Land Information New Zealand
Toitū te whenua

Cadastre 2034

A 10-20 Year Strategy for developing the cadastral system:

Knowing the 'where' of land-related rights

Land Information New Zealand

Contents

Foreword

I am pleased to present Cadastre 2034, a strategy that will enable our cadastral system to continue to meet the needs of our economy and society over the next 20 years and beyond.

New Zealand has a world class cadastre. It gives certainty for individuals about exactly where their boundaries are when they buy, sell and make use of land. It provides a robust foundation for government and private individuals to grow New Zealand's economy, safeguarding nearly $700 billion in residential property wealth alone.

However, society is rapidly changing and people are increasingly demanding ready access to information and using it for a wider variety of purposes; a reliable system of recording rights in land will be crucial to support our economic, cultural and social objectives.

Cadastre 2034 outlines a vision for a broader cadastre where information is readily accessible and people have confidence in the spatial extent of the various rights, restrictions, and responsibilities related to their land and real property.

The strategy envisages a future where cadastral information, including in three-dimensional form, is available in real time through channels that meet user needs – including mobile devices that can be used for locating and depicting boundaries on the ground.

The strategy also sets the cadastral system within the wider location system. LINZ has a leadership role in maintaining and developing this location system in general and the cadastral system in particular. Cadastre 2034 aligns with LINZ's long-term strategic direction to lead the creation of a world class location system.

Growing the location system will prompt the development of innovative tools and information services for generating good decisions about the best use and management of land.

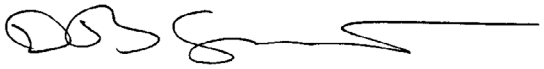
Cadastral data will be able to be reused and integrated with other spatially-related information to support this.

This strategy is the first step on the journey towards developing the cadastre over the next 10-20 years. It will enable the best investment decisions to be made and the benefits to all stakeholders maximised. The broader cadastre extends the cadastral system well beyond the preserve of surveyors and other land professionals to all individuals and organisations interested in the location of land-related property and the various rights, restrictions and responsibilities associated with them (including public lands and public rights).

The document presents the reasons for developing the cadastral system through this strategy, describing the system and the strategic drivers for change. It defines a vision for the cadastre, identifies specific goals, gaps and the high level actions needed to close those gaps. However, implementing the strategy will be an on-going task beyond the scope of the strategy itself and will require all stakeholders to work together.

The benefits of a world-class cadastre extend well beyond LINZ. Consultation and collaboration with all interested parties including central government, local government, academia, the business sector, and professional bodies has been crucial to developing this strategy and the document incorporates changes from this consultative process.

As well as thanking those who responded to the consultation, I want to particularly thank Mark Dyer and Anselm Haanen who worked with me to review consultation responses and develop the updated strategy.



Don Grant
Surveyor-General

1 Introduction

This strategy has been developed to address the cadastral system as part of a broader property rights system.

It is about the 'where' component of the property rights system which enables that system to function effectively.

It is proposed to extend the cadastral system to cater for the spatial representation of all property rights, restrictions and responsibilities (RRRs). This will allow the rapidly changing needs of society to be reflected in a fit-for-purpose property rights system.

This strategy recognises that the elements of what is called the fundamental cadastre must be maintained or enhanced. Public confidence in the fundamental cadastre will not be compromised in achieving goals related to developing a broader cadastre.

The strategy does not seek to directly influence system architecture or data modelling other than identifying broad principles. Nor does it commit to particular actions – obtaining that commitment will form part of an implementation plan.

2 Why develop the cadastral system?

A gap is currently developing between what we have now – a modern cadastral system that is recognised as world class – and the cadastral system that will be needed for the future.

Society is changing rapidly, especially in terms of access to information, the uses to which information is put, and changes in technology. These changes may very quickly result in the New Zealand cadastral system not meeting the needs of the Crown, Māori, government agencies, landowners and holders of other interests in land, and businesses, amongst others. People may become increasingly frustrated in their efforts to readily access the cadastral information they need. The quality of some of the current information falls short of today's needs, and is very unlikely to be fit for future needs unless a clear development path is agreed.

