Professional Services Specifications (PSS)

Last updated: December 2022

T4 – Engineering Survey for Planning and Design

Department of State Growth

Tasmanian Government

Contents

Revision History

Version No.	Date	Description of changes
1.1	July 2020	Interim version prior to undertaking a detailed review. Template updated and references to “DIER” removed. Superseded documents/entities and links updated.
1.2	October 2021	Complete Review and Update – Consultation Draft (State Roads Internal)
1.3	February 2022	Complete Review and Update – Consultation Draft (External Stakeholder Feedback)
1.4	June 2022	Final Draft for Approval (Stakeholder Workshop)
1.5	October 2022	Final Draft for Approval (Specifications & Standards Working Group)
2.0	December 2022	Endorsed for Publication

T4.1 Overview & Purpose

This Professional Services Specifications (PSS) provides the specific requirements for Engineering Surveying services and the collection / delivery of survey data to support the planning investigations and design activities to achieve the required construction tolerances for the Department of State Growth projects. This Specification is part of the set of specifications comprising the Professional Services Specifications (PSS).

T4.2 Scope

This specification sets out the requirements for undertaking engineering surveying services for the purposes of planning and design related to transport infrastructure, in particular:

- Survey Datum & Control
- Engineering Survey
- Digital Terrain Models
- Subsurface Utility Survey
- Property Boundaries
- Verification Survey
- Digital Imagery/Photography/Video
- Survey Feature Coding
- Engineering Survey Report & Metadata Statements
- Deliverables

T4.3 References, Standards & Related Documents

All surveys shall be in accordance with this Specification, all other Professional Services Specifications, relevant standards and reference documents.

<u>Department of State Growth Professional Services Specifications</u>

- T4 - Supplement A - Survey Request Form
- T4 - Supplement B - Primary Survey Control Mark Summary
- T4 - Supplement C - Metadata Statement
- T4 - Supplement D - Subsurface Utilities Metadata Statement
- T4 - Supplement E - Survey Report Template
- T3 - Road Design Guidelines & Standards
- T5 - Environment Investigations
- T6 Geotechnical Investigations
- T13 - CADD Manual

<u>Australian Standards and Austroads Guides</u>

- AS 5488-2013 Classification of Subsurface Utility Information
- AP-T269-14 Best Practice for Mobile LiDAR Survey Requirements

<u>Legislative and regulatory requirements</u>

- Surveyors Act 2002, Tasmania
- Land Acquisition Act 1993, Tasmania

- Survey Coordination Act 1944, Tasmania

Referenced Documents

- GDA2020 Technical Manual, Version 1.5, ICSM
- Standard for the Australian Survey Control Network (2014), Version 2.1, ICSM
- Guideline for the Adjustment and Evaluation of Survey Control (2014), Version 2.1, ICSM
- Guideline for Control Surveys by GNSS (2014), Version 2.1, ICSM
- Guideline for Control Surveys by Differential Levelling (2014), Version 2.1, ICSM
- Guideline for Conventional Traverse Surveys (2014), Version 2.1, ICSM

T4.4 Definitions

The following definitions and abbreviations are to be used in the context of this specification:

Datum - A set of parameters which define the origin and orientation of a reference system with respect to a fundamental absolute system.

Geocentric Datum of Australia 2020 (GDA2020) - A mathematical definition of the earth's shape, with its origin at the earth's centre of mass. GDA was fixed against the International Terrestrial Reference Frame 2014 (ITRF2014) at epoch 2020.0, hence referred to as GDA2020.

Map Grid of Australia 2020 (MGA2020) - Cartesian coordinates from a universal transverse Mercator projection based on the Geocentric Datum of Australia 2020 (GDA2020) latitudes and longitudes.

Australian Height Datum (Tasmania) (AHD-TAS83) - Is based on mean sea level in 1972 at tides gauges in Hobart and Burnie. It was propagated throughout Tasmania using third order differential levelling over 72 sections between 57 junction points and computed via adjustment on 17 October 1983. Mean sea level at both Hobart and Burnie was assigned the value of zero.

AUSGeoid (2020) – Is a combined gravimetric-geometric model used to transfer heights between the ellipsoid (GDA2020) and the Australian Height Datum (AHD).

ALS - Airborne LiDAR Survey

Provider - The legal entity that is contracted to execute the survey.

DTM - Digital Terrain Model of the ground surface generated from a survey

DBYD – Dial Before You Dig. A free national referral service designed to assist in preventing damage and disruption to infrastructure networks. Referrals are provided to relevant utility owners registered with the service, who then provide information of the location of their utilities. Required to establish the location of underground utilities in particular.

GNSS - Global Navigation Satellite Systems

GSD – Ground Sample Distance - resolution of Geo-referenced Aerial Imagery in metres

ICSM - The Inter-Governmental Committee on Surveying and Mapping (ICSM) is the body responsible for coordinating Commonwealth and State agencies who contribute to surveying and mapping at a national level to ensure continued cooperation and technical standards. Its role includes developing survey standards and specifications.

LiDAR - Light Detection and Ranging technology that uses ultraviolet, visible, or near infrared light to measure distance to objects and capture dense point clouds of information from a mobile platform such as a fixed-wing aircraft or helicopter.

"Minor Survey Control (MSC)" - MSC points are established as a stable point of reference for all operational survey aspects i.e., the acquisition of ground feature or cadastral boundary information, or the construction set-out survey. It is accepted that MSC points may be destroyed during the construction process.

MLS - Mobile LiDAR Survey

Relative Uncertainty (RU) - is the average measure, in millimetres, at the 95% confidence level, of the relative uncertainty of the co-ordinates (position), or height, of a point(s), with respect to adjacent survey control marks.

RTK GNSS - Real-time Kinematic Global Navigation Satellite System

"Permanent Survey Mark" – a permanently monumented survey control mark with horizontal coordinates and/or height of known accuracy adopted as a permanent mark under Section 14 of the Survey Coordination Act 1944 (Tasmanian Act) and included in the online register (SurCoM) maintained by the Tasmanian Office of the Surveyor General (*https://surcom.dpipwe.tas.gov.au/surcom/jsp/login*).

Positional Uncertainty (PU) - is the uncertainty of the horizontal and/or vertical coordinates of a survey control mark with respect to the defined datum and represents the combined uncertainty of the existing datum realisation and the new control survey. That is, PU includes SU as well as the uncertainty of the existing survey control marks to which a new control survey is connected.

"**Primary Survey Control (PSC)**" – is a substantial survey control mark that is intended to survive, undisturbed, the entire life of the project– from design to construction, including all necessary compliance and audit surveys. It will either be an existing Permanent Survey Mark or a mark of an approved form described in *T4.6 - Survey Datum and Control*

SP1 – ICSM Special Publication 1 *Standard for the Australian Survey Control Network* (current version 2.2, December 2020), under the Standard for the Australian Survey Control Network heading available at *https://www.icsm.gov.au/publications*.

SurCoM - Tasmania Survey Control Marks Database *https://surcom.dpipwe.tas.gov.au/surcom/jsp/index.jsp*

Survey Uncertainty (SU) - is the uncertainty of the horizontal and/or vertical coordinates of a point relative to the survey in which it was observed and is free from the influence of any imprecision or inaccuracy in the datum connection. Therefore, Survey Uncertainty reflects only the uncertainty resulting from survey measurements, measurement precisions, network geometry and the choice of constraint. It is expressed at the 95% confidence level.

TLS - Terrestrial LiDAR Survey

T4.5 Survey Requirements

T4.5.1 General

Engineering Survey and associated activities can be initiated for number of various purposes in support of the planning, design and construction requirements related to transport infrastructure. This section is structured such that the general requirements for all survey types are presented. Engineering Survey activities support all phases of project planning, design and delivery which include:

- Corridor Planning
- Project Identification/Scoping
- Concept/Preliminary/Detail Design
- Construction/Re-design or design changes
- As-Constructed Survey

Table T4.5.1.1 outlines the various survey types in support of surveying services for the purposes of planning and design related to transport infrastructure.

T4.5.1.1. Survey Types

Survey Type	Requirement	Section
All Survey	Survey Control	0
Engineering Survey	Pavement Feature survey Digital Terrain Model (DTM) Subsurface Utilities Verification Survey Digital Imagery/Photography/Video	T4.7.3 **Error! Reference source not found.** 0 0 0 **Error! Reference source not found.**
Property Boundaries	Property Cadastral Models Property Boundary Models Property Acquisition Survey	T4.10.1 T4.10.2 T4.10.3

Despite the multitude of purposes and, potentially, multiple sources of information for an Engineering Survey, it essentially consists of four components:

1. Location – positional information to represent detail in its correct relative position
2. Definition – accepted descriptive representation of the detail and its component attributes
3. Presentation – present the collected detail in a format that is usable, understandable and unambiguous
4. Quality – systematic methodology and auditing procedures to assure the integrity of the information.

These components exist in some form in all Engineering Survey projects.

T4.5.2 Survey Request Form

The **T4 - Supplement A - Survey Request Form** must be provided before the commencement for any survey work. The form intends to provide project specific details, including the project purpose & scope, survey extents and relevant survey quality levels.

T4.5.3 Quality Levels

Quality Levels (QL) define the various levels of uncertainty (accuracy) of survey types based on the project scope and purpose. The implementation of QL's for all survey types reflects contemporary practice adopted by other State Road Authorities and is consistent with the terminology used in Australian Standards AS 5488:2019 Classification of subsurface utility information.

T4.5.4 Qualification of Surveyors

All surveys shall be the responsibility and be performed under the direct supervision of a qualified surveyor as listed in ***Table T4.5.4.1Qualifications of Surveyors***. All surveyors must be able to demonstrate competence in carrying out the required surveying tasks.

T4.5.4.1. Qualifications of Surveyors

Survey Type	**Qualification**
Survey Control	A person who holds a three- or four-year surveying degree based on the Australian Qualifications Framework (AQF) Level 7 or higher or has a qualification that would enable professional accreditation as an Engineering Surveying Professional – Asia Pacific (ESP-AP) with SSSI; and Possess at least three (3) years practical experience as a survey party leader on major roadworks and/or bridgeworks as appropriate.
Engineering Survey	A person who holds a three- or four-year surveying degree based on the Australian Qualifications Framework (AQF) Level 7 or higher or has a qualification that would enable professional accreditation as an Engineering Surveying Professional – Asia Pacific (ESP-AP) with SSSI; and

Survey Type	Qualification
	Possess at least three (3) years practical experience as a survey party leader on major roadworks and/or bridgeworks as appropriate.
Subsurface Utilities	Where applicable, all personnel undertaking subsurface utilities (asset) investigation must be trained and currently accredited in accordance with the requirements of the owners of the underground assets. This may include restrictions by the asset owner on lifting inspection lids.
Property Cadastral & Boundary Models	Registered Land Surveyor under the (Tasmanian) Surveyors Act 2002.
Property Acquisition Survey	Registered Land Surveyor under the (Tasmanian) Surveyors Act 2002.

