consultant shall develop a DTM from the photogrammetry of the project site consisting of features, break lines and spot heights with sufficient data collected to enable contours to be produced at a height interval of 0.5 metres. The actual interval may be varied according to the topography. The accuracy of the digitized points shall be +/- 0.25 metres for both plan (X and Y co-ordinates), and sufficient level (Z co-ordinate) accuracy to produce reliable contours as required above. The Client may specify other accuracies from time to time in the Contract Scope, depending on the purpose of the information. The Consultant shall ensure that all mapping is carried out in terms of the local survey origin and datum.

The Consultant shall verify the accuracy of densely vegetated portions of the mapping using traditional forms of survey in accordance with Table 1 of this specification. This shall apply particularly to high and low features such as ridges and gullies.

The Consultant shall supply the DTM in three-dimensional DXF format including all contours and digitised features. A ground height shall be assigned to all digitised features. The

Consultant shall reference the electronic aerial photos to the DTM so that it can be plotted as an overlay.

The Consultant shall supply a brief report summarizing the:

- Date aerial photos were taken;
- Verification of accuracy and areas where traditional forms of survey were employed; and
- Location of control marks.

The Consultant shall electronically overlay the DTM with the boundaries and services/utilities. It is acceptable for the Consultant to define non-critical boundaries from a digitised database and determine the location of services and utilities using only the service provider's as-built plans.

## 7.2 Airborne Altimetric LiDAR

The Consultant shall arrange and manage the supply of the LiDAR dataset. The LiDAR dataset shall:

- Consist of XYZ ASCII data files of true ground point data thinned to remove points superfluous to formation of a DTM accurate to 0.25m and corresponding XYZ ASCII files of first return point data giving the best definition of vegetative canopy and manmade structures as is practical.
- Include a metadata statement confirming the datum used for the products and a statement of the geodetic control points on which the survey is based. The metadata statement will also include a summary of the location and number of ground truth points surveyed and a statistical report on the fit between the LiDAR data and the ground truth data.
- Be flown at a height suitable to enable the mapping of data to an accuracy of +/- 0.25 metres for both horizontal co-ordinates and vertical level information (90%) where the ground surface is not obscured by vegetation.
- Include where possible colour ortho photos taken at the same time as the LiDAR is flown suitable for plotting at a scales of up to 1:2000.
- Include an agreed buffer area outside the project limits.

The Consultant shall develop a DTM from the LiDAR true ground dataset of the project site consisting of spot heights with sufficient data density to enable contours to be produced at a height interval of 0.5 metres. The actual interval may be varied according to the topography. The accuracy of the points shall be +/- 0.25 metres for both plan (X and Y co-ordinates), and sufficient level (Z co-ordinate) accuracy to produce reliable contours as required above. The Client may specify other accuracies from time to time in the Scope of Services, depending on the purpose of the information. The Consultant shall ensure that all mapping is carried out in terms of the local survey origin and datum.

The Consultant shall verify the accuracy of densely vegetated portions of the mapping using traditional forms of survey in accordance with Table 1 of this specification. This shall apply particularly to high and low features such as ridges and gullies. In particular the Consultant shall check critical break-lines such as cliff tops are adequately depicted in the dataset and that non-ground features have been adequately removed from the ground point dataset.

The Consultant shall supply the DTM in three-dimensional DXF format including all contours and digitised features. A ground height shall be assigned to all digitised features. The Consultant shall reference the electronic aerial photos to the DTM so that it can be plotted as an overlay.

The Consultant shall supply a brief report summarizing the:

- Date(s) LiDAR dataset was flown;
- Verification of accuracy and areas where traditional forms of survey were employed; and
- Location of control marks.

## 8. LEGAL BOUNDARIES

The Consultant shall ensure that the survey includes the location of all legal cadastral, easements, leasehold and designation boundaries. The Consultant shall annotate the electronic survey plan with the legal description, certificate of title information, owner's name and land minerals license for land allotments affected by the proposed works. The Consultant shall use survey accurate positions (not digitised) when locating boundaries.

The Consultant shall check potential unapproved boundary changes in the project area with LINZ and Local Authorities and inform the Client of possible impending changes to ownership or boundaries if available.

## 9. SERVICES

The Consultant shall:

- Ensure that drainage features are sufficiently detailed to determine longitudinal gradients;
- Measure the diameter and invert levels of all pipes and manholes and record the details on the electronic survey plan;
- Ensure that catchpit invert and the material type of any pipes constructed from non-conventional materials are recorded;
- Obtain as-built service plans from all service authorities (electronically if possible) and incorporate the relevant data into the electronic survey plans;
- Survey the location of all visible evidence of overhead and underground services including junctions/terminals, valve boxes, hydrants, pillar boxes service location markers etc;
- Verify the position of visible services from the as-built information against the surveyed location of such services for accuracy.

Where further accuracy is required as to the depth of the service or a significant discrepancy exists between the as-built and as surveyed information, the Consultant shall have the location of the service identified on-site by the relevant Service Authority and survey the marked position. If accurate information regarding the depth of the service is required that part of the service shall be uncovered and the surveyed location and depths recorded on the survey plan.

## 10. SURVEY COMPUTING AND SOFTWARE

To ensure consistency and interchangeability of data, the Consultant shall utilise software that is consistent with general industry best practice both within the consultancy and construction industry. The Consultant shall provide all files necessary to facilitate any transfer or conversion of data. If the Consultant chooses not to adopt the coding, symbols and line type presented below, then the Consultant shall seek the Client's approval of the proposed style and shall not proceed with the survey until the Client's approval of the proposed style is obtained. The Consultant shall supply the feature code library (or equivalent), macros and

line-type files along with a data exchange file of a format (Genio file of the Survey model and DXF file) that allows other consultants to correctly re-create and interpret the data.

## 11. OUTPUT

Following completion of the survey, the Consultant shall provide as a minimum the following:

- One colour copy of A1 sheet size 1:1000 scale topographical plan(s) with contours and services as appropriate.
- One electronic copy on compact disc with all relevant three-dimensional data in DWG, DXF, LANDXML and GENIO format including all other items required by this specification.
- Two copies of the Survey Report.

The Consultant's Survey Report shall consist of a brief summary including the specified information below:

- Location and type of control survey marks;
- Origin and Datum adopted;
- Time, date, weather conditions of survey;
- Summary of coding;
- Date service plans were obtained and origin of services indicated on the plans;
- DTM detail;
- Items unable to be located or surveyed;
- Plans of drawings specified above reduced to A3 sheet size;
- Field notes;
- Accuracy relative to the Control for the topographical survey; and
- Processing notes.

All of the Consultant's data supplied shall be legible and of suitable standard to be easily interpreted and understood. The Consultant shall supply electronic data in a format that facilitates manipulation, ensuring that different features are independently layered and coloured.

## 12. INFORMATION TO BE SUPPLIED TO THE CONTRACTOR

The Consultant shall ensure that the DTM and topographical features are made available for the use of contractors, both during the tendering phase of physical works and during the construction phase. If required, the Consultant shall supply the physical works contractor with a:

- Three-dimensional DXF file of the ground features including breaklines (e.g. surveyed features);
- The three-dimensional triangulation model (TIN) based on the DTM; and
- The contour information derived from the TIN.