An example is the lack of clear information about the Crown's land holdings. Inability to easily access the required information will adversely impact on government and business decisions and consequently can inhibit the nation's development and economic growth.

The strategy provides a clearly stated vision towards which anticipated future demands can be met by efficient investment and collaborative effort. Without a strategy there is a risk that investment may be applied by central and local government agencies in a piecemeal fashion in response to short-term problems, rather than being solved by initiatives made within a coherent framework.

The strategy provides opportunities to better manage this risk.

For example, the planned Landonline[1] technology refresh that will result from the project known as Advanced Survey & Title Services (ASaTS) will address known technology concerns, but this strategy also provides a framework for the refresh to fully respond to the emerging needs for 3D data, access via mobile devices, integration with other data, and externally available validation tools. Another opportunity might be to address the proliferation of inconsistent land and real property rights databases in different agencies. A third example might be to ensure that a desire to reduce the short term cost of surveying Māori or Crown land in particular, does not result in enduring information gaps, administrative manual workarounds or ambiguities in the land record.

At a higher level, opportunities may be missed to work collectively and coherently across those government agencies that act within the property rights space. Without a strategy to share with those agencies, initiatives are likely to be driven by short term imperatives in business plans and constrained by the resources available from time to time in individual agencies.

This strategy also needs to provide a guide to the further development of the geodetic system[2] that provides the foundation infrastructure for all spatial information in New Zealand.

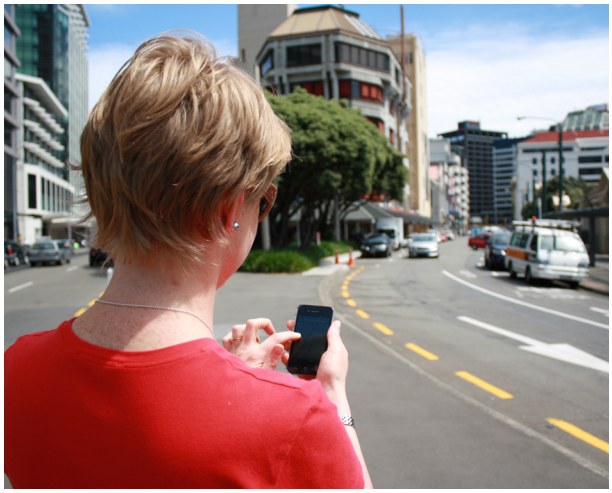
[1] Landonline is the information system used by LINZ to manage survey and title transactions and includes the database of survey and title records. [2] The system that allows coordinates to be assigned to points and facilitates the alignment of spatial databases.

Without a strategic direction that clearly contributes to the nation's prosperity, the necessary funding that is required to develop the cadastral system is unlikely to be available.

The uptake of new technology, and future advances in technology, will significantly change New Zealanders' expectations of the cadastre as an accessible and critical public resource that we can all have confidence in. People increasingly expect to be well-informed of their rights, to be able to have a say in how those rights are recorded and managed, and expect information to be delivered in a form that they can readily understand, use and relate to. The increasing quality and availability of technology in positioning, spatial databases, and consumer mobile devices is expected to have a significant impact on the operation of the cadastre – particularly in reducing compliance costs and a consequential reduced use of manual exceptions as automated processes improve.

Unless the future cadastral system supports the use of technology, particularly increased use by the general public, it is likely that the costs and difficulties that many cadastral users currently experience will increase. Alternative sources of information may be sought by landowners and other members of the public that perhaps are more timely or easily obtained but which are less authoritative and riskier to use for land-related decisions, further undermining the business case for investment.

This strategy discusses why the cadastral system needs to expand and change over time and defines the best steps to take to achieve the vision.



3 The cadastral system

3.1 Description of terms

Within the context of this document, the following general descriptions will help with interpretation.