T4.6 Survey Datum and Control

T4.6.1 Datum

A Survey Datum is the framework upon which all geospatial information is referenced. The Survey Datum not only supports the accuracy of captured survey data, but also provides geospatial correlation with other data sets. It decides the integrity of delivered geospatial products and is the core element for sharing geospatial information within the department and other agencies in government, as well as the private sector.

The datum for all surveys should be the Geocentric Datum of Australia (GDA) to ensure seamless integration with all other national and state datasets. Currently this is GDA2020, with survey data to be provided in MGA2020 coordinates. Generally, the vertical datum for all surveys should be AHD83 (Tasmania).
The origin and methods for realising the Survey Datum (Horizontal and Vertical) must be specified in the *Survey Report*.

Where the use of either of these datums is not practical an alternative datum proposal must be submitted for approval prior to commencement of any survey operations.

T4.6.2 Datum Control

To rigorously propagate datum to the Primary Survey Control Network, direct measurements to the Primary Survey Control Marks are required. Datum Control can be in the form of permanent marks within SurCom administered by NRE and or Continuously Operating Reference Stations (CORS) with a Regulation 13 certificate and or the use of AUSPOS solutions.

When determining the origin for datum establishment and the method adopted for connection consideration must be given to the identity, reliability and quality of the datum control and undertaken in accordance with established survey best practice.

T4.6.3 Quality Levels – Datum Control

For the purposes of selecting datum control regards the connection from the Primary Survey Control network the datum control will achieve and be quantified in terms of **Positional Uncertainty (PU).** PU relates to the reliability of horizontal and/or vertical coordinates of datum control.

Positional Uncertainties (PU) of datum control shall be in accordance with the required Quality Level (QL) outlined within the **T4 - Supplement A - Survey Request Form**. Table T4.6.3.1 specifies the various Quality Level Datum Control Positional Uncertainties (PU).

T4.6.3.1. Quality Levels (QL) Datum Control

Quality Level (QL)	A		B		C		D	
	Positional Uncertainty (PU) (m)							
	Position	Height	Position	Height	Position	Height	Position	Height
Datum Control	±0.020	±0.030	±0.020	±0.030	±0.050	±0.050	±0.050	±0.050

T4.6.4 Horizontal Coordinate Datum

Horizontal coordinate datum for all surveys shall be the Geocentric Datum of Australia 2020 (GDA2020) and implemented in the relevant zone of the Map Grid of Australia (MGA2020). The relevant zone covering the majority of Tasmania is Zone 55, with a smaller area over part of King Island in Zone 54.

For further information on GDA please refer to: *https://www.icsm.gov.au/gda2020*

When selecting the origins of the horizontal datum control the following hierarchical system shall be considered in descending order of desirability:

- Use of a Permanent Survey Mark held in SurCoM with PU consistent with QL in table T4.6.3.1
- Use of Continuously Operating Reference Stations (CORS) with a Regulation 13 certificate with PU consistent with QL shown in table T4.6.3.1
- Use of AUSPOS solution – where the AUSPOS report must indicate that a reliable solution has been achieved with PU consistent with QL shown in table T4.6.3.1

T4.6.5 Azimuth Datum

The Azimuth is obtained from the horizontal coordinates used for establishment of the Horizontal Datum.

T4.6.6 Vertical (Height) Datum

All surveys on the Tasmanian mainland and near-shore islands (e.g., Bruny Island) shall be based on the Australian Height Datum (AHD83 Tasmania). Local height datums apply on King and Flinders Island but the process for obtaining heights on those local datums is the same as for obtaining AHD83 heights specified below.

For more information on AHD refer to:

- *https://nre.tas.gov.au/land-tasmania/geospatial-infrastructure-surveying/geodetic-survey/coordinate-height-and-tide-datums-tasmania; and*
- https://www.icsm.gov.au/sites/default/files/2022-08/AGRS_Compendium_20220816.pdf (Chapter 16 - AHD)

When selecting the origins of the vertical datum control the following hierarchical system shall be considered in descending order of desirability:

- Use GDA2020 ellipsoidal heights (h) and Ausgeoid2020 (N) to calculate AHD83 heights (H); whereby (H = h – N) from SurCom marks held in SurCoM with GDA2020 ellipsoidal height PU consistent with QL in table T4.6.3.1
- Use GDA2020 ellipsoidal heights (h) and Ausgeoid2020 (N) to calculate AHD83 heights (H); whereby (H = h – N) from CORS with a Regulation 13 certificate with GDA2020 ellipsoidal height PU consistent with QL in table T4.6.3.1
- Use of AUSPOS solution – where the AUSPOS report must indicate that a reliable height solution has been achieved with GDA2020 ellipsoidal height PU consistent with QL shown in table T4.6.3.1.

- Use of a Permanent Survey Mark held in SurCom with height PU consistent with QL in table T4.6.3.1

GDA2020 ellipsoidal heights for SurCom marks can be obtained from the Basic mark report downloaded from the SurCom Site https://nre.tas.gov.au/land-tasmania/geospatial-infrastructure-surveying/geodetic-survey/survey-control-marks-database-(surcom)

SurCom does not provide GDA2020 ellipsoidal PU values relating to mark records within it. Therefore, for the purposes of this specification GDA2020 ellipsoidal Height PU for marks in SurCom can be calculated as 1.5 x the datum control Position (horizontal) PU as shown in SurCom.

T4.6.7 Primary Survey Control Network

Survey Control refers to the network of ground marks that both realise the Survey Datum and establishes the physical framework from which the observations & measurements for the Engineering Survey will propagate. The *Intergovernmental Committee on Surveying and Mapping (ICSM) Standards and Practices for Control Surveys (SP1)* sets out standards of accuracy and provides recommended survey and reduction practices for control surveys. The current document can be found at *https://www.icsm.gov.au/standard-australian-survey-control-network-special-publication-1-sp1*

Survey Control is a fundamental component of any infrastructure project, supporting the various phases in relation to planning, design, and construction activities. The *quality*, i.e., the density, stability and accuracy of the control network is largely defined by the project requirement and the intended use of the survey.

A Primary Survey Control Network shall be established as part of the Engineering Survey. The Primary Survey Control Network is a key component of the Survey Datum (Horizontal and Vertical) and defines the position of a project as evidenced by the coordinates of the survey control network marks. As a minimum, it must consist of at least three (3) Primary Survey Control (PSC) marks in the survey and engineering works.

T4.6.8 Primary Survey Control Mark

Permanent Survey Control (PSC) marks are to be placed or an existing PSC is to be adopted for Primary Survey Control on projects. All PSC marks within the project limits or immediately adjacent shall be connected to and referenced in the project records.

The prime consideration in the location of a PSC, should be the safety of the surveyor and the public, including livestock. A PSC mark should preferably be located so that it will survive indefinitely i.e., the life of the entire project. However, it is recognised that often during the initial Engineering Survey the extent of the final construction earthworks is unclear, and no guarantee can be made of PSC longevity. If this is the case the PSC must be positioned on the basis that it would survive intact indefinitely if no construction were to take place, with the condition that PSC should never be placed between the road centreline and an open roadside drain on a formation without kerb and guttering.

In general, a PSC mark should be:

- Made of good quality, durable, corrosion resistant materials. It should employ robust construction techniques and where possible be installed in stable ground or in solid rock, such that it is least likely to be subject to local displacement or other seasonal or periodic movements. If a survey control mark is to be installed in an unstable area, permanent marking may require placing deep-seated survey control marks that penetrate the surface soil to the depth of refusal, thus bypassing the zone of seasonal or periodic influence.
- Permanently and clearly marked with a unique identifier to ensure unambiguous identification. A station identifier should be engraved or stamped on the survey control mark, or a durable tag with the identifier firmly attached. A marker post or indicator should be installed if a survey control mark will not be easy to find.
- Accessible to allow for its proper use, and
- Located in a position that maximises the use of various measurement techniques and connection to existing and future marks. For instance, a survey control mark that is intended to be observed using GNSS techniques will require optimal sky view, free of obstruction, multipath and radio frequency interference (RFI) sources.
- Located away from underground services in the area. Due to the depth of the star picket, there is a real danger that some underground cables may be damaged. Such damage will be the responsibility of the Surveyors placing the PSCM.

A suitable PSCM must either be an existing State Permanent Mark– as defined within the Tasmanian Survey Control Marks Database (SurCoM) that meets the requirements as indicated below, and / or a mark of a form as follows:

- A minimum 1350mm long star bar (or minimum 14mm diameter rod), driven to resistance or to full length, preferably 20mm below natural surface (or as close as possible to natural surface if this is not achievable).
- A new bolt, screw or bar affixed with a rapid-set grout in a pre-drilled hole in concrete or bedrock.
- Any existing fixing bolt or bar in concrete.
- A PSC must have a witness mark unless it is not safe to livestock or the public to do so. The PSC should have a unique identifying label attached to the physical mark, or alternatively a witness mark, and marked in a permanent way (i.e., the number stamped or engraved on an aluminium tag).
- A PSC must be located adjacent to all road intersections so that it is possible to define intersection detail, a pair of marks may be needed for large intersections.

When considering a suitable type of PSCM its it is important to preserve the vertical stability of the mark, so it is suggested that the ground mark be of suitable quality and dimensions to achieve this. **Appendix C provides suggested options for various mark types in different areas and soil/ground conditions**.

T4.6.9 Quality Levels – Primary Survey Control

The current ICSM Standard for the Australian Survey Control Network - SP1 (*https://www.icsm.gov.au/standard-australian-survey-control-network-special-publication-1-sp1*) is to be used as reference for the minimum requirements to determine position and associated uncertainty for the Primary Survey Control Network. SP1completes the transition from CLASS and ORDER to Uncertainty as the basis for evaluating and expressing the quality of measurements and positions.

For the purposes of survey control quality, the Primary Survey Control will achieve and be quantified in terms of **Survey Uncertainty (SU).** Survey Uncertainty relates to the reliability of horizontal and/or vertical coordinates of a survey control mark relative to the survey in which it was observed and is free from the influence of any imprecision or inaccuracy in the underlying datum realisation (Datum Control). Therefore, SU reflects only the uncertainty resulting from survey measurements, measurement precisions, network geometry and the choice of constraint. A minimally constrained least squares adjustment is the preferred and most rigorous way to estimate and test SU. SU is expressed in SI units at the 95% confidence level.

Survey uncertainties (SU) of PSC shall be in accordance with the required Quality Level (QL) outlined within the **T4 - Supplement A - Survey Request Form**. Table T4.6.9.1 specifies the various Quality Level PSC Survey Uncertainties and related information.

T4.6.9.1. Quality Levels (QL) Primary Survey Control

Quality Level (QL)	A		B		C		D	
	Survey Uncertainty (SU) (m)							
	Position	Height	Position	Height	Position	Height	Position	Height
Primary Survey Control	±0.010	±0.005	±0.020	±0.010	±0.050	±0.050	±0.050	±0.050
Maximum Distance Between PSC Marks	100m		500m		5km		10km	

When establishing and observing a survey control network there are a variety of measurement and processing methods available. Equipment and techniques which best suit the requirements of the project shall be selected, keeping in mind the limitations of each technique. The survey control guidelines associated with SP1 outline the recommended survey practices to achieve required levels of uncertainty.

