

Is there a Future for the Survey Peg?

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ABSTRACT

Survey marks are a big part of a surveyor's life. From having to find old survey marks placed and buried years ago to connecting to the state geodetic network and marking new property boundaries, survey marks make up so much of the tasks carried out by a cadastral surveyor. The requirements for survey marking have evolved from early surveying in this country, brought over by the First Fleet and then subsequently changed by various Surveyor Generals over the years as technology and techniques changed. This evolution has come to the point as detailed in the current Surveying and Spatial Information Regulation 2017, which was only recently made. The standards for marking have typically been based on cost and efficiency, and what was easily available on hand. The wooden boundary peg is a prime example of this, typically formed from local timber available on site and fashioned by hand to meet the standards at the time and to suit the conditions being faced. Due to changes to the nature of our work, particularly cadastral work being more urbanised, and the increased need for efficiency, easy transportation, mass production and reduction of survey team size, the wooden survey peg has had to evolve. Furthermore, there was the need for standardising across surveys to assist other occupations and the public to understand which peg actually marked their boundary corners. Our current requirements for pegs are 350 mm long with a top of 75 mm by 35 mm for urban surveys and 450 mm long with a top of 75 mm by 75 mm for rural surveys, made of sound, durable hardwood or white cypress pine or polycarbonate. However, are this type and the other boundary and reference marks we currently use sustainable into the future? This paper investigates our current marking requirements, considering their deficiencies and strengths, compares current standards to our past and to other jurisdictions within Australia and overseas, and formulates some ideas for the profession to consider as we head into the future.

KEYWORDS: *Cadastral, survey marks, survey peg, boundary mark, reference mark.*

1 INTRODUCTION

The survey profession has a long and distinguished history, which provides the foundation for our current practices, standards and techniques, but what will the future hold? The world is not static, and society views and expectations are continually evolving as new technology and ideas are introduced. Even in the last 20 to 30 years, we have seen the introduction of an array of new technology that has developed into now common everyday tools. Technology such as Global Navigation Satellite Systems (GNSS), laser scanners, drones, smart phones and improving computer power has enabled us to collect large amounts of data in a quicker time, thereby having a large impact on the way surveys are carried out. One constant during this time has been survey marking, but this too is under pressure from our changing world. Will the practices we use today still be here in the future? Can we learn anything from our past or from comparing our current practices to other jurisdictions?

This paper investigates how the marking standards developed in NSW and compares these with current marking standards of other jurisdictions across Australia and New Zealand as well as overseas. It then looks into the future and discusses changes that could be made to our current marking standard to meet the pressures of our changing world, with the main aim to spark discussion within the surveying profession regarding the role of surveying marking and surveyors into the future.

2 REVIEW OF PAST MARKING STANDARDS IN NSW

The foundations of our current marking standards are based on the original marking standards brought to NSW by each of the early Surveyor Generals. The main focus for early marking was to quickly map the new colony and mark out the early land grants. As such, marks were mainly pegs fashioned from wood, which was obtained on site, and nearby trees being blazed and marked, with the main aim to quickly mark land grants and ensuring that boundary extents were identifiable to the land owners in the area. Due to the constraints on equipment available, the type of country in which measurements were being made, and the urgent nature for surveys to be completed, marking overrode measurement. This is still one of the overriding principles in our current marking standards, even though our measurement accuracy is so much greater.

It was also figured out early in the development of NSW that standardisation of marking was required to provide consistency between surveys and ensure land owners and the general public could identify official marking of boundaries. This saw the introduction and development of the first survey directions, which subsequently became the basis of our current Surveying and Spatial Information Regulation 2017 (NSW Legislation, 2017). The first known written direction to surveyors was a circular to surveyors issued in 1836 during the term of Surveyor General Mitchell. From this initial direction, over the years, there has been the introduction of new types of survey marks and marking standards with the issuing of each new direction or regulation. Table 1 lists the major milestones in the development of marking standards in NSW, as detailed in Marshall (2002).

Table 1: Major milestones in development of marking standards in NSW (Marshall, 2002).

Date	Milestone
1 January 1836	First recorded directions - Surveyor General Mitchell to all surveyors.
10 April 1848	Specification for corner marking.
9 July 1853	Blazed lines, numbered reference trees and lockspitting.
11 August 1855	Report from the Commissioners appointed to inquire into the Surveyor General's Department.
9 May 1864	Line marking and trenches 20 links in length. Town sections to be lockspitted 6 links long and allotments 4 links only. Road surveys - marking of mile trees. Adoption of standard needle. Reference to corner schedule introduced on plans. Rock on boundary line to be marked with a pick line - portion corners with broad arrow. Forerunner of permanent marking in town surveys introduced. Posts to be mounded.
30 January 1872	The use of circumferentor is prohibited. Maximum offsets to natural features introduced. Road marking formalised - 3" square peg introduced - mile posts 4' 6" long and not less than 12" in diameter. Trenching standardised to 10 links in length in both town and country. Plain country remains at 20 links.

	<p>Corner marking of portions where no trees exists - pegs to be 30" long and driven 18" into the ground (survey post). Expressions of bearing to be related to North and South only.</p>
1 May 1882	<p>A "dot", the forerunner of the drill hole is introduced. Intervisible line marks of a permanent nature invoked - pegs 3" by 2" by 18" long. In plain country and in absence of trees - peg to be mounded by earth 6' in diameter and 2' high. Steel ribands in use - 66' long only. True bearing to be determined by stellar or solar observations. Bearings to be observed to trigonometrical stations. Fence posts, marked with a broad arrow over the letter R.</p>
September 1884	<p>Introduction of limits of error allowable in closes. Mode of marking standard length - chain standardisation.</p>
July 1886	<p>Alignment stakes in lieu of trenching. Permanent marking introduced, e.g. bottle, gas-pipe, iron bolt, vertically below survey post at corner, 3' 6" below ground surface - homestead leases only. Fence posts marked with the broad arrow over the letters RD. Reserve roads to be marked on both sides. Lineal closures introduced into regulations. Bearings of reference to corners to read 0 to 360. The 5-chain steel riband introduced to the regulations.</p>
20 February 1895	<p>Special marking of surveys for recovering of azimuth and the standard of measure of a survey.</p>
24 January 1901	<p>Survey stakes to be 4" by 4" by 24" long. Alignment and direction stakes to be 18" long and 3" by 2". Reference and corner posts to be 3' 6" long, 6" square or 8" in diameter. All corner and/or reference trees to be blazed on four sides. Lines of stones acceptable in lieu of lockspits. Drilled hole at a corner on rock introduced. Line pegs at 10-chain intervals - reference stations each 80 chains. A concentric circle on plans to indicate a special mark. Gunter's chain ceases to be standard equipment. Instructions for alignment of streets introduced - consequent to Municipalities Act, No. 23 AD 1897. Omissions of fractional quantities on plans.</p>
2 December 1914	<p>Reference trees to be within 200 links of corners. Widths of lanes in towns amended to 20' wide and not less than 31 links.</p>
1 January 1915	<p>Issuing of Instructions to Surveyors by the Registrar General's Department - the first instructions specifically for surveyors undertaking surveys of real property land.</p>
June 1920	<p>Survey marking under the Local Government Act 1919 introduced in Ordinance 32.</p>
12 May 1933	<p>Commencement of the Survey Practice Regulations 1933. These regulations applied to both Crown surveys and real property surveys.</p>
1 October 1963	<p>Portion corner pegs become 3" square and 21" long in lieu of 4" square. Lockspits become 4' long in lieu of 10 links. Reference trees beyond 150 links of the corner necessitates placement of additional marking pursuant to Survey Practice Regulations 1933 - reference trees up to 300 links. Crown survey bound by Survey Practice Regulations 1933 as well as the special requirements of the Department of Lands. Age of fencing defined. Dimension of alignment pins prescribed for the first time.</p>
1 January 1981	<p>Lockspits 1 m long.</p>
1 September 1990	<p>Commencement of the Survey Practice Regulation 1990. Requirements for the connection of surveys to the survey control network.</p>
1 October 1994	<p>Minor amendments to the Survey Practice Regulation 1990 - refinement of requirements for connections to the survey control network and use of the Integrated Survey Grid for orientation.</p>
1 September 1996	<p>Commencement of the Surveyors (Practice) Regulation 1996.</p>
1 September 1998	<p>Commencement of the Survey Co-ordination Regulation 1998. Minor amendments made to clarify certain clauses. Use of Type 3 State Survey Marks discontinued.</p>

In addition to Marshall’s (2002) list, Table 2 lists other regulations for survey marking that have been introduced since 1998.

Table 2: Changes in survey regulations since 1998.

Date	Milestone
1 September 2001	Commencement of Surveyors (Practice) Regulation 2001, which replaced the Surveyors (Practice) Regulation 1996. Introduction of use of Map Grid of Australia for orientation. Allowance for cadastral surveys using Global Positioning System (GPS) included. Surveyor to indicate type of survey - urban or rural.
25 June 2003	Repeal of Surveyors Act 1929, Survey Co-ordination Act 1949, Survey Co-ordination Regulation 1998, Survey Marks Act 1902 and Survey (Geocentric Datum of Australia) Act 1999. Surveyors (Practice) Regulation 2001 renamed Surveying Regulation 2001 and incorporates the majority of the provisions included in the repealed legislation. Mining surveying and registration incorporated into Surveying Regulation 2001. Approved boundary marks, permanent marks, and conventional symbols and signs added as schedules of the Surveying Regulation 2001. Introduction of non-corrodible rod or spike as approved boundary mark. Introduction of galvanised iron star picket, non-corrodible nail in timber and PVC pipe as approved reference marks.
1 September 2006	Commencement of Surveying Regulation 2006, which replaced the Surveying Regulation 2001. Use of GPS extended to other Global Navigation Satellite System (GNSS) equipment and measurements derived by this type of equipment are to be noted on plan of surveys. The showing of natural boundaries on plans changed from traverse/offsets/radiations to table of short lines directly along natural boundary. Introduction of polycarbonate pegs, non-corrodible nail in concrete/rock, star picket and boundary mark tokens as approved boundary marks.
14 December 2009	Surveying Regulation 2006 renamed to the Surveying and Spatial Information Regulation 2006.
1 September 2012	Commencement of Surveying and Spatial Information Regulation 2012, which replaced the Surveying and Spatial Information Regulation 2006. Schedule detailing street addresses for each property surveyed to be included on plan of survey. For partially surveyed or compiled surveys, the type of terrain needs to be indicated on plan. Introduction of Permanent Survey Mark Type 11 (Tier 2 CORS Pillar), Permanent Survey Mark Type 12 (Tier 3 CORS Pillar - Freestanding), and Permanent Survey Mark Type 14 (Tier 3 CORS Pillar - Wall mounted). Introduction of non-corrodible nail and wing in tree, non-corrodible nail in concrete, and PVC star picket introduced as approved reference marks.
18 December 2015	Introduction of new State Survey Mark Type 15.
1 September 2017	Commencement of Surveying and Spatial Information Regulation 2017, which replaced the Surveying and Spatial Information Regulation 2012.

Upon review of the marking standards, some common themes appear amongst the various standards. These include:

- The need to mark boundaries so that they are readily and unambiguously discernible on the ground.
- Consistency between surveys, in particular shape and size of marks and standard of measurement.
- The need to place or connect to permanent marks to allow future surveyors to re-establish boundaries.