3.1.1 Property rights

The term 'property rights' can generally encompass a wide range of legal interests in or related to land and real property. That is, interests which are defined by statute or otherwise recognised in law and which relate in some way to a particular area of 'land' (as it is described below).

Interests in relation to land can be categorised as identifying things that you can do (rights), things that you can't do (restrictions), and things that you have to do (responsibilities). These three (rights, restrictions and responsibilities) are sometimes abbreviated as 'RRR'.

Within this document, for simplicity, the term 'rights' by itself can generally be taken to refer to rights, restrictions and responsibilities unless the context is clearly limited only to rights.

The most significant right in land is ownership. In some cases, that ownership right is limited by legal restrictions and may be subject to responsibilities.

Elements of social tenure such as those arising from The Treaty of Waitangi (Te Tiriti o Waitangi), and which have a spatial element, do form part of the cadastral system and are included in this strategy, at least in broad terms.

3.1.2 Property rights system

The property rights system is the overarching social construct that includes the cadastral system and tenure systems. This system also includes all those matters that, when combined, maintain efficiency and confidence in transacting property rights.

A property rights system will define what, who, when and (through the cadastral system) where. These components are as follows:

- **what** the RRR is in law
- **who** (or which organisation) holds the RRR or is subject to it
- **when** the RRR came into effect or when it ceased to apply
- **where** the land or real property is that it applies to, including its extent.

The first three of these are defined in the tenure system and the last one is the subject of this strategy.

3.1.3 Real property

Real property includes land but also structures and other immoveable improvements such as mines, dams and roads. It is the legal concept of real property that enables the creation of capital – the ability to obtain a mortgage and so use the value of the property for other purposes (such as to build a house or invest in business), as well as enjoying the use of the land itself.

References to 'land' include real property unless the context dictates otherwise.

3.1.4 Land

The term 'land' does not only apply to dry land. It is used here in the context of rights in land and encompasses the definition of rights below the land/seabed (e.g. mineral rights, tunnels), and above it – the airspace or, in the case of lakes, rivers, and marine areas, the water column also.

3.1.5 Tenure system

A tenure system is a fundamental component of a property rights system. It is essentially a legal system for registering and transferring rights, restrictions and responsibilities (RRR) in land and is closely linked to the cadastral system.

3.1.6 Cadastral system

The primary purpose of the cadastral system is to define the 'where' in the property rights system. Significant value is added by enabling this "where" to be related to other location-based information datasets, as shown in the diagram below. This system includes more than the repository of information about the current and historical extents of rights. It also includes the physical boundary and survey marks, regulations, rules and standards, required competencies, and occupational regulation. The system enables the relationship of the rights to be confidently established and understood in the real world. The cadastral system is distinguished from the tenure system only in so far as survey components are different from registration components. However, they are closely integrated to the point that the cadastral system necessarily depends on tenure information and vice versa.
A clear dividing line between the cadastral system and its related tenure systems cannot be drawn. This is because each tenure system depends on the locational definition provided by the cadastral systems.

And conversely, the cadastral system primarily exists to support all tenure systems. So each contains links to the other.

Therefore the cadastral system is perhaps best described in terms of what it should be able to be used for.

The cadastral system should be able to be used to answer the questions below, all of which make use of location-based concepts. In most cases, these questions cannot be answered solely by the cadastral system. They depend on linked information in the applicable tenure system and other information on land use, planning, etc.

- At this location what am I allowed, or not allowed, to do?
- On this land whose permission do I need for certain activities (e.g. who is the landowner administrator)?
- Where are the boundaries of the RRR? Or:
  - Is this fence on the boundary?
  - Is that building encroaching on my land?
- Do any RRRs overlap with other RRRs and, if so, are they compatible with each other?
- What land is adjacent to this land and how does that affect legal rights for this land (e.g. adjacent roads for legal access, adjacent rivers with moveable boundaries)?
- What intended changes in land use or boundary definition on or near my property are proposed or have been consented to?