T4.6.10 Survey Datum & Control Records

T4.6.10.1. SPC Mark Summary

For each PSC mark used or established a Mark Summary document is required to be completed and supplied as part of the project deliverables, using the **T4 - Supplement B – Primary Survey Control Mark Summary**.

The PSC mark summary, using the template, is to include at a minimum:

- Project Name / Description (Include project reference, where applicable)
- Mark Description & Location.
- Photo of mark placed/adopted
- PSC Coordinate information
- Details of GNSS Observations when applicable

T4.6.10.2. Minor Survey Control

Minor Survey Control marks may be placed as required but it is accepted that they may be destroyed during the construction process, and therefore are considered temporary marks only.

Where Minor Survey Control marks are placed and coordinated for the purposes of the engineering survey, a list of marks placed, coordinates and heights calculated shall be provided as part of the Engineering Survey Report.

MSC marks, if placed, must conform to the same level of accuracy as PSC marks and should have a unique identifying label to distinguish them from PSC marks.

T4.6.10.3. PSC GNSS Baseline Records

GNSS baselines measurements associated with the PSC are to be supplied as part of the project deliverables. The non-adjusted baselines (preferably in a proprietary Leica SKI-ASCII or Trimble TBC format). In addition, the baseline records in conjunction with the Survey Report are to be provided to the Office of the Surveyor General, Land Tasmania (*osg@nre.tas.gov.au*), such that this information can be assessed and used to update the Tasmanian Survey Control Marks Database (SurCoM).

T4.7 Engineering Survey

T4.7.1 General

Engineering Surveys are used for recording the status of the physical world, they define a projects topography (ground) and locate (model) those entities (features) that may influence a road infrastructure project. Engineering surveys can be initiated for several purposes, which include:

- Corridor Planning
- Project Identification/Scoping
- Concept/Preliminary/Detail Design
- Construction/Re-design or design changes
- As-Constructed Survey

The preceding list is not exhaustive, and each purpose has its specific requirements. The project scope, i.e., feature type & density and related accuracies, depends on the purpose for which the survey information is to be used. The **T4 - Supplement A - Survey Request Form** is intended to specify the relevant details including survey purpose and scope of project.

The data capture methodology used to detail the pavement surface (i.e., Total Station, RTK GNSS) is to be decided by the surveyor, however the method chosen must be capable of achieving the Quality Level of the survey as outlined in the **T4 - Supplement A - Survey Request Form**.
Appendix A provides a guide to data capture methods and what Quality Levels they can achieve.
Appendix B provides a guide to good practice for feature capture and coding. It includes examples for the points / feature codes to be captured for several feature types.

T4.7.2 Quality Levels – Engineering Survey

The located points which make up the break lines, spot heights and detail features are to be located to an accuracy commensurate with that specified by the Quality Level (QL) within the request form.

Table *T4.7.2.1* sets out the required Relative Uncertainty (accuracy) for Engineering Survey Features related to the relevant Quality Level.

T4.7.2.1. Quality Levels (QL) Engineering Survey

Quality Level (QL)	A		B		C		D	
	Relative Uncertainty (RU) (m)							
Feature Class	Position	Height	Position	Height	Position	Height	Position	Height
Constructed Pavement	±0.015	±0.010	±0.050	±0.030	±0.100	±0.050	±0.200	±0.200
Structures	±0.020	±0.010	±0.050	±0.030	±0.100	±0.050	±0.200	±0.200
Ground Features	±0.100	±0.100	±0.100	±0.100	±0.200	±0.200	±0.500	±0.500
Trees/Vegetation	±0.100	NA	±0.100	NA	±0.200	NA	±0.500	NA

Accuracies stated above in terms of 'Relative Uncertainty' is the average measure (in millimetres) at the 95% confidence level of the relative uncertainty of the co-ordinates (position), or height, of a point(s), with respect to adjacent survey control marks. This can be thought of as the allowable semi-major axis of the standard error ellipse with respect to the known control station.

Appendix B describes the various feature types within each of the feature classes shown in table T4.7.2.1.

T4.7.3 Quality Level Pavement and Sealed Roads

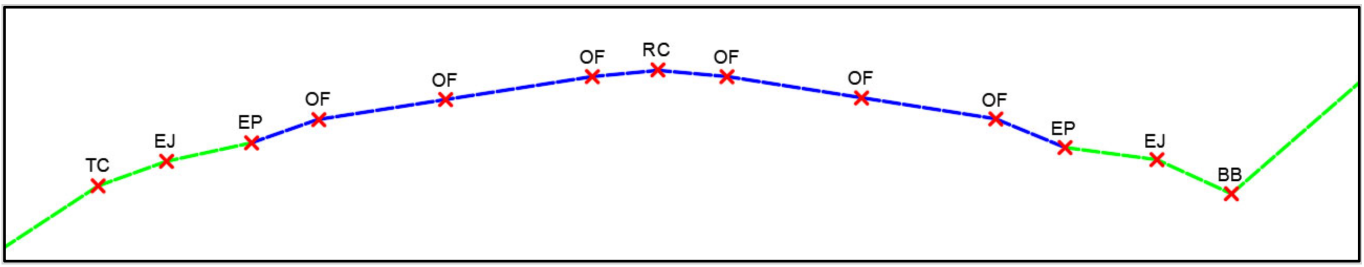
Sufficient points and strings must be captured/modelled across road surfaces to ensure the shape is accurately defined to the specified QL tolerance. At a minimum, any sealed road surface with a 'crown' requires a string to be surveyed on the crown and strings on either pavement edge.

T4.7.3.1. Quality Levels (QL) Pavement Survey

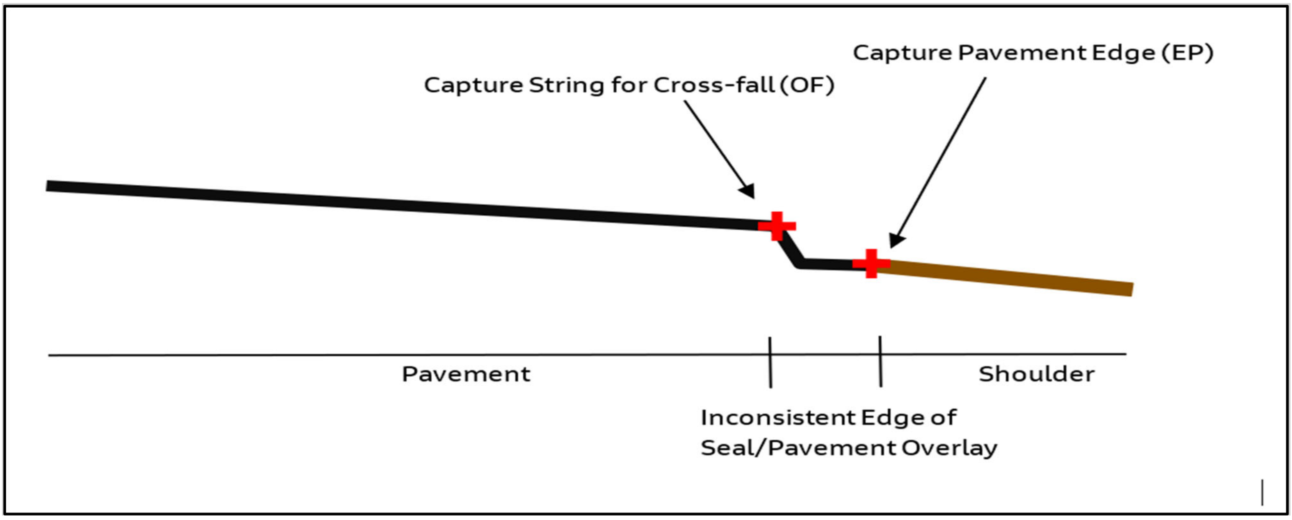
Quality Level (QL)	A	B	C	D
Maximum Linear distance between sections	10m	20m	30m	40m
Arc to Chord tolerance (vertical)	±0.015	±0.050	±0.100	±0.200

A separate pavement Digtial Terrain Model (DTM) shall also be provided in accordance with requirements shown in Section 0.

A QL-A or QL-B survey will require several strings to be captured across the pavement surface to allow crossfall to be accurately assessed. The number of strings surveyed in a single cross section will vary depending on the survey QL; ensuring the maximum vertical Arc to Chord tolerance is not exceeded. An example typical cross section and edge of seal/pavement diagram is provided below. The typical section, diagram and plan views are also provided in Appendix B.



Example cross section of crowned road -meeting Quality Level QL-A



Example cross section of road at Edge of Pavement

T4.8 Digital Terrain Model

Within the project extents, sufficient points and features shall be captured to suitably describe the terrain surfaces by observing changes of grade and measuring as many intermediate points as are needed between the changes of grade to ensure the description of a feature maintains its relevant Survey Uncertainty.

Depending on the relevant Quality Level required for the project purpose/scope (Table T4.8.31), the following terrain models are to be provided.

T4.8.1 Triangulated Digital Terrain Model (DTM)

Triangulated ground models (DTM) are generated using points, strings, and break line observations of appropriate ground features. Separate 3D triangulated terrain model is to be provided for the following:

- Surface Model – DTM of all surfaces including the pavement surface.
- Pavement Model – DTM of the pavement surface between the edges of pavement and/or back of kerb

The surface and pavement DTMs must fit together seamlessly.

T4.8.2 Gridded Digital Terrain Model (DTM)

A gridded DTM is a single ground model generated using a regular grid of ground points across the survey extents, which can either be produced from ground survey measurements or existing LiDAR. When requested the spacing between gridded points within the DTM must be consisted with the QL of the constructed pavement and not greater than 30 metres in all other areas.

T4.8.3 Quality Levels – Digital Terrain Model

T4.8.3.1. Quality Levels (QL) Pavement Survey

Quality Level (QL)	A	B	C	D
Terrain Model(s) Required	Triangulated DTM Surface and Pavement Model	Triangulated DTM Surface and Pavement Model	Gridded DTM Single Ground Model	Gridded DTM Single Ground Model

T4.9 Subsurface Utilities Survey

The survey may require subsurface utility assets to be located. The Provider shall be responsible for the collection of subsurface utility data for the purposes of planning, detail design, maintenance and construction. The Provider when investigating subsurface utilities shall liaise with the appropriate Utility Owner to determine any conditions that are required by the Utility Owner are met. Location of subsurface utilities shall be undertaken by an accredited service provider.

T4.9.1 Quality Levels – Subsurface Utilities

For subsurface utilities, Australian Standard AS 5488 (2019) Classification of Subsurface Utility Information "Quality Levels" shall apply. Each Quality Level is determined by the method of data acquisition and describes the relative uncertainty of the information that is collected.