- Flexibility of types of marks available to cater for all types of terrain and specific situations, e.g. drill hole & wing in concrete, PVC pipe in swampy areas.
- Continual evolution of marking to cater for availability of material suitable for marking, the introduction of new types of marks that may be suitable for marking, new and different techniques of installation, changes in terrain (particularly the increase of hard surfaces such as concrete and bitumen), and the cost of marking.

The one common mark over all the standards is the wooden peg. It has come in many sizes but remains the most common boundary mark for most surveys. The wooden peg does have its disadvantages of being susceptible to fire, pests, disease, movement and removal, but in most cases, it is easy to manufacture, easy to install and the material is easy to source. The use of wood into the future may be affected by cost and availability of hardwood, particularly with the continued trend of replacing hardwood forests with quicker growing softwood forests. Another aspect that may need to be considered is the sustainability of this particular material. Deforestation and the release of carbon into the atmosphere may also affect the availability of wood into the future.

However, the wooden peg cannot be used in all situations, e.g. rock and concrete, and is not permanent in nature due to its disadvantages. As such, a number of alternative marks have been developed to cater for situations where wooden pegs cannot be placed and to provide more permanency to the marks to enable surveyors to re-establish the boundaries in the future. Our environment is also becoming more highly urbanised, which means an increase of hard surfaces such as concrete and bitumen, unsuitable for the wooden peg. Flexibly in types of boundary marks will therefore become important due to the various surfaces that may be encountered while marking out boundaries.

Initially trees were marked and lockspits placed, but these also had the same disadvantages as the wooden peg. This saw the introduction of special marks such as rock marks, gas-iron pipes, bottles and iron bolts. In urban areas, efforts were put into permanently marking street alignments with marks such as alignment posts, stones or pins. Later with the introduction of the Local Government Act, street alignments were marked with concrete blocks at set offsets from the street alignment. This made re-establishing the street alignment a less onerous task for surveyors and authorities. The disadvantages were subsequent conflicts with the installing of utilities in the street and the reconstruction of kerbs with many marks destroyed. One main reason would be the lack of resources placed into the maintenance and replacement of alignment marks, with other works such as road construction and utility installation having far more importance in the eyes of government and the public, even though the survey marks were used to assist in the construction of roads and utilities. Set offsets were changed from 3 feet 6 inches (3' 6") to 1 foot 6 inches (1' 6") to counter this, but without success, so subsequently surveyors were allowed to place reference marks at any distance less than 30 m from a boundary corner, in such a place which the surveyor felt would not be destroyed by subsequent road and utility construction.

The destruction of survey marks would be an ongoing battle for the profession with various changes to the marking standards implemented to counter the destruction. Changes such as placing more marks, making marks more visible and authoritative looking, connecting surveys to current geodetic datum, and deferment of the placement of survey marks. These have all initially assisted in the protection of survey marks, but due to a lack of diligence from the profession to support these initiatives fully and a lack of ignorance from Council, utility providers and the public, survey marks continue to be destroyed. Ignorance does not only

include the lack of understanding of how important survey marks are for re-establishing boundaries but also the lack of understanding of the effort and cost involved in establishing the marks in the first instance, their maintenance and re-establishment if destroyed. There is also a lack of understanding of the extra costs in re-establishing boundaries when survey marks are destroyed, which in most cases are passed onto consumers via higher survey fees, even though competition within the profession lowers the effects of the full cost of establishing property boundaries.

3 CURRENT MARKING STANDARDS IN NSW

The current marking standard in NSW is the Surveying and Spatial Information Regulation 2017 (NSW Legislation, 2017). This legislation came into force on 1 September 2017, repealing the previous marking standard, being the Surveying and Spatial Information Regulation 2012. A summary of the marking standards contained in the Surveying and Spatial Information Regulation 2017 is contained in Table 3.

Table 3: Current marking standards in the Surveying and Spatial Information Regulation 2017.

Subject	Details
Datum and orientation of surveys	<p>Surveys must be connected to Map Grid of Australia 94 (MGA94) if established permanent marks are within 300 m of land surveyed for urban surveys and within 1,000 m of land surveyed for rural surveys at the time of writing this paper. In other cases, rural surveys still need to be connected to MGA94 by connecting to established permanent marks within 5,000 m or by approved GNSS methods.</p> <p>For urban surveys where established permanent marks are not within 300 m, surveys can either be connected to MGA94 by connecting to established permanent marks within 1,500 m or by approved GNSS methods or establish datum and orientation from marks shown on a plan filed or recorded with the Registrar General.</p> <p>It is noted that from 1 January 2020, surveys are required to connect to the new Map Grid of Australia 2020 (MGA2020) datum.</p>
Boundary marking	<p>All corners of the land surveyed and the lines of the land surveyed need to be marked with an approved boundary mark. The only exception are natural boundaries such as mean high water and banks of streams. Where a boundary mark cannot be placed at a boundary corner, an approved reference mark must be placed unless the corner is within the material of a structure. Unless a peg is placed, details of the mark placed are to be noted on plan or obstructed corner to be shown if corner is within the material of a structure.</p>
Approved boundary marks	<p>Peg of sound durable hardwood or white cypress pine pointed for about two-thirds of its length or polycarbonate pegs as approved. Pegs for rural surveys to be at least 450 mm long and at least 75 mm by 75 mm nominal section at the top end. Pegs for urban surveys to be at least 350 mm long and at least 75 mm by 35 mm nominal section at the top end. Peg to be placed upright in the ground, pointing downwards and top not more than 80 mm above ground level.</p> <p>Drill hole of at least 5 mm in diameter and at least 10 mm deep drilled into rock, concrete or substantial structure and if practicable a chiselled wing cut and directed to the mark.</p> <p>Non-corrodible nail at least 65 mm long driven completely into fixed timber and if practicable a chiselled wing cut and directed to the mark.</p> <p>Solid metal spike at least 300 mm long and external diameter of at least 20 mm placed vertically and driven flush to the surface. Only to be used if placement of a peg is not practicable.</p> <p>Galvanised iron pipe at least 300 mm long with an internal diameter of at least 20 mm and a rim wall thickness of at least 3 mm placed vertically and driven flush to the surface. Only to be used if placement of a peg is not practicable.</p> <p>Star picket at least 450 mm long placed vertically and at least flush with the surface of the ground.</p>

	<p>Non-corrodible token at least 32 mm in diameter and 1.5 mm thick with “Boundary Mark” permanently stamped, engraved or etched on the upper surface, secured using a non-corrodible nail, spike, rivet or screw.</p> <p>Non-corrodible nail at least 50 mm long and 6 mm in diameter placed in a drill hole of a minimum of 5 mm diameter into rock, concrete or substantial structure and if practicable a chiselled wing cut and directed to the mark or a boundary mark token secured.</p> <p>Broad arrow comprising three chiselled wings at least 80 mm long, 20 mm wide and 10 mm deep at the base, pointed at one end, cut in rock, concrete, substantial structure or fixed timber. Only used for surveys carried out by Surveyor General or public authority.</p> <p>Steel fence post, excluding a star picket, which is durable and installed in a permanent and stable base.</p> <p>Marks approved by the Surveyor General from time to time.</p>
Additional requirements for marking of unfenced rural survey boundaries	<p>Line marks to be placed on boundary line at intervals of at least 200 m if not visible between line marks and at least 500 m if visible between line marks. Lockspits to be placed in the direction of the boundary from each corner, angle or line mark.</p> <p>Lockspits are to be a trench or line of packed stones not less than 1 m long, 200 mm wide, 150 mm deep and commencing 300 mm from each boundary mark.</p> <p>If type of soil renders trenches ineffective, direction stakes at least 50 mm wide by 30 mm thick by 450 mm long may be placed in the direction of the boundary lines 4 m distant from the corner.</p> <p>Unless environmental considerations dictate otherwise, boundary must be reasonably cleared and any tree with a trunk diameter greater than 100 mm and within 500 mm of the boundary must be blazed or if situated on the boundary, double blazed.</p>
Placement of reference marks	<p>For urban surveys when abutting a road, a reference mark is to be placed at each extremity of the land surveyed, including the junction or intersection of roads and at intervals of not more than 100 m along a road frontage that has intervening side boundaries. If an urban survey does not abut a road, at least two reference marks in suitable locations to be placed in relation to the land surveyed.</p> <p>For rural surveys, reference marks must be placed at the extremity of the land surveyed, road intersections, at intervals of not greater than 1,000 m along roads and not greater than 500 m along banks of streams, and not greater than 2,400 m for other boundaries. Each parcel should have two reference marks in positions suitable for redefinition.</p>
Approved reference marks	<p>Permanent Survey Marks as described in Schedule 4 of the Surveying and Spatial Information Regulation 2017, i.e. marks in ground in cover box, brass plaques in concrete/kerb, trigonometrical stations, and CORS stations.</p> <p>Drill hole at least 5 mm in diameter and at least 10 mm deep drilled into rock, concrete or substantial structure with chiselled wing cut and directed to the mark.</p> <p>Chiselled wing at least 80 mm long, 20 mm wide and 10 mm deep at the base, pointed at one end, cut in substantial structure, fixed timber or the sound wood of a suitable tree where point of the chiselled wing being the reference point and chiselled wing to face towards the relevant corner.</p> <p>Broad arrow comprising three chiselled wings at least 80 mm long, 20 mm wide and 10 mm deep at the base, pointed at one end, cut in rock, concrete, substantial structure, fixed timber or the sound wood of a suitable tree. Only used for surveys by Surveyor General or public authority.</p> <p>Metal spike at least 300 mm long with an external diameter of at least 20 mm placed vertically and at least 80 mm below ground surface.</p> <p>Galvanised iron pipe at least 300 mm long, an internal diameter of at least 20 mm and a rim wall thickness of at least 2.6 mm, placed vertically and at least 80 mm below ground surface.</p> <p>Specific point on a permanent and substantial structure and if practicable a chiselled wing must be cut and directed to the mark. If the corner referenced abuts a road an additional reference mark must be placed.</p> <p>Galvanised star picket at least 450 mm long placed vertically and at least 80 mm below the surface of the ground.</p>