3.1.7 Fundamental cadastre

In this document we use the term 'fundamental cadastre' to describe the repository of cadastral survey datasets lodged with LINZ and integrated into its database, and which are regulated by the Cadastral Survey Act 2002 (CSA02).

3.1.8 Broader cadastre

There exist other RRRs in land which are created and managed in terms of other legislation or rules of law and which are not clearly part of the fundamental cadastral system regulated by the CSA02. Some examples are:

- licenses, such as for mining
- Quota Management Areas which apply in defined marine areas
- unregistered leases or licenses to occupy
- consents granted under the Resource Management Act
- consents granted under the Building Act
- responsibilities to maintain public drains on private property
- residual parcels such as those arising from moveable boundaries.

The extents of these subsidiary rights often exist within or in relation to the boundaries of rights in the fundamental cadastre. These all impact on a landowner's use and enjoyment of their land and arguably do fall within the description of the property rights system suggested above. We also use the term 'broader cadastre' as the repository of the data and information about the extents and boundaries of these other rights, restrictions and responsibilities (*see diagram 1 on next page*).

The broader cadastre would not necessarily be held in a single database but will be linked to the fundamental cadastre.

3.1.9 Cadastral information and other related datasets

Cadastral information (also defined as the 'cadastre' in the CSA02) is information held by the Crown or Crown agencies that defines the boundaries of RRRs.

As shown in Diagram 2 on page 18 there are also many other datasets which depend on the cadastre or which gain much of their value when used in relation to cadastral information. This can raise questions as to whether these datasets are also cadastral information.

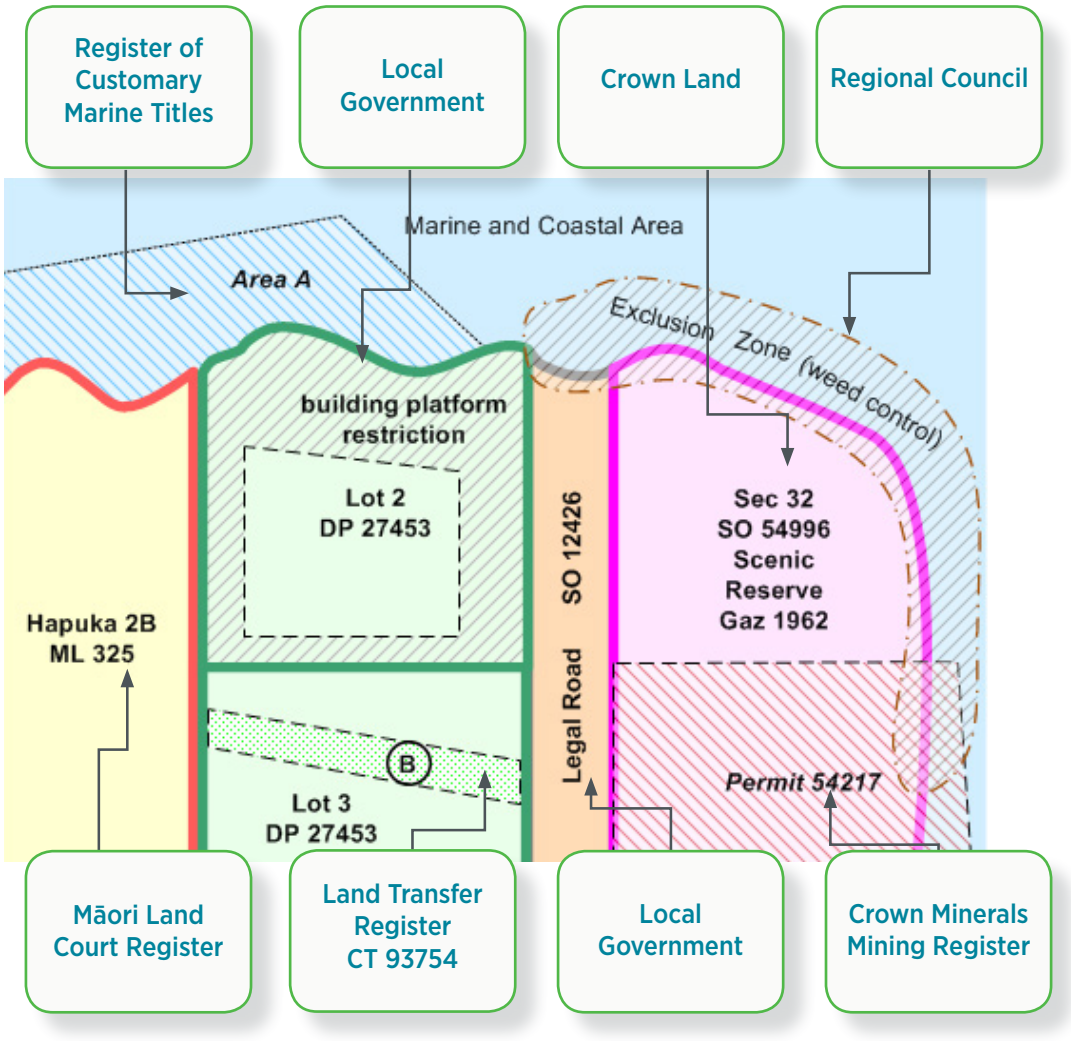
For example, information on natural hazards and land condition are not directly part of the cadastre (even though they will ideally be linked to it) because they do not define the location of the boundaries of RRRs. However, the information may be used by an authority to determine the extent of a restriction in relation to those hazards. Those extents will form part of the cadastre.