T4.9.1.1. Quality Level – Subsurface Utilities

Quality Level (QL)	A		B		C		D	
	Position	Height	Position	Height	Position	Height	Position	Height
Relative Uncertainty	±0.050	±0.050	±0.300	±0.500	±1.000	N/A	N/A	N/A
Observation Density	Maximum of 15m between observations and all changes of direction				N/A			

T4.9.1.2. Subsurface Utilities Quality Level D (QL-D)

The Provider will be required to perform the following tasks to complete a QL-D utilities search.

- Collect utilities data from Dial Before You Dig (DBYD) or the service providers / custodians. This can include property owners, mine sites, local government authorities, State Growth, etc.
- Supply all utility information in digital format using State Growth feature codes and file formats. These lines are to be clearly layered in the underground utilities survey model with the layer post fix "QL-D".
- Supply all raw data obtained from the service providers; include evidence of no services in area responses.
- Provide an underground utilities survey meta data statement.

T4.9.1.3. Subsurface Utilities Quality Level C (QL-C)

The Provider will be required to perform the following tasks to complete a to QL-C utilities survey.

- Perform all tasks for a QL-D utilities search.
- Capture all surface utility features.
- Alter all subsurface utility locations obtained from QL-D utilities search to align with captured surface features to depict their location.
- Supply all utility information in digital format using State Growth feature and file formats. These lines are to be clearly layered in the underground utilities survey model with the layer post fix "QL-C"
- Provide an underground utilities survey metadata statement.

T4.9.1.4. Subsurface Utilities Quality Level B (QL-B)

The Provider will be required to perform the following tasks to complete a to QL-B utilities survey.

- Perform all tasks for a QL-C utilities survey.
- All utilities shall be surveyed by an indirect survey method. This can involve locating gas, electrical, phone, water, sewer and other cables with methods such as ground penetrating radar, active and passive frequency detectors, electromagnetic detectors and acoustic detection systems.
- Leave markings on the earth's surface to denote the position of the underground utility.
- Supply all utility information in digital format using State Growth feature codes and file formats. These lines are to be clearly layered in the underground utilities survey model with the layer post fix "QL-B"
- Provide an underground utilities survey metadata statement.

T4.9.1.5. Subsurface Utilities Quality Level A (QL-A)

Quality Class-A is the highest accuracy order for a subsurface utilities survey.

The Provider (or subcontractor) must be licensed or accredited with the utility owner to expose requested utilities. All necessary approvals must be in place to undertake the work.

The Provider will be required to perform the following tasks to complete a QL-A underground utilities survey.

- Perform all tasks for a QL- B utilities survey.
- Liaise with State Growth / project design Provider to identify pothole locations required.
- Expose / pothole the utility and directly measure it using adequate survey methods.
- Survey methods must achieve accuracies of ±50mm horizontally and ±50mm vertically.
- Potholes created in roads or pathways will require backfilling and reinstatement to allow safe traffic and pedestrian movement after the work is completed.
- The Provider must ensure the integrity of the utility and the safety of the workers and public are maintained at all times.
- Supply all utility information in digital format using State Growth feature codes and file formats. These lines are to be clearly layered in the underground utilities survey model with the layer post fix "QL-A"
- Provide an underground utilities survey metadata statement.

T4.9.2 Attribute Information

Attribute information (where available) shall include, but is not limited to:

- Quality Level (This information is contained within the feature layer name)
- Location Method
- Justification (Top of pipe, centreline of pipe etc)
- Asset type
- Size
- Material
- Condition
- Status

T4.9.3 Gravity Pipelines

Stormwater and sewer pipelines that are gravity mains that can be surveyed by measuring invert levels in junction pits, may form part of a subsurface utilities survey and or be included in the engineering survey.

T4.10 Property Boundaries

Generally, property information consists of a boundary model that provides information relating to the location, ownership, and tenure of property boundaries within the project area.

All property boundary survey work shall be undertaken under the direct supervision of a Registered Land Surveyor under the (Tasmanian) Surveyors Act, and in accordance with requirements of the Surveyor General and the Survey Direction pursuant to the Surveyors Act.

The Engineering Survey Report is required to provide an estimate of the positional accuracy (uncertainty) of the property boundaries in relation to its true position. The estimate should be based on an assessment of the information used and methodology adopted.

T4.10.1 Property Cadastral Model

The Property Cadastral Model is based on the current LISTMap cadastral parcel overlay/data model (*https://listdata.thelist.tas.gov.au/opendata/index.html#LIST_Cadastral_Parcels*) and will consist the following information.

- Property boundaries based on:
    - (LIST Cadastral Data);
- Owner Names;
- Folio References;
- Nature of ownership of road corridor including "User Roads"; and
- Crown Land and Reservations.

T4.10.2 Property Boundary Models

The Property Boundary Model comprises a model showing the position of property (title) boundaries based primarily on a desktop compilation of existing title survey information and will consist of the following information:

- Property boundaries based on:
    - Desktop compilation of title plan & associated survey material, supported by information captured for engineering survey, such as pegs and fencing etc.
- Owner Names;
- Folio References;
- Easements and other encumbrances affecting properties;
- Nature of ownership of road corridor including "User Roads";
- Crown Land and Reservations.

T4.10.3 Property Acquisition Survey

Where Property Acquisition is required as part of the project, all Property Acquisition Surveys shall meet the requirements of the Surveyor General and the Survey Direction pursuant to the Surveyors Act.

Survey diagrams shall be prepared to the requirements of the Lands Titles Office and in accordance with the Land Acquisition Act 1993.

T4.10.4 Quality Levels – Property Boundaries

The Survey Request Form will define the survey scope including the relevant Quality Levels. Table T4.10.4.1 indicates the various QL for property boundary survey/information.

T4.10.4.1. Quality Level Property Boundaries

Quality Level (QL)	A	B	C	D
Type	Acquisition Survey	Boundary Model	Cadastral Model	Cadastral Model

T4.11 Verification Survey

To assess conformance with the Quality Levels (QL) a verification survey of the engineering pavement and surface models must be undertaken unless otherwise specified for all engineering surveys that are specified for preliminary & detail design and/or construction/re-design.

Verification shall be carried out by measuring 'quality line strings' across the project using equipment and methodology that meets or exceeds the accuracies in Table T4.7.2.1. A quality line string is a series of surveyed points measured across the engineering survey model to provide compliance. The results are to be included in the survey report.

The following guidelines apply to verification surveys:

- **Validation strings must be observed independently of the survey observations**.
- The verification strings may be in a separate model and not included in the engineering models.
- The PSC used must be the same control used for the engineering survey. However, the same instrument set-up for ground detail and verification measurements must not be used. The instruments must be completely removed and re-set up. The preferred method is to make the validation observations following completion of processing the engineering survey.
- Validation strings must be provided as follows:
  - A minimum of three strings per survey, and
  - Two strings per road intersection, and
  - One string for each 250 metres of surveyed corridor on urban projects, or
  - One string for each 1km of surveyed corridor for rural projects
- Each string should traverse the model at approximately 45 degrees to the nominal centreline of the road.

The Pavement and surface models shall be compared to the verification strings and the height differences reported. The surface is deemed to pass vertical deviation requirements if:

- **95%** of verification points are within **two (2) times the accuracy** range defined in the survey request and specified in Table T4.7.2.1 for the **pavement model** & **68%** of verification points are within the accuracy range defined in the survey request and specified in Table T4.7.2.1 for the **pavement model.**

- **80%** of verification points are within the accuracy range defined in the survey request and specified in Table T4.7.2.1 for the **surface model**.

T4.12 Digital Imagery/Photography/Video

In addition to the requirement to provide digital photographs of Primary Survey Control Points, the following types of digital imagery may be requested as part of a survey.

T4.12.1 Geo-referenced Aerial Imagery

If requested, the Provider shall provide geo-referenced aerial imagery of the Project site. The Provider should consider the requirements (Ground Sample Distance, scale etc) as provided in the survey brief. Geo-referenced Aerial Imagery can be provided through various sources and methods. Methods and techniques which best suit the requirements of the project shall be selected, keeping in mind the limitations of each technique.

- Existing Land Tasmania orthorectified digital aerial imagery (LISTMap). Since 2012 digital aerial photo orthomosaics have been acquired by Land Tasmania over areas of Tasmania as part of the Tasmanian Imagery Program. This imagery continues to be acquired on a project area basis from several providers.

- Capturing new geo-referenced digital aerial imagery. The use of Remote Piloted Aircraft (RPA) or “drones” will need to comply with the conditions and requirements of the Civil Aviation Safety Authority (CASA). Verification that those conditions can be met will need to be provided as part of the submission to a survey request.

T4.12.2 Site Photography

If requested, The Provider shall provide colour digital photographs of:

- the site
- culvert inlet & outlet structures
- signs
- any features of particular interest to the road designer, and label or number of photograph and geo-tag as appropriate.

The Provider shall provide an index that includes the location of the feature, and the position and view direction from which the photograph was taken.

T4.12.3 Site Drive-through Video

If requested, the Provider shall provide drive-through video of the site in both directions. The resolution and frame rate must not be less than 1280x720 (HD) and 25fps respectively. The accepted video file formats are MP4 and AVI.

T4.13 Survey Feature Coding

The standard survey feature labels / codes are provided within Professional Service Specification (PSS) T13: CADD Manual.

All features defined within the survey project area shall be captured and represented as coded points or strings using survey labels defined in T13. A template in (AutoCAD dwg format) with feature layering to conform to presentation standards is included in the T13 support files download available from the Professional Services Specifications / Technical Specifications web page:
(*https://www.transport.tas.gov.au/roads_and_traffic_management/contractor_and_industry_information/professional_service_specifications*)

Note that some feature codes are directional (e.g., barrier/separation lines) and must be applied accordingly to ensure the string is aligned to the feature (some samples are provided in Appendix B). Measurement accuracies of points and string features shall be in accordance with the required Quality Level as outlined in the survey request form. The Quality Level attained for the survey is to be reported in the **T4 - Supplement C - Metadata Statement**.

T4.14 Engineering Survey Report & Metadata Statements

An Engineering Survey Report must be completed and be supplied with the survey data models. The Survey Report must append all applicable Supplements, including the Survey Request Form, PSC Summary & Metadata Statements.