	<p>Non-corrodible nail at least 65 mm long driven completely into fixed timber or driven into the sound wood of suitable tree, and if practicable a chiselled wing cut and directed to the nail.</p> <p>PVC star picket at least 600 mm in length made of material with a thickness of at least 3 mm, placed vertically and at least 80 mm below ground surface in soil, swampy or marsh areas.</p> <p>Reinforced concrete block in form of a truncated pyramid 400 mm long, 150 mm square at the lower end and 100 mm square at the upper end. A non-corrodible nail or plug at least 80 mm long to be inserted at least 75 mm into top. Concrete block to be placed vertically and at least 80 mm below ground surface.</p> <p>Non-corrodible token at least 32 mm in diameter and 1.5 mm thick with “Reference Mark” permanently stamped, engraved or etched on the upper surface, secured with a non-corrodible nail, spike, rivet or screw.</p> <p>Non-corrodible nail at least 50 mm long and 6 mm in diameter placed in a hole of 5 mm in diameter drilled into rock, concrete or substantial structure with a chiselled wing cut and directed to the mark or a reference mark token secured.</p>
Connecting and placement of permanent marks	<p>Surveys to be connected to a minimum of two permanent marks, either existing or placed. Further permanent marks need to be connected if survey involves more than 10 parcels or if survey redefines the frontage of a formed road or creates a new road greater than 1,000 m for an urban survey and 200 m for a rural survey.</p> <p>New permanent marks to be placed to a position suitable for orientation of survey and redefinition of the survey (particularly in regards GNSS methods), be located in a position unlikely to be disturbed, situated at road junctions, road intersections, road angles or crest of hills so as to be visible from other permanent marks without obstruction and suitable for inclusion in the State Control Survey.</p> <p>Sketch plans to be prepared for all new permanent marks.</p> <p>Heights for new permanent marks to be determined if survey has been connected to existing permanent marks which have appropriate height accuracy.</p>
Approved permanent marks	<p>Type 1 State Survey Mark (brass plaque), Type 2 State Survey Mark (brass plaque), Type 4 Permanent Mark Urban Type (stainless steel pin with cover box), Type 6 Permanent Mark Non-Urban Type (star picket with cover box), Type 7 Permanent Mark (feno spike with cover box), Type 8 Permanent Mark DWR “C-Type” (steel rod and pipe with cover box), Type 9 Trigonometric Station (concrete pillar), Type 10 Trigonometric Station (rooftop pillar), Type 11 Tier 2 CORS Pillar (concrete pillar), Type 12 Tier 3 CORS Pillar (freestanding), Type 13 Tier 3 CORS Pillar (wall mounted, no eaves), Type 14 Tier 3 CORS Pillar (wall mounted, with eaves), Type 15 State Survey Mark (stainless steel pin and disc), Type 16 State Survey Mark (domed brass plaque).</p>

Changes introduced into the Surveying and Spatial Information Regulation 2017 include:

- The requirement for all rural surveys to be connected to Map Grid of Australia 94 (MGA94) via established permanent marks or approved GNSS methods.
- The requirement for urban surveys to be connected to MGA94 slightly tightened to encourage the majority of urban surveys to be connected to MGA94 by connection to established permanent marks or approved GNSS methods.
- New schedules for the noting of coordinates of all permanent marks connected or placed as part of the survey, GNSS validation to ensure the survey has been correctly connected to MGA94, height schedule and height difference schedule of all permanent marks connected or placed if a new permanent mark has been placed and connected to permanent marks with accurate heights.

The strengths and deficiencies can be summarised as:

- Strong focus on connecting the cadastre to the current geodetic datum (MGA94, now MGA2020).
- Good flexibility in the types of marks that can be used.

- Strong emphasis on standardisation, accuracy of measurement and permanent marking of surveys.
- Too many marks or just enough?
- Rural surveys – do we still need to lockspit and blaze trees?
- Are we giving more incentive to surveyors to use newer types of marks or are we allowing them to just continue with the same techniques?
- Do any marks need to be phased out?
- Profession centric – are we considering the needs of the public?

4 MARKING STANDARDS IN OTHER JURISDICTIONS

4.1 Australian Capital Territory

The current marking standard in the Australian Capital Territory are the Surveyors (Surveyor-General) Practice Directions 2013 (No 1) (ACT Legislation, 2013). A summary of the marking standards contained in the Surveyors (Surveyor-General) Practice Directions 2013 (No 1) is contained in Table 4.

Table 4: Current marking standards in the Australian Capital Territory.

Subject	Details
Datum and orientation of surveys	<p>The bearing used for the orientation of the survey shall:</p> <ol style="list-style-type: none"> where possible and practical, be calculated from co-ordinate values of established survey control marks. Such coordinates shall be obtained from the ACT Government Survey Control Mark Register within 3 months before the completion of the survey and be accurate to Class C Order or better. The bearing adopted must be verified by angular connection, and (if practicable) distance connection, to at least one other established survey control mark; or be taken from a registered or approved survey plan either directly or by calculations from stated dimensions. Whenever possible the defining marks adopted shall be contained within a single registered or approved survey; or be obtained from GNSS observations; or be obtained from astronomical observations.
Boundary marking	<p>For urban surveys, whenever possible, each corner must be firmly marked with a peg or mark as prescribed in the Directions. Where it is not possible or practical to mark a corner, an approved reference mark must be placed. In addition to the corners, all unfenced boundary lines shall be marked distinctly and durably with pegs or marks prescribed in the Directions placed at intervals of not more than 200 m, and the position shown on the plan. Marking of urban surveys shall not be completed until land servicing has reached a stage where all CRMs, reference marks and corner marking will be durable and stable.</p> <p>For rural surveys, all boundary lines which form or are to form the boundaries between parcels shall be marked distinctly and durably with a peg or mark prescribed by the Directions together with lockspits cut in the direction of each unfenced boundary from each corner and angle; and on unfenced boundaries with pegs or marks and lockspits as prescribed in the Directions placed at intervals of not more than 200 m where one peg or mark cannot be seen from the next, or 500 m where one peg or mark can be seen from the next, and the position shown on the plan. Where it is not possible or practical to mark a corner, an approved reference mark must be placed.</p>
Approved boundary marks	<p>Where any line or corner of any portion of a survey is required to be marked in accordance with the Directions, the points shall be firmly marked with a peg; drill hole in rock, concrete, or similar material; a chisel mark or nail in fixed timber; or otherwise suitably marked. For rural surveys, or surveys of blocks of 5,000 m² or more, all pegs shall be of sound durable wood at least 350 mm long and not less</p>

	<p>than 75 mm by 75 mm section at the top end. For urban surveys of blocks less than 5,000 m², pegs shall be of sound durable wood at least 250 mm long and not less than 75 mm by 35 mm section at the top end. All pegs are to be pointed for approximately two-thirds of their length and be bevelled at the top. All pegs are to be placed upright, so that the top is not more than 75 mm above the ground level for rural surveys and 40 mm above ground level for urban surveys. Lockspits shall consist of trenches at least 1 m long, 200 mm wide at the surface and 150 mm deep dug in the direction of the boundary lines and commencing 300 mm from each corner or angle or may consist of packed stones of similar dimensions. Where any corner, angle or other point is marked other than with a peg, where practicable wings shall be cut in solid rock, concrete or fixed timber, 75 mm long, 20 mm wide and 10 mm deep commencing 50 mm from the corner or where the surface renders it desirable lines may be painted at least 300 mm long and 20 mm wide. Where practicable, a corner or angle may be marked using a boundary mark token securely attached to timber, fence or other surface using a non-corrodible nail, spike, rivet or screw. The boundary mark token shall be at least 32 mm diameter and 1.5 mm thick, with “Boundary Mark” permanently stamped or etched on the upper surface.</p>
Placement of reference marks	<p>For urban surveys, when abutting a road, a reference mark is to be placed at each extremity of the land surveyed, including the junction or intersection of roads, and for streets where reference marks or CRMs have not been placed or have been disturbed reference marks are to be placed at intervals of not more than 150 m throughout the length of the frontage of the land surveyed. If an urban survey does not abut a road, two reference marks are to be placed suitable for orientation. For rural surveys, where the land surveyed is not being subdivided, at least two reference marks suitable for redefinition of the survey must be placed. Where land surveyed is being subdivided at least two reference marks must be placed in respect of each parcel. For road frontages, reference marks shall be placed at each extremity, and at intervals of not more than 1,000 m intervals. For boundaries, other than road frontages and exceeding 2,400 m, additional reference marks at intervals not more than 1,500 m must be placed.</p>
Approved reference marks	<p>Reinforced concrete block in form of a truncated pyramid 375 mm long, 150 mm square at the lower end and 100 mm square at the upper end with a galvanised nail or other suitable non-corrodible metal plug not less than 75 mm fixed therein.</p> <p>Galvanised iron pipe at least 300 mm long and internal diameter not less than 10 mm with a rim wall thickness of not less than 3 mm.</p> <p>Solid non-corrodible metal spike at least 300 mm long and having an external diameter of at least 20 mm.</p> <p>Galvanised iron spike at least 100 mm long driven into fixed timber with a wing 75 mm long cut into the timber and directed to the galvanised iron spike.</p> <p>Drill hole cut into a kerb or other substantial structure at least 5 mm in diameter and 10 mm deep with a wing at least 75 mm long, 20 mm wide and 10 mm deep at the base, and the point directed thereto.</p> <p>Drill hole into bedrock at least 10 mm in diameter and 25 mm deep with a wing 75 mm long and directed thereto where such bedrock exists within 300 mm of the natural surface of the ground.</p> <p>Chisel mark cut into the sound wood of a suitable tree.</p> <p>Mark of durable character or a specific point on a permanent or substantial structure.</p>
Connecting and placement of CRMs	<p>Existing CRMs within 200 m of an urban survey are to be connected to the survey by closed traverse. CRMs of the type of a plaque in concrete block or steel rod are to be placed at a ratio of at least 1 such CRM per one 100 parcels of land. CRMs of type of a plaque in concrete kerb shall be installed along roads at intervals of not more than 150 m throughout the length of the land surveyed and should have a clear line of sight to adjacent CRMs. Where a CRM is installed in such a position that it has, or the surveyor may have reason to consider that it may have in the future, clear line of sight only to one other CRM, then the surveyor shall place nearby a reference mark and shall connect the CRM to it by closed traverse.</p>
Approved CRMs	<p>Non-corrodible metal plaque set in a concrete kerb.</p> <p>Non-corrodible metal plaque set in the top of a concrete block in the form of a truncated pyramid at least 500 mm long, 450 mm square at the lower end and 300</p>

	mm square at the upper end with a minimum volume of concrete of at least 0.07 m ³ . Such mark shall be placed such that its highest point is flush with or below the surface of the ground. Deep driven stainless-steel rod.
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As the Australian Capital Territory (ACT) is surrounded by NSW, it is not surprising that their marking standards are quite similar to NSW. Cross sectional sizes of pegs are the same as NSW but slightly smaller in length and must be of sound durable wood. Other types of boundary and reference marks are quite similar to NSW albeit with less options but do allow some flexibility by allowing other similar marks of the same durability and stability. The ACT standards also have a strong focus on the connection to and placement of Coordinated Reference Marks (CRMs) which are very similar to the network of Permanent Marks (PMs) and State Survey Marks (SSMs) in NSW. Their requirements require a closed network of CRMs to be installed in new roads at regular intervals of 150 m and clear line of sight between CRMs. As the name suggests, these marks are also coordinated and provide a strong basis for future surveys in the area.

4.2 New Zealand

The current marking standard in New Zealand are the Rules for Cadastral Survey 2010 (NZ Legislation, 2010). A summary of the marking standards contained in the Rules for Cadastral Survey 2010 is contained in Table 5.

Table 5: Current marking standards in New Zealand.