The recorded use and valuation of land depends on the cadastre but is not part of the cadastral system.

Physical features such as fences, walls and floors of buildings, water margins, and, of course, survey marks, often have a role to play in defining the locations of boundaries or resolving conflicts. If the physical feature directly defines the boundary (e.g. a boundary peg or a wall in relation to a permanent structure boundary) then information on the location of that feature is a necessary part of the cadastral system. Similarly, if a physical feature defines the spatial extent of a right or restriction in the broader cadastre (e.g. transmission lines or public drains), then these features are part of the broader cadastre.

In other cases, the location of the feature may not directly define the boundary but may provide supporting evidence for the definition of the boundary. In those cases, this information may be included as part of the cadastral system where required.

Diagram 1: Cadastral information and related data sets



The Cadastre defines the extent of the rights, restrictions and responsibilites recorded in various tenure systems

3.2 Characteristics of the current cadastral system

The management of New Zealand's cadastral system is governed by the CSA02. Legal boundaries are defined by physical evidence of the boundaries. The coordinates record the position but they are highly variable over time, and in their accuracy in relation to the physical evidence of boundaries. Coordinates have no legal standing in the fundamental cadastre because the common law of boundary definition assigns high evidential weight to undisturbed boundary marks. Also, coordinates are affected by earth deformation.

The definition of the 'cadastre' in the CSA02 is broad and includes all of the information related to boundaries of interests in land which is held by the Crown or Crown agencies.

However, in practice the cadastral system is largely confined to matters related to the cadastral surveys that are:

- regulated by the Surveyor-General
- conducted by licensed cadastral surveyors
- lodged with LINZ for approval and integration into the (fundamental) cadastre.

The RRRs that have their boundaries described by these surveys are those that are registered on titles under the Land Transfer Act 1952 or their equivalent for Crown or Māori land.

All cadastral surveys are required by CSA02 to be carried out by, or under the direction of licensed cadastral surveyors. These are surveyors who have been judged to meet the competency standards set by the Cadastral Surveyors Licensing Board.

The steps applied by a surveyor carrying out a cadastral survey could be listed as:

- collect all relevant evidence on existing boundaries
- interpret that evidence to locate those existing boundaries
- create new boundaries that are accurately related to the existing boundaries
- prepare a cadastral survey dataset including all relevant information and evidence relied on – judgements made in determining the location of an existing boundary; measurements made; survey and boundary marks used or placed; information on the new interests that are intended to be created and existing rights to be retained.