The survey report is to include, at a minimum:

- Statement that the project has been conducted and completed according to the Survey request and is compliant with this specification
- Project Name / Description (Include project reference, where applicable)
- Road Name, Number and extents, or location description as applicable.
- Survey datum & control, including Information of all control established and used.
- Engineering, subsurface and property survey methodology and information.
- Model verification reports

T4.15 Deliverables

Deliverables associated with an Engineering Survey will be as per the Survey Request Form and meet the following requirements:

Name	Digital File Format
Engineering Survey Report & Metadata Statements	• PDF
Primary Survey Control (PSC) • PSC Mark Listing • PSC Summaries, as per template • PSC GNSS Baselines	• Text (CSV/TXT formatted in Point ID, Easting, Northing, Height, Description) • PDF • Leica SKI-ASCII or Trimble TBC
Metadata Statements, as per templates	• PDF
Engineering Survey Models • Engineering Feature Model - containing all features (points/strings) • Digital Terrain Model (Pavement) • Digital Terrain Model (Ground Surface) • Contour Model • Sub-surface Utilities Model Property Boundary Model	• CAD (DWG/DGN preferred) • CAD (3D LANDXML – DTM) • Text (GENIO preferred, 12da acceptable)
Point Cloud Data (MLS/TLS/ALS)	• LAS or LAZ format
Aerial Imagery	• ECW, TIF or JP2
Photos "Location enabled/geotagged"	• JPG

T4.15.1 File Naming

Deliverables & files provided must be appropriately named according to the naming convention below:

3100B-4-8_ XXXXXX_ YYYYYYYY.ext

Where:

- ***3100B-4-8*** is the Contract / Engagement Number
- ***XXXXXX*** is either:
    - "EFMS" Complete Engineering Feature Model Survey
    - "DTMCP" 3D Digital Terrain Model – Constructed Pavement
    - "DTMG" 3D Digital Terrain Model – Ground Surface
    - "SSUM" Sub-Surfaces Utilities Model
    - "EFMREP" Survey report
    - "PSCSUM" PSC Summary
    - "PSCBAS" PSC Baseline Data
    - "EFMMTD" Engineering Feature Survey Metadata
    - "SSUMTD" Engineering Feature Survey Metadata
    - "MLSPTS" - MLS Point Cloud
    - "TLSPTS" - TLS Point Cloud
    - "ALSPTS" - ALS Point Cloud
    - "EFMIMG: - Ortho Imagery
- ***YYYYYYYY*** is the Project Zone / coordinate system.
  (Can be more than 3 characters where necessary).
- ***.ext*** is the file extension

Appendix A – Data Capture Methods

Various new and emerging methods for capturing survey measurements are currently available. The Department is interested in utilising these where appropriate to the project. The suitability of each method is dependent on the accuracy (Quality Level) required by this specification. Projects for planning, feasibility and concept may specify in the Project Survey Scope a lower accuracy to meet their requirements. Providers should adopt and utilise data capture methods based on their experience and be of suitable capability to meet (or exceed) the project requirements and associated Quality Levels. Higher or lower accuracies may be achieved depending on factors such as the measurement equipment, environmental conditions, calibration, measurement procedure and data processing.

Total Station

The Total Station represents the most common method of data capture available for engineering ground survey able to achieve Survey Uncertainty (SU) better than 10 mm for horizontal position and 10 mm for height.

Relevant applications include:

- Establishment of horizontal control by traversing.
- Establishment of vertical control by trigonometric heighting.
- Detail survey of constructed pavement and hard structures
- Observation of control targets for MLS or TLS survey methods

Global Navigation Satellite Systems (GNSS)

Static GNSS is a common method for establishing survey control and is generally able to achieve SU within 15 mm for horizontal and 20 mm for height when operated using appropriate procedures. Network and Real Time Kinematic (RTK) GNSS surveying and is used for ground data capture and is generally able to achieve SU within 30 mm for horizontal and 50 mm for height, provided it is operated using appropriate procedures.

When using GNSS for an engineering survey an appropriate method shall be adopted based on the surveyor's experience and the general requirements described the ICSM Guidelines for Control Surveys by GNSS (SP1 V2.2).

Relevant applications for the use of GNSS include:

- Establishment of horizontal and vertical control with a static GNSS network.
- Modelling of survey features using RTK GNSS such as 'greenfield' road alignment, soft surface detail and underground services.

Mobile LiDAR Survey (MLS)

Mobile LiDAR Scanning technology captures dense point clouds from a moving platform such as a motor vehicle or boat. It has an advantage by minimising traffic management requirements, lane closures on highways and intersections, and can remove the need for surveyors to access the pavement. These technologies are generally not appropriate for natural surfaces / vegetated areas or areas that the scanner cannot physically measure (i.e. internal drainage pit details).

MLS, when applied, is to be in general accordance with the discussion paper prepared by Austroads titled '*Best practice for Mobile LiDAR Survey Requirements'.*

Relevant applications include:

- Urban roads, highways and intersections
- Bridges and structures over water
- Overhead features such as powerlines
- Urban Facades and streetscape modelling

The MLS system used shall be of suitable accuracy to achieve the results specified and have systems in place to confirm the accuracy of the raw data.

Terrestrial LiDAR Scanning (TLS)

Used for capturing dense point clouds of information from a laser scanner set in a series of fixed locations around the project. They are particularly useful in obtaining detailed survey information of surfaces or structures where access is difficult or hazardous or where a more complete model is required. Typically used in conjunction with a total station to aid in controlling the scans, TLS point clouds can achieve SU better than 10 mm with connection to appropriate survey control.

Relevant applications include:

- Structures such as bridges or culverts
- Urban roads
- Areas where access is limited or potentially hazardous, such as busy intersections or retaining walls and cuttings where there is a risk of falling

Photogrammetry

Mapping from digital aerial photography is suitable to capture ground data for a lower accuracy project. Digital cameras can be mounted in a small Remotely Piloted Aircraft (RPA), helicopters or fixed wing aircraft. Survey control on the ground is required to achieve suitable accuracies from the post-processed imagery. The best achievable vertical SU is between 50 mm and 150 mm depending on the ground surface, sensor, accuracy of control and other factors. When data capture is for projects that are only for the purpose of planning, feasibility and concept studies, there may not be a requirement for ground control.

Applications include:

- Route analysis, 'greenfield' road alignment, waterways, soft surface embankment
- Production of colour ortho-photos, DTMs and DSMs, reality meshes

Regulations, as outlined by the Civil Aviation Safety Authority (CASA), must be adhered to when undertaking any RPA survey.

Aerial LiDAR Survey (ALS)

Where a large-scale terrain model is required for planning or concept design purposes, airborne LiDAR surveys can provide a detailed model with accuracies of between 100 mm and 300 mm in height. The need for access on the ground is minimal so these surveys can be very useful in areas that are remote, inaccessible or where sensitive landowners exist.

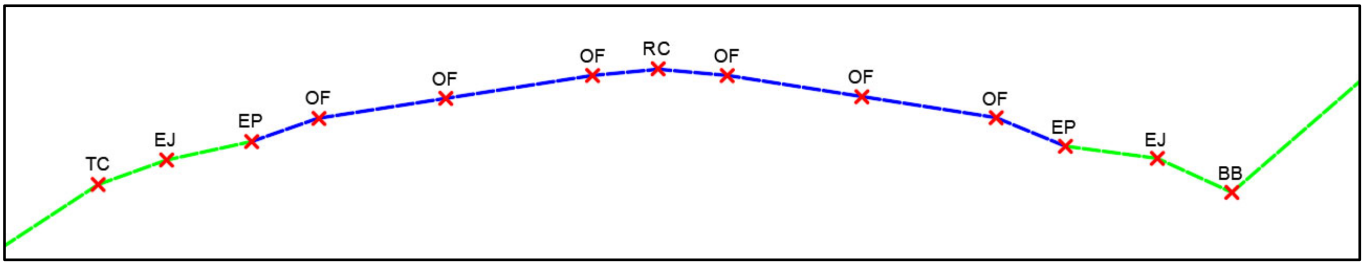
Appendix B – Feature Capture/Coding Examples

Pavement and Sealed Roads

Sufficient points and strings must be captured/modelled across road surfaces to ensure the shape is accurately defined to the specified QL tolerance. At a minimum, any sealed road surface with a 'crown' requires a string to be surveyed on the crown and strings on either pavement edge.

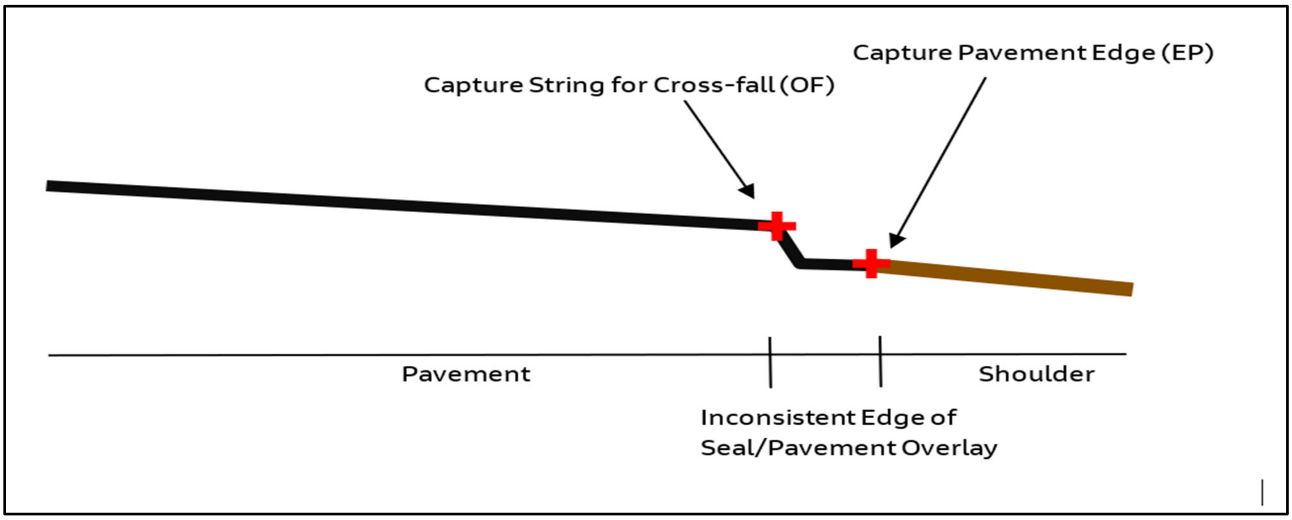
Pavement strings to define vertical shape that do not represent specific features (for example line marking or kerb) are to be coded as Crown Offset string (OF) with a minimum of 2 connected points.

A QL-A or QL-B survey will include OF strings captured across the pavement surface to allow crossfall to be accurately assessed. The number of OF strings surveyed in a single cross section will vary depending on survey QL; ensuring maximum vertical Arc to Chord tolerance is not exceeded. An example typical cross section that may be captured as part of a QL-A level feature survey is shown below.