Subject	Details
Datum and orientation of surveys	Every bearing in a cadastral survey that defines or marks a new primary parcel boundary point must be oriented in terms of an official geodetic projection applicable to the area unless the survey does not make a new field measurement or if the survey is a boundary reinstatement survey.
Boundary marking	The following boundary points must be marked, where practicable: <ul style="list-style-type: none"> a) each new boundary point on a new primary parcel, unless: <ul style="list-style-type: none"> i. it is a boundary point that is only between new parcels that are all intended to remain in Crown ownership, or ii. it is on a survey under the jurisdiction of the Maori Land Court, or iii. it is a boundary point that is only between parcels that are required to be, or as a result of the survey will be required to be, held in common ownership, or iv. it is on a boundary where parcels on each side of that boundary are required to be, or as a result of the survey will be required to be, subject to reciprocal rights of way, or v. it is unlikely that it will need to be physically located in the foreseeable future because of the terrain, ground cover, or protected vegetation, or vi. the boundary point is readily identifiable by occupation along the boundary; b) each boundary point on an existing boundary of a new primary parcel, that is required to be defined by survey, unless: <ul style="list-style-type: none"> i. a reliable mark is already in place, or ii. it is part of a parcel where the title is to remain limited as to parcels and the boundary point is not in common with a new parcel where the limitation is not going to remain; and c) each primary parcel boundary point that results from an existing irregular class A boundary that is being converted to one or more right-line boundaries.
Approved boundary marks	A new boundary mark must be: <ul style="list-style-type: none"> a) a wooden peg, chamfered at the top, with a minimum width of 45 mm and at least 3,000 mm² in cross-section, or b) a post, or c) any other type of peg that is clearly labelled as a boundary mark, or

	<p>d) if the above marks are impractical, any other type of mark which must, if practical, be clearly labelled as a boundary mark.</p> <p>A new boundary mark must be:</p> <p>a) soundly anchored in place, and</p> <p>b) readily visible, where practical.</p>
Placement of witness marks	<p>The following points on a cadastral survey must be witnessed:</p> <p>a) every boundary point on a primary parcel boundary that is being defined by survey,</p> <p>b) every new boundary point on a parcel where the purpose of the parcel is for a lease and the boundary is not a permanent structure boundary,</p> <p>c) every new or old boundary mark on the boundary of a parcel under survey, and</p> <p>d) every new stratum boundary point.</p> <p>A cadastral survey must have at least one witness mark within the applicable horizontal distances specified in the Rules (Class A – 150 m, Class B – 500 m, Class C – 1,000 m, Class D – n/a) for each of the boundary points specified above.</p> <p>In the case of an extensive rural boundary point, the class B distance may be increased to 1,000 m if the survey is connected by vectors to one or more cadastral survey network marks.</p> <p>A survey that requires a witness mark under the Rules must include a minimum of three witness marks if all boundaries are class A, or a minimum of four witness marks if any boundaries are class B or C.</p> <p>A boundary reinstatement survey must include a minimum of one witness mark.</p>
Approved witness marks	<p>An adopted mark cannot serve as a witness mark.</p> <p>A witness mark must be in a different position to the boundary point it is witnessing and be made of sufficiently durable material, set in sufficiently stable material, and located in a suitable position, so that it can be reasonably expected to survive and remain useable for at least 10 years.</p>
Connecting and placement of permanent marks	<p>Every cadastral survey that is required to have a witness mark by the Rules must include a minimum of two permanent reference marks (PRMs).</p> <p>A boundary reinstatement survey is not required to include a PRM.</p> <p>At least two PRMs required by the Rules must be within the applicable horizontal distance specified in the Rules of a least one boundary point that is required to be witnessed (Class A – 300 m, Class B – 500 m, Class C – 1,000 m, Class D – n/a). In case of an extensive rural boundary point, the class B distance may be increased to 1,000 m if the survey is connected by vectors to one or more cadastral survey network marks.</p> <p>A PRM that complies with the distance requirements specified in the Rules may be used as a witness mark.</p> <p>Two PRMs must also have reduced levels if any of the witness marks are required to have reduced levels.</p>
Approved permanent marks	<p>An adopted mark cannot serve as a PRM.</p> <p>A PRM must be in a different position to a new boundary point, and be made of sufficiently durable material, set in sufficiently stable material, and located in a suitable position, so that it can be reasonably expected to survive and remain useable for at least 50 years.</p>

The types of marks included in the New Zealand marking standards are very flexible, with the choice of mark for each particular situation left to the surveyor's professional judgement. The main aim is that any boundary mark must be identifiable as a boundary mark, stable and visible, that witness (reference) marks should be durable, stable and located in positions which are unlikely to be disturbed for at least 10 years, and permanent reference marks be durable, stable and located in positions which are unlikely to be disturbed for at least 50 years. The default option for corner pegs are wooden pegs smaller in cross section than NSW at 45 mm square. Once again there is a strong focus to connect surveys to existing coordinated geodetic marks and the placement of such marks, with connection distances similar to NSW.

4.3 Northern Territory

The current marking standard in the Northern Territory is the Licensed Surveyors Act 1983 (NT Legislation, 1983) and the various Survey Practice Directions such as the Survey Practice Directions 2014 – Surveys outside of coordinated survey areas (NT Surveyors Board, 2014). A summary of the marking standards contained in the Licensed Surveyors Act 1983 and various Survey Practice Directions is contained in Table 6.

Table 6: Current marking standards in the Northern Territory.

Subject	Details
Datum and orientation of surveys	<p>A survey within a coordinated survey area is to be in accordance with an approved methodology to delimit land boundaries by geodetic coordinates or with another system of delimitation.</p> <p>For uncoordinated areas, a datum line consisting of at least 3 reasonably spaced original marks or groups of marks is adopted for each survey. The survey must ensure that sufficient work is carried out to confirm that the marks are in their original positions or that they can be related to their original positions.</p>
Boundary marking	<p>For uncoordinated areas:</p> <p>A surveyor must ensure that, in an urban area, each angle, bend or corner of a section, portion or unit not defined or referenced by a structural element, is –</p> <ol style="list-style-type: none"> 1) if the area of the section, portion, lot or unit is not more than 1 ha – marked by a peg; 2) if the area of the section, portion, lot or unit is not more than 10 ha – marked by a peg or a steel peg; 3) if the area of the section, portion, lot or unit is more than 10 ha – marked by a steel peg. <p>For urban areas, a surveyor must ensure immediate pegs are placed on all boundary lines which are not defined or referenced by structural elements in intervals of not more than 100 m.</p> <p>A surveyor must ensure that, in rural areas, each angle, bend or corner of a section, portion, lot or unit not defined or referenced by a structural element, is –</p> <ol style="list-style-type: none"> 1) if the area of the section, portion, lot or unit is not more than 10 ha – marked by a peg or steel peg; or 2) if the area of the section, portion, lot or unit is more than 10 ha – marked by a steel peg and a finder. <p>For rural areas, a surveyor must ensure immediate pegs are placed on all boundaries which are not defined or referenced by structural elements in intervals of approximately 400 m and not more than 500 m. For boundary lines greater than 3,000 m, a steel peg and finder are to be placed at near intervals of 2,000 m.</p> <p>If a boundary mark is not visible from the next adjoining boundary mark on a boundary line, a finder is to be placed on the boundary line of not less than 20 m from each bend, corner or intermediate mark so as to indicate the direction of the boundary line.</p> <p>A surveyor must ensure that a boundary described as a parallel of latitude is marked in a series of chords not more than 10,000 m long.</p>
Approved boundary marks	<p>A surveyor must ensure that a survey mark is constructed of concrete, steel or hardwood or another material that will resist destruction by fire, decay and termites.</p> <p>Peg, being a white-painted, flat-topped mark not less than 50 mm square and 350 mm in length, driven at least 250 mm into the ground.</p> <p>Steel peg, being a white-painted, steel star dropper not less than 600 mm in length driven at least 450 mm into the ground.</p> <p>Another mark that is approved by the Board from time to time.</p> <p>If the above marks are impracticable or unsuitable in a particular case, a surveyor may place or adopt marks of equivalent durability and stability.</p> <p>A surveyor must mark a survey mark with the lot, portion, section or unit number of the parcel being surveyed and adjoining parcels by stamping the numbers onto a metal tag of not less than 1 mm thickness and attaching the tag securely to the survey mark.</p>

	At each peg a finder that is a fence spacer not less than 900 mm long or a white painted, 25 mm square wooden stake not less than 900 mm long is driven firmly into the ground.
Placement of reference marks	<p>For urban areas:</p> <ol style="list-style-type: none"> 1) A surveyor must ensure that one or more reference marks are placed at sufficient points on street boundaries to ensure that groups of reference marks are not more than 200 m apart. 2) If an urban lot is more than 1 ha in area, a surveyor must ensure that sufficient reference marks are placed on each boundary of the lot (other than the road boundaries) to ensure that the reference marks are not more than 200 m apart. <p>For rural areas:</p> <ol style="list-style-type: none"> 1) Two reference marks are placed at all bends in roads and at sufficient other points on road boundaries to ensure that reference marks are not more than 500 m apart. 2) On boundaries (other than road boundaries) of parcels containing an area of 10 ha or less – two reference marks are placed at sufficient corners and bends to ensure that reference marks are not more than 500 m apart. 3) On boundaries (other than road boundaries) of parcels containing an area of more than 10 ha and for every isolated lot irrespective of area – two reference marks are placed at every bend and corner. 4) On long line surveys in isolated areas – two reference marks are placed at or near 2,000 m intervals and at each bend or corner and each intersection with another boundary.
Approved reference marks	<p>Spike, being a steel or iron spike not less than 8 mm in diameter and 200 mm long, driven flush into a paved surface, if practicable, or driven not less than 100 mm below and unpaved surface.</p> <p>Nail, being a broad-headed nail driven or set into concrete or another durable medium, but not placed in the natural surface of the ground.</p> <p>Concrete block, being a plaque, spike, or steel peg, set in concrete, whether poured in situ or precast, which may be placed flush with or below the ground, depending on the nature of the surface.</p> <p>Drill hole, being a hole not less than 5 mm in diameter and 10 mm deep, drilling into a kerb or other substantial concrete structure and with wing(s) not less than 50 mm long cut on the side of the hole to indicate its position.</p> <p>Another mark approved by the Board from time to time.</p> <p>If the marks above are impracticable or unsuitable in a particular case, a surveyor may place or adopt marks of equivalent durability and stability.</p>
Connecting and placement of permanent marks	<p>In urban areas, coordinated reference marks (CRMs) are placed at intervals of not more than 200 m and at road intersections or at a density or at a location prescribed by the Surveyor-General.</p> <p>In rural areas, CRMs are placed at intervals of not more than 1,000 m and at road intersections or at a density or at a location prescribed by the Surveyor-General.</p> <p>A surveyor is to ensure that a locality and warning plate, which indicates that a CRM is in the vicinity, is to be affixed to a substantial structure and placed adjacent to the CRM.</p> <p>A surveyor must ensure that the CRM is suitably located for GNSS observation, adjacent to land or unit boundaries, and in a location that is safe for survey observations.</p> <p>At each CRM measurements to two recovery marks are to be made. Recovery marks are to be within 20 m of the CRM and placed at locations where the likelihood of disturbance or destruction is kept to a minimum. Recovery marks are to consist of either a new or existing spike, a new or existing drill hole, or another mark approved by the Surveyor-General from time to time.</p>
Approved permanent marks	<p>A CRM is in the form of</p> <ol style="list-style-type: none"> a) a brass plaque, stamped with the unique CRM number that is <ol style="list-style-type: none"> i. centrally set in situ on the surface of a concrete block that is precast or in situ and that has a concrete frustum that consist of <ul style="list-style-type: none"> • a truncated pyramid or cone of 200 mm diameter at the top, 300 mm diameter at the base and 450 mm deep set in stable ground; • a cylindrical shape of 200 mm diameter and 700 mm deep in unstable ground.