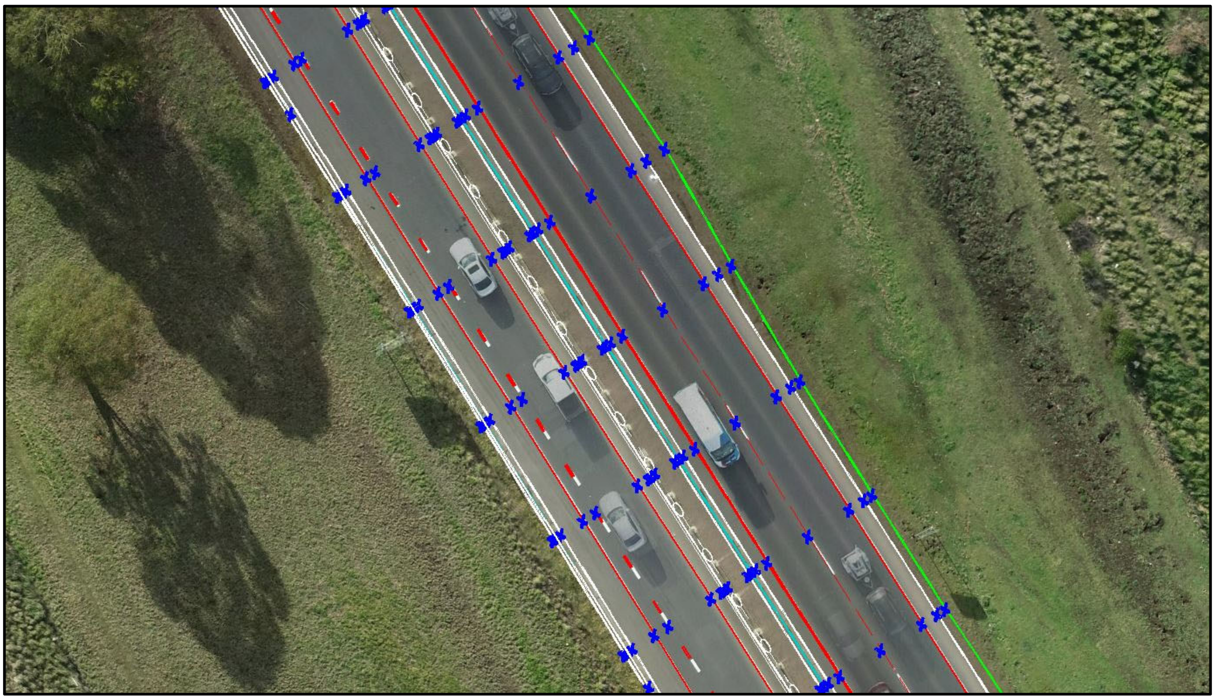
Example cross section of crowned road -meeting Quality Level QL-A

Inconsistency in the horizontal or vertical position of the pavement edge can influence the calculation of cross fall. Depending on the required survey Quality Levels an additional string may be required to accurately model the pavement surface. In this situation the cross-fall point is to be coded as OF and the true Pavement Edge to be coded as EP.



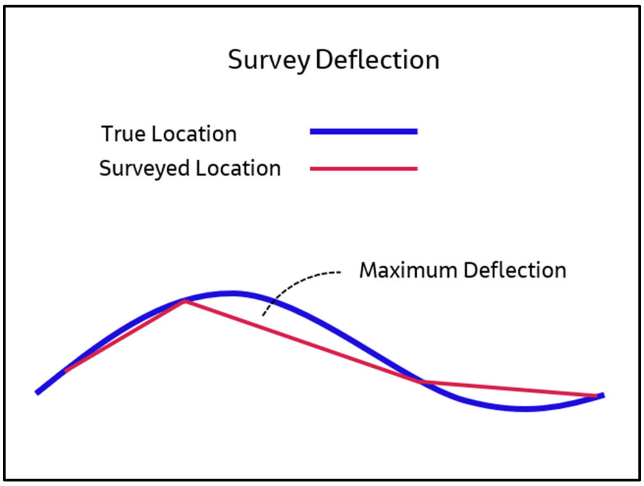
Example cross section of road at Edge of Pavement

Strings defining the road and formation shall be captured such that their respective points align perpendicular to the direction of the road. An example of point locations in plan view is shown below.



Example plan view showing location of points meeting Quality Level QL-A

The maximum distance between sections (points perpendicular to the road) for each Quality Level, and the maximum Arc to Chord tolerance (deflection) for both horizontal and vertical road alignments is outlined in section T4.7.3.1.



Arc to Chord Deflection

Example plan view showing Intersection features

Road Intersections may have a complex surface shape that is not sufficiently defined and represented by capture of specific detail features alone.

Strings are to be captured such that the pavement surface is accurately modelled to achieve the accuracy tolerances as defined in the survey Quality Level. The distance between sections for features such as pavement, medians, and kerbs are such that horizontal and vertical arc to chord tolerances for the survey QL are not exceeded as shown in table **Error! Reference source not found.**.

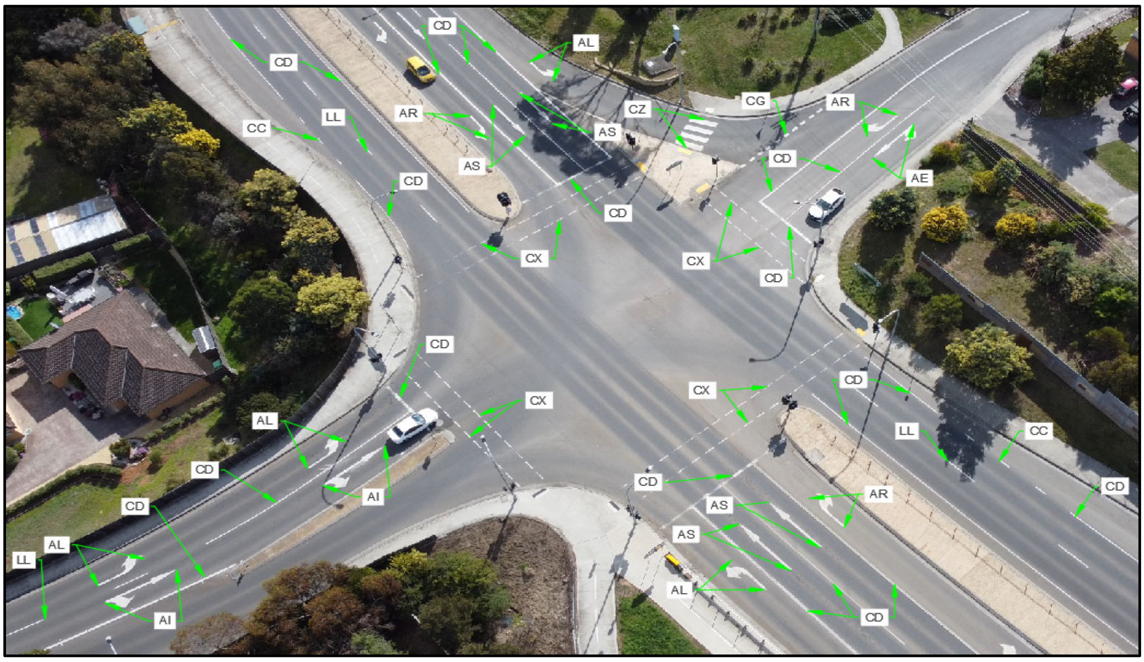
Road Traffic Islands

An example of road features such as traffic islands are shown below. The feature survey shall provide sufficient detail to adequately describe the shape and extent of the feature. The use of automated arcs and or radius should not be used.

Example of Road Traffic Island

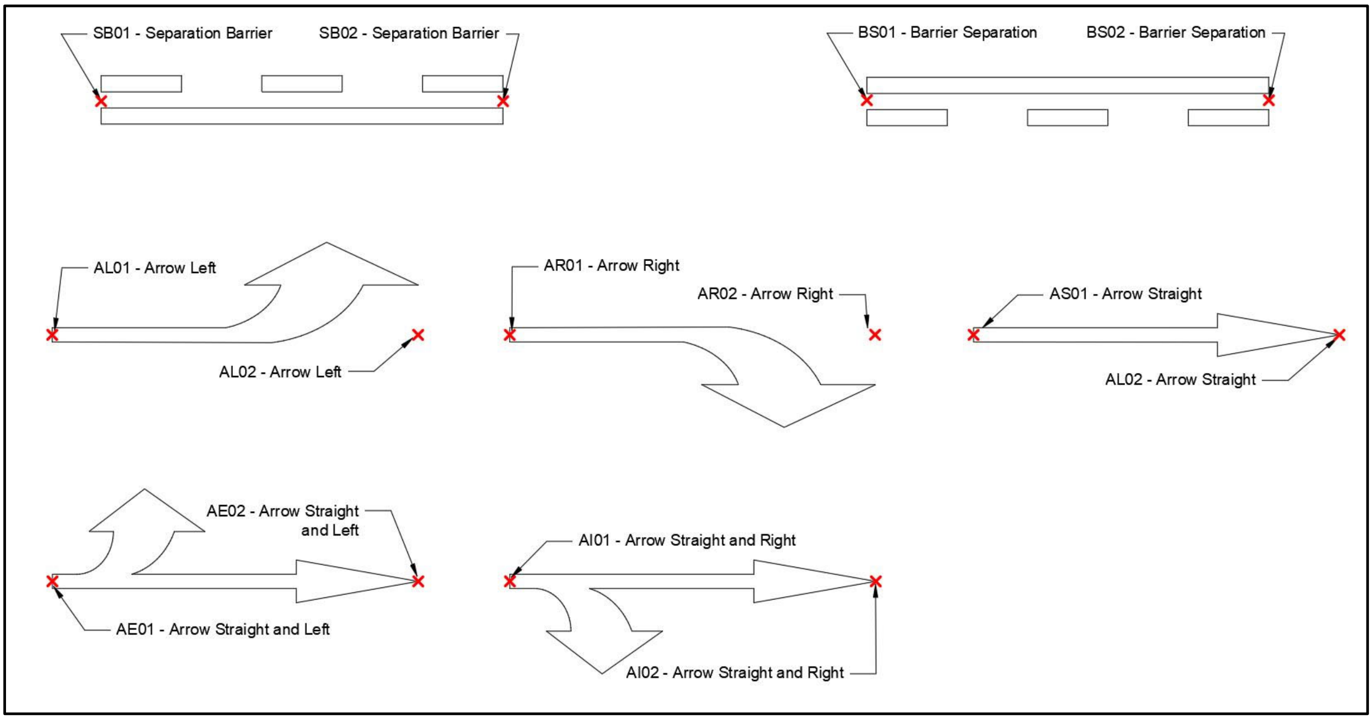
Pavement Line Marking

All pavement line marking must be captured and coded appropriately according to its type.
Pavement line marking is not mandatory for all survey types (depends on prescribed Quality Level) but is often useful in early planning to assist definition of pavement shapes.



Example Coded Line Marking and Direction

Directional pavement line marking such as pavement arrows and barrier / separation lines (SB & BS) are to be captured and coded to ensure they are displayed in the correct direction in the survey model, as indicated in the image below.

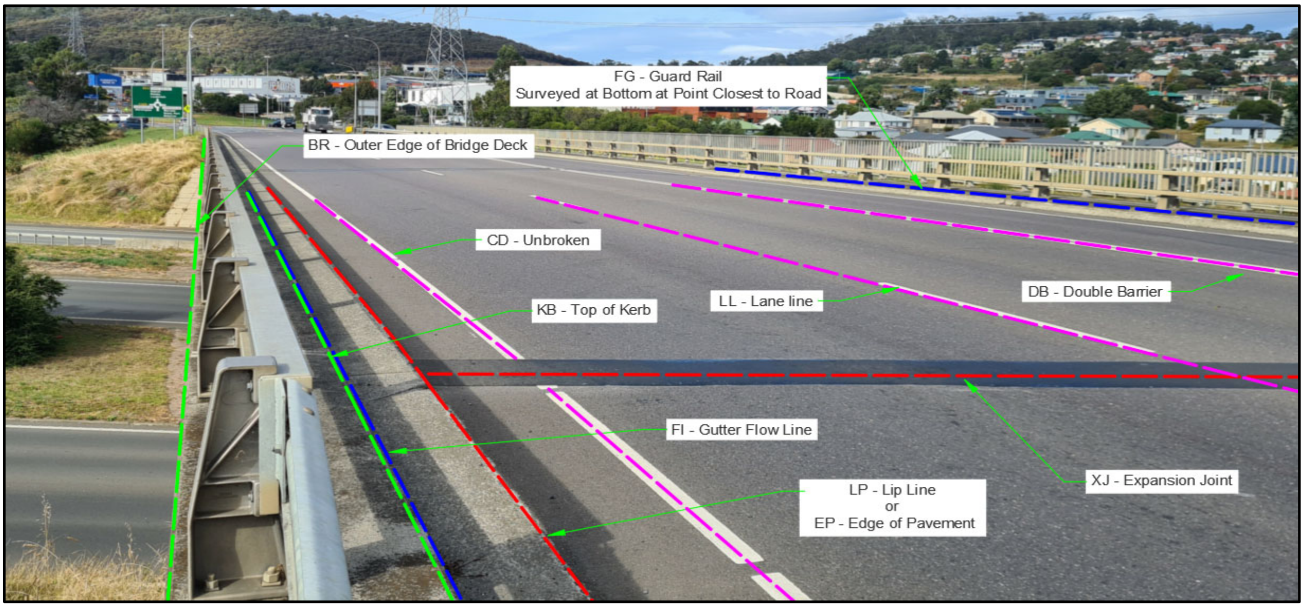


Example directional pavement line marking points

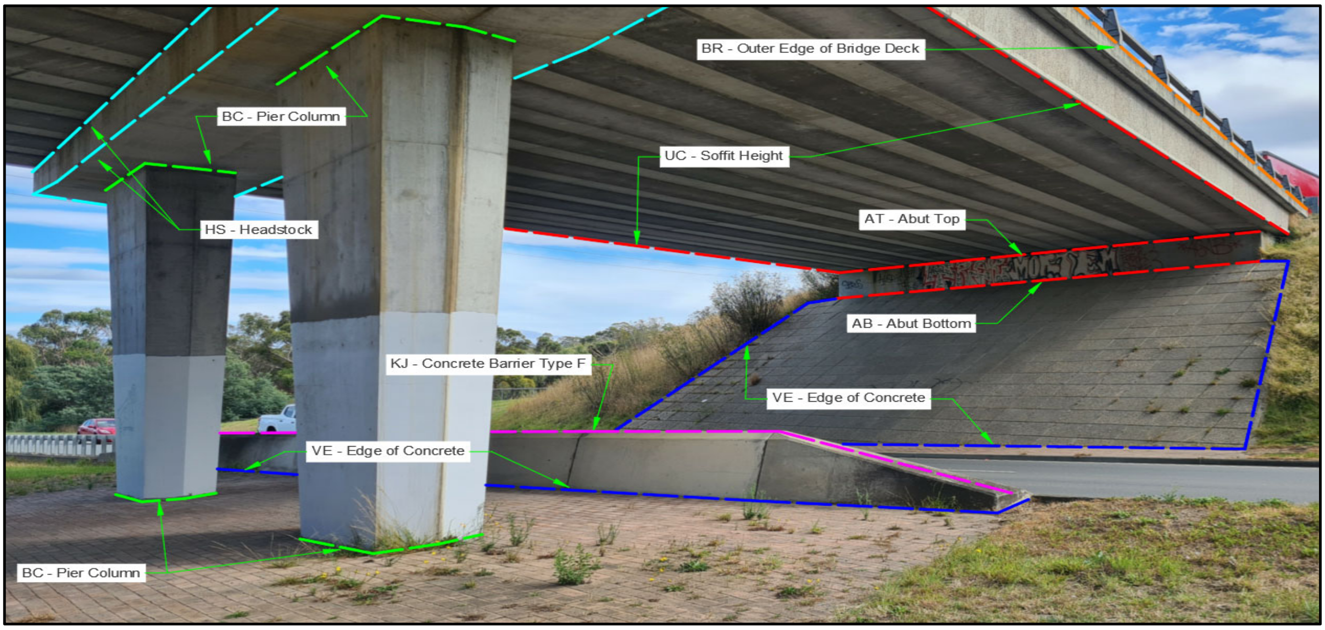
Bridges

The bridge deck is the area of detail suspended from the natural surface of surrounding land. It is normally identified by concrete expansion joints at each end. The bridge expansion plates (XP) and joints (XJ) are to be captured using the appropriate code at each end of the bridge structure. A guide to expectations and use of coding is provided in the following images.

All strings on the surface of the bridge including the bridge deck, kerb, and parapets; and strings under the bridge, including the bridge abutments, form part of the surface model DTM.



Example of bridge surface features



Example of underside bridge features

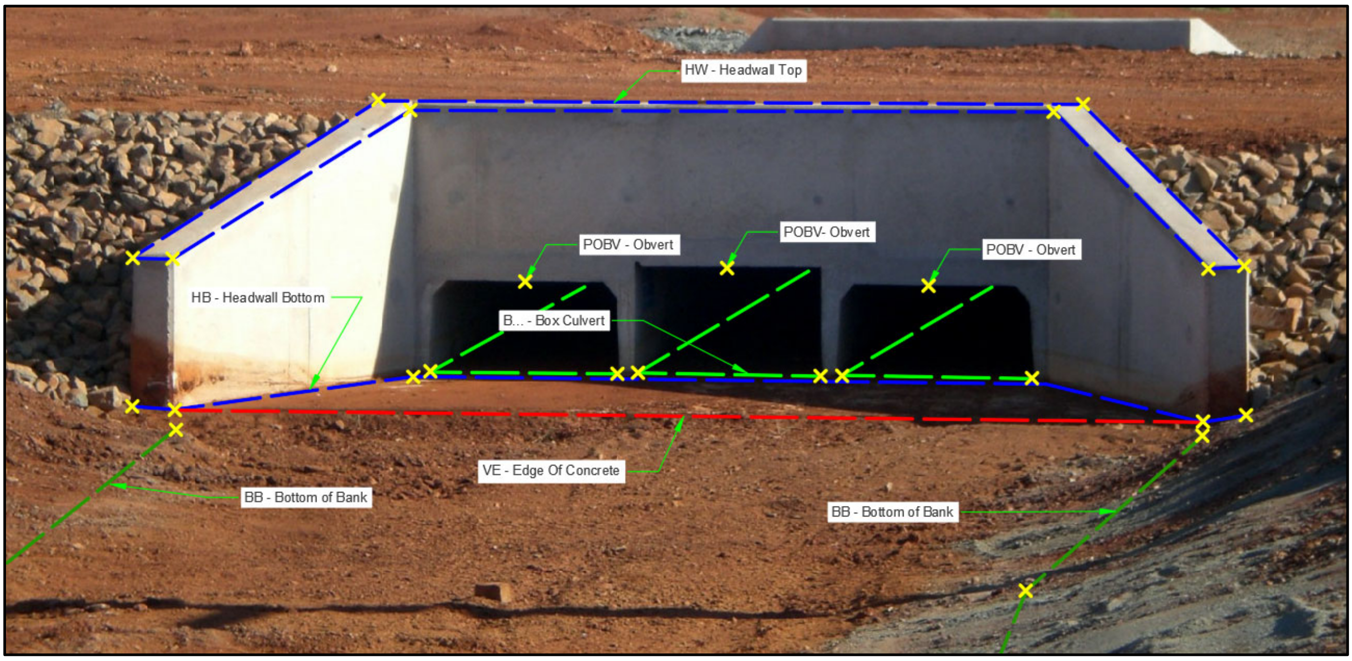
Drainage Infrastructure

Drainage pipes and endwalls

The invert and obvert of drainage pipes and their associated surrounding structure must be captured for all open drainage features. Culvert pipes are to be located with the appropriate code; individual pipes are to be captured with the appropriate PI(xx) code reflecting the minimum internal diameter of the pipe. The connections between each culvert invert is to be captured and coded using the U(x) or V(x) that matches the measured diameter.

Example of Pipe Culvert inlet / outlet features

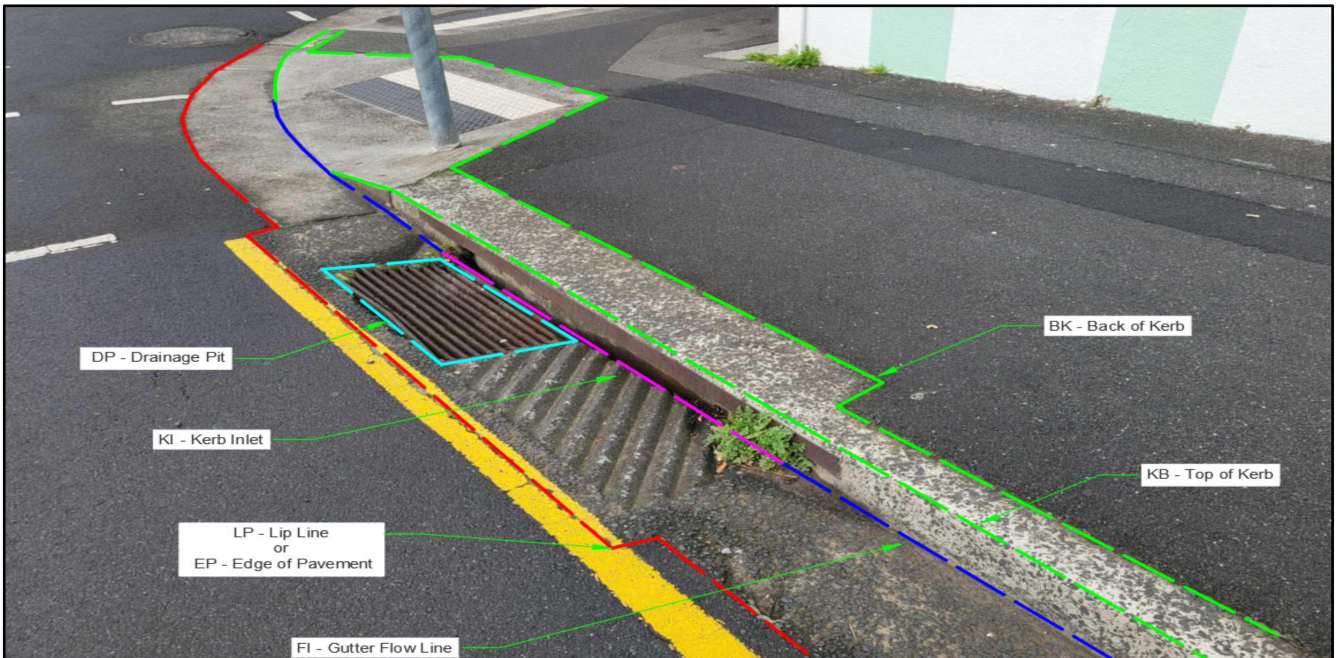
Box culverts are to be captured and coded with the B(x) or D(x) code corresponding to the measured height of the structure. The internal dimension of a box culvert is to be located at the base of the structure.