	<ul style="list-style-type: none"> ii. securely affixed to an existing, stable concrete structure. b) an existing concrete block, post or a drill hole with wings in a substantial concrete structure that is able to be stamped or have affixed to it an identification tag marked with the unique CRM number. c) Another mark approved by the Surveyor-General from time to time.
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The Northern Territory marking standards note the susceptibility of survey marks to fire, decay and termites and as such give the surveyor the option of placing marks made from other material such as concrete and steel in addition to hardwood. Boundary marks come in two forms, one being the familiar peg but with a 50 mm square top and the other the steel dropper. The standards also require the installation of a “finder”, i.e. a star dropper placed in close proximity to a boundary mark and painted the colour white. In addition to placing boundary marks, the Northern Territory marking standard requires the surveyor to indicate lot numbers by affixing a metal tag. Options for reference marks are limited but very similar to reference marks as used in NSW. The Northern Territory also has a strong focus on the connection and placement of stable marks for coordination and future re-establishment of boundaries, with connection distances being very similar to NSW.

4.4 Queensland

The current marking standard in Queensland are the Cadastral Survey Requirements Version 7.1 dated September 2016 (QLD Dept Natural Resources and Mines, 2016). A summary of the marking standards contained in the Cadastral Survey Requirements Version 7.1 is contained in Table 7.

Table 7: Current marking standards in Queensland.

Subject	Details
Datum and orientation of surveys	<p>A cadastral surveyor must connect all field surveys that create 10 or more lots, and are to be lodged for registration, to the State control survey. Connection to the State control survey can be way of:</p> <ul style="list-style-type: none"> • A continuously operating reference station (CORS) network included in the datum control survey, or • Connection to two existing coordinated permanent survey marks in the datum control survey each of which has a horizontal positional uncertainty of <30 mm. <p>The quality of the connection to the State control survey must be able to provide a horizontal positional uncertainty of <50 mm on any mark for which coordinates are determined.</p> <p>Surveys that create less than 10 lots do not have to connect to the State control survey, but may still connect to existing or new permanent survey marks that are of good geometry spanning the survey.</p> <p>Where a survey is connected to the State control survey, MGA bearings must be used to an accuracy of 20 seconds of arc, by derivation from points in the State control survey (such as coordinated permanent survey marks or coordinated CORS) or from astronomical observations. Where a survey is not connected to the State control survey, MGA bearings are still preferred, but the survey may be on one of the following meridians:</p> <ul style="list-style-type: none"> • County Arbitrary Meridian. • The meridian of the original survey. • The meridian of an adjoining survey.
Boundary marking	<p>Recognisable survey marks must be placed at each new corner unless it is physically impractical to do so.</p> <p>A clear description of cadastral survey marks placed, including reference marks, must be shown on the plan, and where applicable in the survey records.</p> <p>A surveyor must mark all existing corners on the subject land that are reinstated in the course of a survey, unless an original mark or suitable occupation exists at the</p>

	<p>corner. However, there are instances where revisiting these corners to mark them may be impractical, such as when traversing to an existing mark, many corners away. In such cases, as a minimum requirement, when a new boundary intersects and existing boundary, both terminal points of that existing boundary must be marked unless one of the following applies:</p> <ul style="list-style-type: none"> • The terminal points are not fully reinstated. • Other marks are used for reinstatement along the boundary (e.g. original line pegs). • The survey is a secondary interest action only. • The survey is an identification survey where a client requires certain corners marked only. <p>Unless fencing is to proceed immediately, subject to environmental considerations, trees standing nearest to the line may be blazed with a horseshoe-shaped mark cut into the heart-wood on opposite sides of the tree in such positions that the marks face along the survey line.</p> <p>Tree through which the boundary lines passes should be double blazed on opposite sides so that the marks face along the boundary line.</p> <p>Where corner marks are not intervisible, sufficient marks should be placed on line between the corners so that the boundary is readily and unambiguously discernible on the ground.</p>
Approved boundary marks	<p>A cadastral survey mark that identifies a boundary must be a peg capable of resisting destruction, corrosion or decay that is at least 350 mm in length, is coloured white and has a square top with a minimum cross section of 50 mm for a sufficient distance from the top to provide for branding. If a surveyor considers that it is impracticable or unsuitable to use a mark of this type, the surveyor may place a survey mark of equivalent durability and stability, and as far as practicable, of a similar character so that they are recognisable as cadastral boundary marks.</p> <p>For rural surveys, alternate marks such as a survey post, galvanised iron pipe or star picket may be placed at corners where circumstances so dictate, provided such marks are identifiable as survey marks.</p> <p>Lot numbers should be marked on corner pegs.</p> <p>For rural surveys, where a fence post is used as a corner, it should be branded with a broad arrow and the lot number except where a reference tree is taken.</p>
Placement of reference marks	<p>A cadastral surveyor must ensure sufficient reference marks exist on a cadastral survey to facilitate future reinstatement of a cadastral survey.</p> <p>A cadastral surveyor must record the location of permanent improvements (e.g. buildings, retaining walls) on the land that will assist in the future reinstatement of boundaries.</p>
Approved reference marks	<p>A cadastral reference mark may be any of:</p> <ul style="list-style-type: none"> • A suitably marked tree or fence post. • A durable mark on a building or other immovable object. • A pin made of durable material that is at least 300 mm in length and 15 mm in diameter. • A permanent survey mark. • Any other mark of equivalent durability and stability.
Approved permanent marks	<p>In order for a survey mark to be accepted as a permanent survey mark, it must conform to the following criteria:</p> <ul style="list-style-type: none"> • The mark must be made of a durable material, preferably metal. • When installed, the mark must be permanent and stable (i.e. have the expectation of longevity). Marks located in shallow structures, such as kerbing or footpaths, do not satisfy this specification. • It must be capable of being readily identifiable as a survey mark. • It must be able to be identified with a unique survey control number (as per the Survey Control Register number) either on the mark itself or attached to the mark (e.g. on concrete collar). • The mark must be recorded in the State's Survey Control Register. • It should be capable of occupation, preferably in a location suitable for measurement by GNSS.

The default boundary mark in the Queensland marking standards is a peg 350 mm long with a square top of 50 mm and painted. Other marks can be used with the main requisite that the mark placed is identifiable as a cadastral boundary mark and that the mark is of similar durability and stability. The requirements for the placement of reference marks is left to the surveyor's judgement but must be sufficient to facilitate future reinstatement. The standards do require surveys to be connected to the state control mark network but there is no mention in regards the placement of new survey control marks as it is in NSW. State control marks are though an approved reference mark.

4.5 South Australia

The current marking standard in South Australia are the Survey Regulations 2007 (SA Legislation, 2007), the Surveyor-General's Directions February 2019 (SA Dept Planning, Transport and Infrastructure, 2019a), and the Cadastral Survey Guidelines February 2019 Version 3.0 (SA Dept Planning, Transport and Infrastructure, 2019b). A summary of the marking standards contained in the South Australia's regulations, directions and guidelines is contained in Table 8.

Table 8: Current marking standards in South Australia.

Subject	Details
Datum and orientation of surveys	<p>In carrying out a cadastral survey of land within the coordinated cadastre, a surveyor must accept the Map Grid of Australia coordinates describing the boundaries of the land, as recorded in the plan of the area filed in the Land Titles Registration Office.</p> <p>In carrying out a cadastral survey of land within a designated survey area, a surveyor must comply with the following additional requirements:</p> <ol style="list-style-type: none"> a) The survey must connect to at least three permanent survey marks or two permanent survey marks and one state survey mark for which the Map Grid of Australia coordinates are known; b) The survey must be adjusted to the scale and orientation dictated by the coordinates of the permanent and state survey marks to which the survey is connected; c) If the survey does not agree with the coordinates of the permanent or state survey marks to which the survey is connected within the standards of accuracy required by the Surveyor-General, the matter must be reported to the Surveyor-General and any directions of the Surveyor-General in relation to the matter followed.
Boundary marking	<p>Every new boundary point defined on a cadastral survey must be marked. It is not necessary to mark existing boundaries.</p> <p>Where it is not practicable to peg the actual boundary corner, a position offset to the boundary corner is to be pegged using a reference mark.</p> <p>Where a survey peg marking a boundary is not visible from an adjacent peg, survey pegs shall be placed along the new boundary so that from any survey peg on the boundary the adjacent survey pegs are visible.</p> <p>New boundaries need not be pegged if their improvements are within 1 m of the boundary, and the relationship between the boundary and the improvement is shown on the plan.</p> <p>If the survey is for a division of land into more than 5 allotments or lot, the allotment or lot numbers must be placed, in a permanent and durable manner, on the top or face of each survey peg.</p>
Approved boundary marks	<p>Peg of a durable nature, composed of wood, metal, plastic or other material approved for the purpose by the Surveyor-General, measuring at least 300 mm in length and 50 mm square at the top and coloured white.</p> <p>Metal spike of at least 300 mm in length to which is mounted a metal or plastic top of durable material, at least 50 mm square and coloured white.</p> <p>Star dropper of at least 300 mm in length and coloured white.</p> <p>If not practicable to drive the above marks due to fencing, walls or permanent covering of the boundary, the following reference marks may be used as alternatives:</p>

	<ul style="list-style-type: none"> Galvanised iron nail driven into the fence and painted white. Masonry nail or screw secured into the wall or pavement and painted white. Deck spike at least 100 mm in length and 8 mm in diameter driven into bitumen and painted white.
Placement of reference marks	No requirement for reference marks.
Connecting and placement of permanent marks	<p>Surveys must connect to at least three Permanent Survey Marks (PSMs) or two PSMs and one State Survey Mark (SSM) in urban areas, or three SSMs in rural areas, existing or new. If any two or more of the marks are within a 100 m radius of each other in urban areas, or within a 500 m radius of each other in rural areas, they shall count as only one mark for the purposes of this requirement.</p> <p>PSMs and SSMs within the survey are required at 200 m spacing from other PSMs and SSMs in urban areas and 2,000 m spacing in rural areas.</p> <p>In all areas, PSMs and SSMs shall be placed in safe locations where they are least likely to be disturbed. Below ground marks shall be set at least 200 mm below ground level to allow encasement in urban areas and to reduce the risk of being disturbed in rural areas.</p> <p>Below ground PSMs or SSMs shall be protected by a cast iron cover suitably supported by a 195 mm diameter PVC pipe:</p> <ul style="list-style-type: none"> When placed in urban areas. On re-establishment of the pavement after existing PSMs or SSMs are found in place below pavements. <p>PSMs and SSMs shall be witnessed by a steel dropper with a witness plate attached:</p> <ul style="list-style-type: none"> When placed in rural areas. If existing PSMs and SSMs connected in rural areas are not already witnessed by a dropper, or the witness dropper and/or its plate are in state of disrepair such that they are no longer serve their purpose. If not practicable to protect below ground PSMs and SSMs placed in urban areas with a cast iron cover. When placed below ground in divisions of land in urban areas of more than 5 allotments or lots (as well as the cover required above). <p>Witness droppers shall be placed to best protect the PSM/SSM, and to be in safe locations. In urban areas, witness droppers shall be encased in a PVC sleeve; a rolled witness plate shall be fixed to the PVC sleeve.</p> <p>The witness plates to be used on steel droppers or PVC sleeves shall be those provided by the Surveyor-General, with the relevant details of the PSMs location marked on the witness plate in a permanent manner.</p>
Approved permanent marks	<p>Permanent Survey marks are:</p> <ul style="list-style-type: none"> A below ground permanent survey mark being a brass plaque inscribed survey mark or a steel rod measuring at least 300 mm in length and 10 mm in diameter set in a concrete block measuring at least 150 mm square at the top, 250 mm square at the base and 300 mm in depth. An above ground permanent survey mark being a brass plaque inscribed survey mark or a metal rod set in concrete pillar firmly secured in the ground. Stainless steel pins, at least 50 mm long and 5 mm in diameter, with inscribed washer suitable for permanent installation in concrete. <p>State Survey Marks are:</p> <ul style="list-style-type: none"> Brass plaque inscribed survey mark set in a concrete block measuring at least 150 mm square on the top, 250 mm square at the base and 300 mm in depth. Beacon being a wooden or metal tripod or quadripod fixed to the ground, or a stone cairn supporting a wooden, metal or plastic vane or cap, constructed for survey observations. Any other mark approved by the Surveyor-General as a State Survey Mark permanently placed on land for use in surveying.

The South Australian marking standard is based upon new boundary corners being marked and a very strong coordinated survey control network. There are no requirements for reference marks within the South Australian standard and the marking of reinstated corners is only

optional. The default boundary mark is a peg 300 mm in length and top of 50 mm square, but the surveyor does have flexibility when the circumstances do not allow a peg to be installed.

4.6 Tasmania

The current marking standard in Tasmania are the Survey Directions, Tasmania (Land Tasmania, 2018). A summary of the marking standards contained in the Survey Directions, Tasmania is contained in Table 9.

Table 9: Current marking standards in Tasmania.

Subject	Details
Datum and orientation of surveys	<p>The horizontal datum for bearing and coordinates to be adopted for all surveys of a type listed in the Directions must be GDA94. All bearing and coordinate values must be expressed in terms of MGA94.</p> <p>The MGA94 coordinates for a survey must be determined specifically for that survey and:</p> <ol style="list-style-type: none"> in the case where a previously established survey mark is used as the origin of the MGA94 coordinates, it must be a permanent mark held in SURCOM, or in the case where a CORS network is used as the origin of the MGA94 coordinates, it must be derived from a CORS network whose stations have Regulation 13 certified coordinates, or in the case where a single CORS base station is used as the origin of the MGA94 coordinates, it must be a station with Regulation 13 certified coordinates, or in the case where an AUSPOS solution is used as the origin of the MGA94 coordinates, the AUSPOS report must indicate that a reliable solution has been achieved.
Boundary marking	<p>A boundary mark must be placed at every corner of surveyed boundaries. In rural areas, a corner boundary mark must be secured with a pile of stones, where these are available.</p> <p>Where a physical impediment exists at a corner preventing the placement of a boundary mark at the corner, a boundary line mark must be placed along one or more boundaries terminating at that corner, as near as practicable to the corner and the survey notes must report its position and description and the reason for not marking the actual corner.</p> <p>The line of a boundary between corners, if not sufficiently defined by a fence, hedge, wall, natural feature, or some other similar feature, must be defined and made clearly evident by the placement of boundary marks. For the purpose of line marking of boundaries in rural areas, the line of a boundary may be considered to be clearly evident where a fence, hedge, wall or other similar feature falls within 0.5 m of the boundary as defined.</p> <p>A boundary in bushland, if not able to be made clearly evident by placement of boundary line marks alone, shall in addition be made clearly evident by</p> <ol style="list-style-type: none"> clearing; or flagging with pink tape or discrete painting with pink paint, in accordance with the Forest Practices Code in force at the time; or placement of stakes. <p>A boundary in bushland may be made evident by the marking of trees and logs in preference to or addition to clearing, flagging, painting or placement of stakes only where</p> <ol style="list-style-type: none"> the owners on both sides of a boundary require it to be so marked; and the action is not contrary to any environmental statutory requirement or limitation.
Approved boundary marks	<p>Wooden peg at least 75 mm square in cross section extending at least 100 mm from the top and is to have a length of not less than 400 mm.</p> <p>Metal peg in the form of a steel star bar at least 450 mm long.</p> <p>Plastic peg at least 50 mm square in cross section at its top with a length of not less than 350 mm for urban surveys and at least 75 mm square in cross section at its top with a length of not less than 400 mm for surveys in all other areas.</p>

Placement of reference marks	<p>A survey must be connected to at least three reference marks.</p> <p>The minimum number of reference marks connected to shall be one mark per 500 m of external perimeter of the area under survey, subject to a minimum of 3 marks for surveys of 3 lots or less, 5 marks for surveys of 4 to 9 lots, and 7 marks for surveys of 10 or more lots.</p> <p>Subject to availability, a clearly identifiable corner of, or mark on, a permanent building or an immovable object must be located as a reference mark in preference to other types.</p> <p>Where reference marks are placed during a survey, they must be situated so as to provide for an even distribution throughout the survey, with a maximum likelihood of preservation and ease of accessibility and future discovery. A reference mark must be situated within 10 m of the corner being referenced unless this would compromise its future preservation, in which case it must be placed as close to the corner as physically practicable consistent with its future preservation.</p>
Approved reference marks	<p>Any durable, clearly described mark on a building or on an immovable object.</p> <p>Iron spike, bar or pipe of not less than 12 mm in diameter and 300 mm in length driven flush with a paved surface or 50 mm below an unpaved surface.</p> <p>Tree marked in accordance with the Directions.</p>
Connecting and placement of permanent marks	<p>A survey must be connected to all permanent marks within 100 m of any part of the lots under survey that are reasonably accessible and discoverable, which may be substituted for the location or placement of other prescribed reference marks.</p>
Approved permanent marks	<p>Permanent marks comprise any mark adopted as a permanent mark under section 14 of the Survey Co-ordination Act 1944.</p>

The default boundary mark within the Tasmanian marking standard is a wooden peg with a square top of 75 mm and 400 mm in length. The standard does allow for metal and plastic pegs and allows for smaller pegs of 50 mm square in urban areas. Reference mark types are fairly limited to trees, iron spikes, iron bars, iron pipes and marks on a building or an immovable object. There is no requirement to place permanent marks in the marking standard, but all surveys are required to be connected to MGA94 and all permanent marks within 100 m of the survey need to be connected to.

4.7 Victoria

The current marking standard in Victoria are the Surveying (Cadastral Surveys) Regulations 2015 (VIC Legislation, 2018) and the Cadastral Surveys Practice Directives July 2018 (VIC Dept Environment, Land, Water and Planning, 2018). A summary of the marking standards in Victoria is contained in Table 10.

Table 10: Current marking standards in Victoria.

Subject	Details
Datum and orientation of surveys	<p>A licensed surveyor making a cadastral survey must</p> <ul style="list-style-type: none"> • adopt and verify a datum in accordance with a previous cadastral survey or plan; • if an abstract of field notes is to be lodged with the Surveyor-General or the Registrar of Titles, bring the bearing datum on to the Map Grid of Australia 2020 (MGA 2020) as is reasonable in the circumstances.
Boundary marking	<p>A licensed surveyor making a cadastral survey must ensure that boundaries</p> <ul style="list-style-type: none"> • are marked with pegs together with any additional markings that are necessary to assist in locating the pegs and the direction of boundaries; or • if pegs are not practical, are marked with other suitable marks approved by the Surveyor-General. <p>A licensed surveyor must ensure that line identification and marking is implemented in a manner so that the defined boundary can be readily identified.</p> <p>Intermediate 'line' pegs are also required at distances no greater than 200 m apart on boundaries of significant length and/or when the ends of the boundaries are not inter-visible.</p>

	<p>If it is impractical or inappropriate to place marks at the corners themselves, another form of marking the boundaries in the vicinity of the corners, such as offset marks, is to be implemented.</p> <p>Options for providing identification of boundaries and their direction include trenching, staking, stamping numbers on pegs (front and rear), or by using a combination of these methods.</p> <p>In rural environments, and where appropriate in urban areas, the preferred method of indicating a boundary direction is by trenching, rock-filled trenches, or laying rock mounds.</p>
Approved boundary marks	Peg , not less than 50 mm square and not less than 300 mm long, made of sound seasoned timber or other durable material, and set with the top not more than 20 mm above the ground.
Placement of reference marks	No requirement for reference marks.
Connecting and placement of permanent marks	<p>A licensed surveyor making a cadastral survey must connect the cadastral survey to permanent marks and primary cadastral marks in accordance with the following principles:</p> <ul style="list-style-type: none"> • For up to and including 10 allotments or lots at ground level, to at least three permanent marks or primary cadastral marks in the immediate vicinity of the subject land. • If there are more than 10 allotments or lots at ground level, further permanent marks or primary cadastral marks must be placed within the subdivision so that the distance between these marks is not greater than <ul style="list-style-type: none"> ○ 100 m, or ○ an alternate distance approved by the Surveyor-General. • If more than four marks are required to be placed for more than 10 allotments or lots, then one in every five marks placed must be a permanent mark. • If the design or layout is unusual, place additional permanent or primary cadastral marks within the subdivision as is reasonable in the circumstances.
Approved permanent marks	<p>A permanent mark must be in the form as described in the Survey Co-ordination Regulations 2014 or other survey monuments as adopted or authorised by the Surveyor-General. Current forms of marks in the Regulations are:</p> <ul style="list-style-type: none"> • Approved metal plaque installed in situ in top of block of 30 Mpa concrete with a base of not less than 300 mm diameter, top of 120 mm diameter, and length of at least 600 mm. • Approved metal plaque installed in top of pre-cast 30 Mpa concrete block with a base 300 mm square, a top 120 mm square, length 600 mm, and contains 500 mm long 6 mm diameter mild steel rod reinforcement. • 3,000 mm corrosive rod in sleeve with cast iron cover and concrete collar. • 1.8 m, 25 mm diameter mild steel rod coated with bitumen with approved metal plaque welded to top of rod and installed in 100 mm diameter hole with bottom 500 mm in concrete, backfilled with crush rock, and concrete collar. <p>A Primary Cadastral Mark (PCM) is a survey mark of a permanent nature. To qualify as a PCM, a survey mark must be all of the following:</p> <ul style="list-style-type: none"> • Made of a durable material. • Permanent and stable in construction. • Placed so that it can be readily found and accessed. • Placed such it does not present a hazard to the public. <p>When establishing PCMs, surveyors should endeavour to place them in locations where they are not likely to be damaged or destroyed such as in concrete kerbs and other places away from pedestrian or vehicular traffic. Surveyors should endeavour to establish PCMs in GNSS friendly locations, where possible.</p> <p>Marks suitable for nomination as PCMs include:</p> <ul style="list-style-type: none"> • For hard artificial surfaces (e.g. concrete, brick and stone): <ul style="list-style-type: none"> ○ aluminium rivets ○ hardened survey nails ○ expanding metal dowels with a collar ○ drill holes at least 10 mm deep with wings

	<ul style="list-style-type: none"> ○ etches (or chisel cuts) that are prominent and well-defined with wings at least 50 mm in length and not less than 3 mm deep <p>Survey marks placed in bitumen or asphalt are not considered suitable as PCMs.</p> <ul style="list-style-type: none"> ● For natural surfaces: <ul style="list-style-type: none"> ○ Steel star posts or other survey marks of metal construction (e.g. rods or pipes) at least 600 mm in length. Such marks should be placed with the top not less than 50 mm beneath the surface. <p>For all PCMs connected to and established in a cadastral survey, surveyors must:</p> <ul style="list-style-type: none"> ● Preserve the PCM numbers already assigned to existing PCMs connect to. ● Assign numbers to all new PCMs from the series of numbers pre-allocated to them by the Surveyor-General. ● Show the connections to the PCMs on the abstract of field records or RE Plan. ● Include the PCM numbers on the survey documents (abstract of field records, RE Plan and licensed surveyor's report) associated with the survey.
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The Victorian marking standard has adopted MGA2020 for the majority of their cadastral surveys. Similar to South Australia, Victoria has adopted a 50 mm square peg as the default boundary mark, has no reference mark requirements, and is heavily focused upon a network of survey control marks for future re-establishment of property boundaries.