Example of Box Culvert

Kerb Profiles and Concrete Inverts

An example of concrete kerb and drainage pit features are shown below. Feature survey shall ensure the following features are captured and coded accordingly.



Example of Concrete Kerb and Drainage

Gravity Sewer and Stormwater

All gravity sewer and stormwater structures, including drainage and access pit, within the project extents must be captured. Any pit opening and/or access pit must be captured to describe the top of access chamber, and large pits that are flush with the surface by a single string to indicate its size, shape, and grade of the top. Additional details may be required which include:

- Drainage Pit/Access Pit Cover Relative Level
- Invert level of the structure (pit)
- Invert level of all pipes at inlets and outlets

Ground Features

All ground features beyond the road footprint additional to structures, hard surfaces and road furniture within the project extents must be captured. This includes (as a minimum) the following feature types:

Trees & Vegetation
All significant trees within the project extents (unless specified otherwise) are to be captured/modelled. The definition of significant tree is when the trunk diameter exceeds 100 mm at 1.5 metres above ground level. Dense areas of other (small diameter) trees & vegetation (scrub/shrubs) should be captured by a string around the vegetation identified by the dripline.

Natural / Topographical Features
All natural and topographical features within the project extents are to be captured. In addition to features considered as a natural break line these include batters, edge of formation/pavement and drain line. The position and height of water levels in ponded areas, dams, lagoons etc., as well as the position and height of flood level information, watercourses, dams, swamps and inundated areas are to be captured.

Overhead Power Lines and Poles

All overhead electricity structures including poles and stay anchors shall be captured. Where the actual height and catenary of the powerlines can be easily obtained (MLS/ALS Point Cloud), the powerline should be captured in 3D by a minimum of three (3) points; a point at each end where the powerline attaches to a power pole or support structure and one at the lowest point of the span.

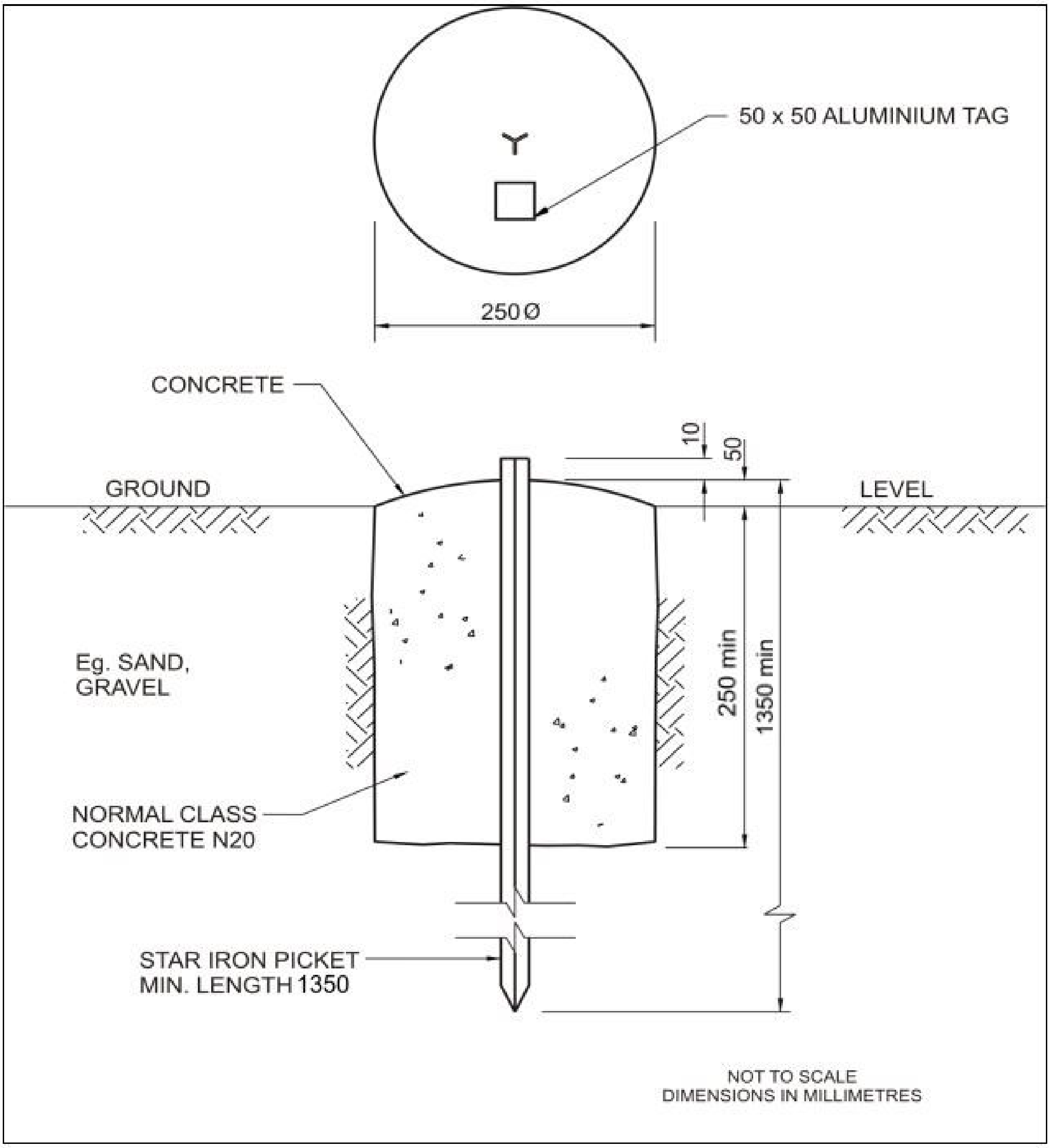
Other Features

In addition, all features/structures defined within the survey project area shall be captured and represented as coded points or strings using survey labels defined in T13. As a minimum the following features must also be captured:

Buildings:	The outer wall surface Protruding awnings Record the reduced level of the floor. Locate and level low eave lines.
Road/Street Furniture:	Street lighting, signage, safety barrier, pedestrian fencing (?)
Railway Lines:	Locate tracks within the project extents
Other structures:	Noise walls, concrete barriers, guardrails, fencing, pedestrian/bike paths

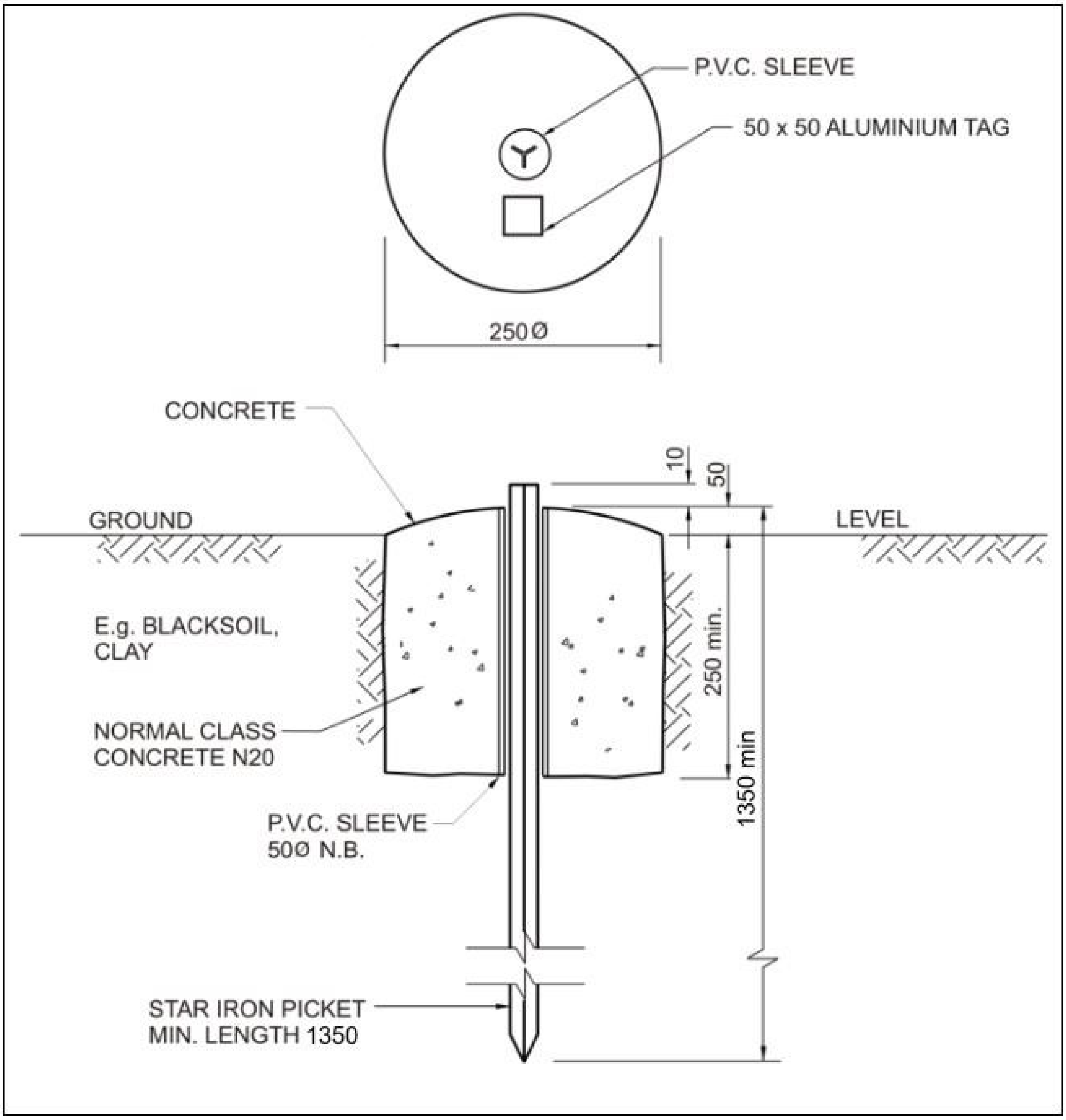
Appendix C – Example Primary Survey Control Marks (PCMS)

Primary Survey Control Mark for Stable Soil



Credit: Western Australia Main Roads: Geodetic Control Survey March 2022 - Appendix B: Road reference mark for stable soil – rural areas only

Primary Survey Control Mark for Unstable/Reactive Soils



Credit: Western Australia Main Roads: Geodetic Control Survey March 2022 - Appendix C: Road reference mark for unstable soil, where clay blacksoil, "crab-holes" exist – rural areas only

Tasmanian Government

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