4.8 Western Australia

The current marking standard in Western Australia are the Licensed Surveyors (General Surveying Practice) Regulations 1961 (WA Legislation, 1961a) and the Licensed Surveyors (Transfer of Land Act 1893) Regulations 1961 (WA Legislation, 1961b). A summary of the marking standards in Western Australia is contained in Table 11.

Table 11: Current marking standards in Western Australia.

Subject	Details
Datum and orientation of surveys	Each survey must be connected to a previous survey. Authorised surveys are to be connected on a map grid approved by the Board.
Boundary marking	<p>The corners and angles of a boundary or land parcel must be marked. The numbers of all relevant land parcels are to be indicated on boundary marks.</p> <p>On all permanent boundaries that exceed 250 m in length, a mark consisting of an iron spike at least 10 mm in diameter and 400 mm long driven flush is to be placed on the boundary line at intervals not exceeding 250 m such that from each mark at least one other mark is visible forward and backward. Alternative intermediate marks can be used if iron spikes are not reasonably available or conditions are unsuitable for their use, and that alternative marks used are of equivalent durability and stability. If the length of any boundary exceeds 2 km, numbered reference kilometre posts shall be placed in the boundary.</p> <p>If there are no improvements indicating the direction of a boundary, the direction must be clearly indicated by trenches, stakes, stone pointers or other appropriate marks on the ground.</p>
Approved boundary marks	<p>Area over 4 ha:</p> <ul style="list-style-type: none"> ● Hardwood post, pointed at the top, 100 mm square, at least 600 mm long; or ● Concrete post, 60 mm square, at least 450 mm long; or ● Steel post or peg, 60 mm square, at least 900 mm long; or ● Mark made from polypropylene, 75 mm square, at least 450 mm long. <p>Area 4,000 m² to 4 ha:</p> <ul style="list-style-type: none"> ● Peg, 75 mm square at least 350 mm long; or ● Concrete post 60 mm square, at least 450 mm long; or ● Steel peg, 75 mm square, at least 600 mm long.

	<p>Area under 4,000 m²:</p> <ul style="list-style-type: none"> • Peg, 50 mm square, at least 350 mm long; or • Concrete post, 50 mm square, at least 400 mm long. <p>Posts and pegs are to be made from jarrah, jam (wood) wandoo, steel, concrete or polypropylene.</p> <p>Where the above marks are inappropriate, an alternative mark can be used if it is of equivalent durability and stability, is identifiable as a cadastral mark, and sufficiently resembles a standard mark so as to be identifiable as such by the public.</p> <p>Where practicable, all exposed portions of posts and pegs shall be coloured white or if they are hardwood pegs 75 mm square may be coloured red.</p> <p>All concrete posts are to be topped by a secure non-corrosive metal plate.</p>
<p>Placement of reference marks</p>	<p>Two reference marks must be placed:</p> <ol style="list-style-type: none"> At each angle of the boundary if it is the boundary of a land parcel that is greater than 4 ha. At key points along the boundary if it is the boundary of a land parcel that is equal or less than 4 ha. At each corner and angle of the boundary if it is another boundary. <p>A single reference mark (without trenching) must be placed at each instrument point that is not otherwise permanently marked.</p> <p>The objective of the placement of a reference mark is to ensure its long term stability and accessibility.</p> <p>At any truncated corner of the street, right-of-way, pedestrian access way, drainage reserve or railway:</p> <ol style="list-style-type: none"> The intersection of two adjoining alignments must be marked with a single reference mark; and Two other reference marks must be placed in positions so as to minimise the chance of disturbance and to enable the re-establishment of both alignments. <p>If a corner or angle of the street, right-of-way, pedestrian access way, drainage reserve or railway is not intervisible with an adjoining corner or angle, the intermediate instrument point (being the point from which both corners or angles are visible) must be marked by a single reference mark (without trenching).</p>
<p>Approved reference marks</p>	<p>Iron spike at least 10 mm in diameter and 400 mm long, driven flush into a paved surface or sunk, where practicable, at least 250 mm below an unpaved surface.</p> <p>Where such marks are not reasonably available or conditions are unsuitable for their use, alternative marks of other materials of equivalent durability and stability may be used.</p> <p>Marks with a head or lip such as bridge nails or dog spikes should not be placed in situations where they are to be excavated for use.</p>
<p>Connecting and placement of permanent marks</p>	<p>On every authorised survey (including re-pegs and survey stratas) in town and suburban lands, if the re-establishment or new line passes within 100 m of a standard survey mark (SSM), that SSM must be connected to the authorised survey unless the SSM has in the past been directly connected to a cadastral alignment to which this authorised survey is directly connected. If more than one SSM is passed both or all must be connected. For rural lands, the proximity to an SSM is extended to 2 km (or 10 km if GPS is being used). Although desirable, it is not necessary to provide an azimuth connection, but surveyors are encouraged to consider the use of a remote reference object (RO), and to connect to any SSM that is conveniently visible even if it is outside the stated proximity.</p> <p>Every subdivision (which is not within a special survey area) within the following specifications must be connected to the geodetic network, unless that subdivision is connected to a cadastral alignment that has previously been directly connected to the network:</p> <ul style="list-style-type: none"> • Of more than 10 lots, within 800 m of an SSM • Of more than 10 km of new boundary, within 5 km of an SSM. • Surveyed by GPS if within 10 km of an SSM. <p>The horizontal stability of the SSM(s) must be validated from reference marks.</p>
<p>Approved permanent marks</p>	<p>Approved brass plaque set in pre-cast concrete block with square base of 180 mm and square top of 115 mm and length of 500 mm. Concrete block is installed in 400 mm deep in-situ concrete and pre-cast concrete hatch cover and lid with at least 150 mm clearance between lid of cover and top of brass plaque.</p>

	<p>For remote areas, approved brass plaque set in concrete 300 mm diameter and 200 mm deep connected to a star iron picket or galvanised pipe driven into the ground so that top of brass plaque is 50 mm above ground level. Brass plaque to be connected to star picket or pipe by tie wire and concrete is to encase this connection.</p> <p>A minimum of three reference marks shall be placed around the SSM preferably at 120° separation at least 200 mm below the natural surface and approximately 3 to 5 m away from the SSM.</p>
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The Western Australian marking standard is based around the size of the land being surveyed determining the type and size of mark to be placed. Boundary marks range in top size from 50 mm to 75 mm depending upon the circumstance and are quite long compared to other jurisdictions to allow boundary marks to be marked with lot numbers and other identifying features. Connection to existing survey control network is required in the marking standard but does not include a requirement of placing additional survey control marks.

4.9 Canada and USA

Canada and the USA are two other jurisdictions that are based on a commonwealth of states, provinces and territories with the basis of their legal and land title systems being common law. The development of these two countries has seen the land divided into lots based on a rectangular grid system and the development of marking standards based upon similar principles as Australia, where boundary marks need to be visible and recognisable as boundary marks by the public as well as be stable and durable. Their marking standards have also evolved over the years based upon materials available, differing techniques and changes in public perception. Currently the preferred mark is a mark consisting of steel or concrete, placed so it is stable and visible. The mark also requires having some sort of identification either being a plastic or steel cap or metal plate. This identification includes details identifying who has placed the mark and their authority, being their registration number, and details of the corner marked being the lot and section numbers. Their standards are very similar to NSW and other jurisdictions in Australia where boundary lines as well as corners need to be clearly identified by placing extra marks on line at a certain interval, the placement of reference marks to enable re-establishment of property boundaries, and the connection of boundaries to a geodetic datum.

5 COMMON ASPECTS OF SURVEY MARKING

When comparing marking standards across various jurisdictions, a number of common aspects appear. These include:

- 1) Recognition by the general public – survey marks and particularly boundary marks need to be recognised and accepted as being boundary marks. A number of jurisdictions note this particular need within their marking standards and have adopted a default colour (typically white) and size of mark as a boundary mark. Each jurisdiction allows for other marks to be used but the choice of mark by a surveyor needs to be based on its close similarity to the default boundary mark and its recognition by the general public as well as stability, durability and suitability for the environment in which the mark is to be placed.
- 2) Authoritative – marks placed, particularly boundary marks, need to be trusted that they have been accurately placed and correctly denote the boundary it purports to have marked. Each jurisdiction requires that only competent surveyors mark and deal with property boundaries and as such these surveyors may be authorised, licensed or registered by that particular jurisdiction to carry out the marking and surveying of boundaries. Jurisdictions in Canada

and the USA have gone a step further and require the surveyor to note their authorisation/license/registration number on the mark itself.

- 3) Visible – corner marks and boundary lines need to be visible and easily identifiable to land owners and contractors carrying out work close to the boundary line. All jurisdictions researched require surveyors to place marks at boundary corners as well as intervening marks along boundary lines at particular intervals. Jurisdictions also require the direction of each boundary line at each mark placed to be identified using various methods including trenches, piles of stones, stakes, blazing of trees and logs, and painting. Some of the jurisdictions also required lot numbers to be identified on the mark itself using branding, stamping or attaching a metal identification tag. Each jurisdiction is quiet on how long such marks should be visible. Typically, visibility is only required until boundary works such as fences and retaining walls are completed. Some members of the public are happy to try to maintain the position of their boundary pegs indefinitely as it provides a guarantee regards the location of their property boundaries.
- 4) Durable and stable – all jurisdictions require marks to be placed to be durable and stable to counter such threats such as decay, pests and easy removal. New Zealand has indicated that reference marks should have at least a time span of 10 years and permanent marks a life span of at least 50 years. With the choice of alternative marks, the marking standards of all jurisdictions indicate that any alternative mark must be of similar durability and stability of the default marks described in the standards. All marking standards researched advise surveyors to consider the location of reference and permanent marks, in particular the likelihood of disturbance or destruction due to construction works. In this case, all the standards give surveyors some flexibility in their placement.
- 5) Permanent to allow re-establishment of boundaries – all jurisdictions have some method of permanency to allow for future surveyors to re-establish boundaries. For South Australia and Victoria this is based upon a network of permanent marks, for NSW, Tasmania and Western Australia it involves the traditional method of placing reference marks. All jurisdictions also require surveys to be connected to a geodetic datum of some kind for most type of surveys. Permanency or some method of enabling re-establishment in particular is quite important to surveyors but is also important to the general public as it alleviates the potential of confused and lost boundaries in the future and potential high survey costs as boundaries would need to be re-established from greater distances due to lost marks in the local area.
- 6) Standardised – all jurisdictions have indicated what the size, colour, look and material of survey marks placed in their jurisdiction should be. This fits into the need for the general public to recognise marks placed as survey marks but also sets a minimum standard that surveyors must meet.
- 7) Flexible – all marking standards have some flexibility regarding the types of marks that can be used. It is obvious that not one kind of mark is suitable for all situations and environments. As stated above, the standards do allow the surveyor some choice but when using alternative marks, the surveyor must make a professional judgement that the alternative marking meets most of the aspects of a survey mark as detailed above.
- 8) Evolving – even though not directly indicated in any of the standards, marking standards are forever evolving. Such changes include new geodetic datums, new surveying techniques, new materials for marks, and changing perceptions of society. It is obvious from research that all the marking standards have been reviewed and amended at certain intervals allowing for the standards to evolve as required. It is assumed that these changes and reviews would be undertaken in consultation with the surveying profession and the general public.

6 THE FUTURE

Before we look at a possible future for survey marking, we need to consider the current trends and changes occurring in society to try to determine what the future may look like. Some trends that may have an affect on survey marking into the future include:

- 1) Moving to a digital world – the last 50 years have seen the introduction and adoption of computers and electronics to assist in our day-to-day lives, the recording of data, banking, communication, navigation and the management of large systems. The surveying profession has not been immune to this. Gone are the days of log tables, calculations done by hand, and drafting of plans by hand. We live in an era where large amounts of land can be mapped very quickly with the same resources it took to survey much smaller areas in the past. This data is in a lot of cases also freely available through platforms such as Google Maps and SIX Maps, giving members of the public unprecedented access to data. This is changing the way we look at land and its management. One particular example is the development of a “Digital Twin” by NSW Spatial Services, where the State of NSW is being mapped so as to create a digital world where potential concepts and designs can be tested before being implemented in the real world. Another change that moving to a digital world has created is the ease and accessibility to navigate across the world. Finding a location is as easy as opening your mobile phone and either entering a location or selecting a location on a map and then following the directions displayed to navigate to the point chosen. Gone are the days of taking astronomical observations and using dead reckoning.
- 2) Urbanised world and the consolidation of rural lands – since the introduction of the Industrial Revolution, the trend has been to urbanise our world. This, together with the reduction of jobs in agriculture due to the introduction of machinery and the consolidation of farmland into large properties, has seen a huge increase of people living and working in urban areas. This increase of population requires the development of houses, offices, factories, roads, railways and other services. This has brought about an increase in various different hard surfaces and changes to the landscape. Another trend is the building of walls on boundaries and the increase of multi-storey developments. The trend of rural lands being consolidated into large properties to benefit from economics of scale has also seen a decrease in the need for rural boundary surveying and as such the type of marking that goes with surveying rural boundaries.
- 3) Possible introduction of a 3D cadastre and possibly a 4D cadastre – height, the third dimension, is becoming more important, especially with the increase of multi-storey development and therefore the need to relate boundaries to height via stratum and strata. This has brought new management issues for councils and governments in visualising the landscape to assist in planning and providing services. Time, the fourth dimension, may also be added to the cadastre, especially with the introduction of a time-dependent geodetic datum and the greater need for analysing data over time.
- 4) Sustainability and access to material for survey marks – no resource is infinite and that includes material that is used for boundary marks. The wooden peg has been a long time standard, but is that type of material still sustainable into the future? Hardwood forests take a long time to develop and as such more emphasis has been placed on softwood forests. This has seen a decrease in the availability of appropriate hardwood and the increase in cost for such material. This has opened the opportunity to look at other materials, especially with the introduction of portable power tools, which make installing some materials a lot easier.
- 5) Public perception and cost of surveys to the public – the public perception of surveying is quite low compared to the past due to the lack of understanding of what is involved to establish boundaries. The majority of the general public also have a lack of understanding how much the establishment of secure property boundaries contributes to society. The other

trend is the rising cost of goods and services, in particular property. This is placing pressure to find ways to keep costs down by finding more efficient ways to provide services or providing value for money.

So, what does this hold for the future of survey marking? The first question that does come to mind is whether survey marking will still be required into the future. Some would argue that with the introduction of coordinated cadastres and easy access to navigation and positioning tools such as GNSS, marking will not be required. The property owner and contractors should be able to easily determine their location in regards the local geodetic datum and cadastre and then determine the location of their boundaries. Is this something the public wants? If it is, it is not something that will happen in the short term. It will require quite a bit of funding by government and effort by surveyors to accurately coordinate each boundary. It could also increase the amount of land disputes due to a lack of understanding of coordinate systems and measurement techniques by non-competent people, but it could open new opportunities and enable the development of new services and data.

Machine guidance is a prime example of this working on a smaller scale, with equipment operators determining their location without the need for surveyors to place numerous marks. However, this has not eliminated the surveyor as the surveyor needs to coordinate the site in respect to the datum which the equipment measures to, and place datum marks and benchmarks for operators to check upon in order to ensure that their equipment is measuring correctly. The surveyor is also there to provide advice and fix any problems that may arise.

This may be a possible long-term view, but what about the short term? Marks need to be placed so that fences and walls can be erected, and other improvements can be placed within the required offset of boundaries. This raises the question if our current marking system is suitable in the near future and the possible changes required to meet long-term expectations.

The wooden peg has met (and in most present cases still meets) the requirements of pegging as detailed above, but it is meeting several pressures in this modern world. Our urbanised world has put up quite a few barriers to placing survey marks including:

- Increasing number of hard surfaces that do not allow marks such as wooden pegs to penetrate.
- Increasing corners being inaccessible to marking due to a structure being placed on the corner or boundary, or corners are located at a certain reduced level.
- Increasing amount of marks being disturbed or destroyed due to lack of recognition of their importance or pressures to have other works constructed to tight timelines.
- Increasing costs for materials and installation. Wood was plentiful, but is this still the case and will it be into the future?

From the perspective of the public, it feels that corner marking is not important anymore as the public's understanding is that the fence is the boundary until there is a boundary dispute. This may be correct if the fence is carefully erected on the boundary line, but as surveyors we know of many cases of this not happening.

A corner peg can be a god saver when undertaking a survey where all marks are gone, but how reliable is it for the boundary definition? Pegs are at the lower end of the hierarchy of boundary definition, just above occupations and dimensions. To be acceptable, they need to be stable. However, can they really be deemed stable in this urbanised world, especially after various construction activities have been undertaken nearby?

Options that may assist with countering the above pressures may include:

- Instigating a wider education of the general public of the importance and recognition of survey marks. Having a better idea of the types of survey marks and their importance may help with their acceptance, raise their profile, and assist with their protection. This may also assist with the profession's aim of lifting its standing within society as the public gains a better appreciation of our role and what skills and services we provide. It is noted that work towards this is occurring, in particular at NSW Spatial Services with the "Protecting survey marks" information sheet (NSW Spatial Services, 2019) and Surveyor General's Direction No. 11: Preservation of Survey Infrastructure (NSW Spatial Services, 2020). These have been quite successful but need to reach a wider audience, possibly through other means such as social media, television, radio and newsprint, and reconfigured to appeal to that wider audience. This of course will take time, funding and support by the profession.
- Making marks more visible and authoritative. Other jurisdictions require marks to have lot details or even the surveyor's details placed on the mark in some way. Even the inclusion of the words "Boundary Mark" may assist with better recognition and acceptance of their importance by the general public. The extra time and cost to install such marks will need to be highly considered in the implementation of this option. This may be offset by considering the amount of marks to be placed and using existing improvements to define a boundary. An example of this is South Australia where only new corners are marked and boundaries do not need to be marked if it can be defined by showing offsets to various improvements close to the boundary.
- Placement of offset marks on substantial structures such as kerbs instead of at the corner. Once again, they will probably require some sort of identification installed with the mark to ensure they are visible and recognised by the public. Lot details and possibly offset measurement could be noted on the mark. Examples of where this has occurred in the past are the placement of drill hole and wings in kerbs along boundary lines in many previous Department of Housing developments, and the marking of railway alignments. Stability may be a concern with this method as concrete kerbs may seem to be stable but are prone to movement due to settlement and movement of subgrade below the kerb.
- Investigating methods to protect marks such as cover boxes or visible ground marks with authoritative markings. This may mean moving away from the installation of marks currently used such as galvanised iron pipes, concrete blocks and drill hole and wings unless they can be identified as authoritative survey marks. De Belin (2012) has detailed his success in implementing the installation of cover boxes over existing underground marks, which has greatly helped in their preservation. Research and experimentation with different types of cover boxes should be considered such as PVC cover boxes similar to cover boxes used in irrigation or PVC pipes and caps. For surface marks, washers or identification plates could be installed with or alongside the mark to identify the mark as a survey mark. Once again, cost and time to install would need to be considered, but with the availability of portable drills this should be minimised. It is interesting to note that many utility providers already use these types of methods to protect their services, e.g. the numerous installations of on-ground marks with washers on concrete kerbs at intersections placed by AAPT to mark the location of their underground cables where they cross the road.
- Reviewing the current requirements for placement of reference marks and permanent marks, in particular the density of marks placed and their positioning. It is noted that some jurisdictions are moving away from the placement of reference marks to a strong network of coordinated permanent marks, typically consisting of very stable marks placed so they are intervisible, marked in an authoritative way, centrally recorded in a state-wide database, in areas unlikely to be disturbed and able to be occupied by GNSS. This network becomes a strong spine for the surrounding cadastre and goes back to the old survey principle of

“from the whole to the part”. These marks become a quasi-permanent marking of street alignments as was previously undertaken in the late 19th and early 20th centuries via alignment stones, posts and pins. A prime example of this is the redefinition of street alignments of various streets within the Sydney CBD after the 2000 Olympic Games by the City Council with reference to existing and new permanent marks and the ongoing maintenance of this network of permanent marks. As in this example, long-term maintenance of such a network is an issue and some consideration needs to be made in regards to sharing such an issue between local government, state government and the surveying profession.

- Reviewing the number of acceptable mark types. NSW has a number of acceptable types of marks compared to other jurisdictions, including reference to a number of historical mark types that may not be applicable anymore. This provides a high amount of flexibility to the professional surveyor but is probably adding confusion to the public and therefore ignorance in regards to the disturbance and destruction of such marks. Other jurisdictions have allowed flexibility by leaving the choice of mark to the surveyor and their professional judgement, but the mark placed must be as durable and stable as the default survey mark and recognised as a survey mark.

7 CONCLUDING REMARKS

The aim of this paper was for professional surveyors to gain a better understanding of how the current survey marking standard has developed, how it compares to other jurisdictions, and the importance and societal requirements surrounding boundary marking. The other aim was to encourage the profession to start considering the future and its effect on survey marking. Our world is not static, with the prime example being the introduction of a new static national datum (GDA2020) to cater for continental drift and moving towards a time-dependent datum (ATRF). As the world progresses, we need to evolve and improve on past practices, and become even more efficient. The surveying profession is not immune to this and has proven in the past to be great accepters of new technology.

Our marking standards have developed over the last 232 years, with a number of changes as new materials, techniques and technologies have been developed. It is also interesting to note how similar other jurisdictional marking standards are, with the only changes being size and type of mark but based on the same principles, i.e. marks need to be recognisable by the public, authoritative, visible, durable, stable, permanent, standardised and flexible. The future will see further changes required to our marking standards, especially the increasing urbanisation and digitising of the world, the ease of navigation and positioning, and changing societal views.

With the principles in mind, our profession has an opportunity to consider how our marking will operate in the future, with questions such as if marks are required, their type, and their density needing to be answered.

It should be noted that the ideas, opinions, suggestions and recommendations given in this paper are the author's alone. By putting these forward, it is hoped to start discussion within the profession to think strategically about the future not only in regards survey marking but also the profession as a whole. Where do we see ourselves in the future and what role we will play? These are important questions to consider, unless we want these questions answered for us by someone else.

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