Before they can legally be used to enable the creation or definition of rights in land, these cadastral survey datasets must first be certified as correct by the surveyor, and lodged and approved by LINZ. The surveyor takes enduring responsibility for the correctness of the information that they provide and certify.

Once a dataset has been approved, it is integrated into the set of all cadastral data held by LINZ. In practice, this integration takes place in the database and software system known as Landonline. Once approved the cadastral survey dataset can be relied on by the managers of tenure systems to create new rights, restrictions or responsibilities in land with confidence that these will not conflict with, leave gaps, or overlap with other such rights in a manner that has not already been identified and provided for.

Because this data is almost all held within the Landonline database, managed there and made available from there, it is common for people to think that Landonline essentially is the cadastral system.

The spatial database element of Landonline is, in essence, two dimensional. Changes over time also occur as new information comes to hand. This new information is most commonly new cadastral datasets but changes are also made as a result of new information on the current location of geodetic control and in response to deep seated ground movement, as in Canterbury, reflecting a time dimension. Three dimensional rights are recorded using plan graphics rather than three dimensional (3D) objects.

The development of the cadastral system by LINZ under the CSA02 and its predecessors has contributed to efficiencies for creating and managing cadastral survey transactions and for accessing related information for those matters covered by the CSA02.

This strategy deliberately covers the broader cadastre – not just the fundamental cadastre that is managed by LINZ under the CSA02.

3.3 Rights, restrictions, and responsibilities as applied in NZ

The cadastral system provides the spatial framework for the tenure systems that record the RRRs related to land and real property. This provides confidence in the spatial integrity of the over-arching property rights system.

There are different tenure systems in New Zealand for recording those RRRs. For example, Crown Land rights are dealt with differently from rights held in titles under the Land Transfer Act 1952. These in turn are handled quite differently from rights to Crown Minerals. RRRs related to such matters as electricity transmission lines or public drains are generally not available through the cadastral system unless they are registered as easements.

The efficiency and effectiveness of the present property rights system to the New Zealand economy cannot be overstated. The existing system has resulted in a low cost, low risk system with very high value (in the form of a Crown guarantee of ownership of the title in the case of private land in the Land Transfer tenure system). This system enables people to confidently and efficiently transact property rights, with very little fear that their transactions will be challenged and without the need for title insurance. The value of residential land in New Zealand was $688 billion in June 2013[3]. This reflects the confidence of investors in the property rights system which, in turn enables capital to be leveraged for other economic activity.

Most rights do not have any specified height limits which mean that they can be, and are, represented in two horizontal dimensions in the cadastre despite their three dimensional nature. However, increasingly boundaries are being defined in three dimensions to cover rights in multi-storey buildings, underground environments (including tunnels, passageways), and airspace. This is particularly true in our cities where space is intensively used. Those creating and transferring 3D RRRs expect the same efficient process and utility of cadastral information as for those represented as 2D RRRs.

[3] PropertyIQ House sales, HPI, Housing value, Statistics New Zealand.

The overwhelming majority of rights in the fundamental cadastre are based on dry land. However, in the broader cadastre there are also RRRs in the marine areas. The potential exists for these RRRs to be in conflict with each other - especially where their overlaps are not readily apparent and where possible conflicts have therefore not been provided for or resolved.

An important aspect of RRRs is their legal provenance – that is, they are granted or created by the legally empowered person in terms of the correct land, and are the correct rights that apply to that land. New Zealand has a history of recording fundamental RRRs over 170 years. The extents of RRRs created and recorded in tenure systems must be capable of being visible at any time in history so that it can be confirmed that they were created correctly.

3.4 Tenure systems in New Zealand

There are several tenure systems which have RRRs recorded: Crown land, general land, and Māori land. The cadastral system that enables the creation and transfer of interests in land, through providing the spatial definition and alignment of those rights, is maintained by LINZ.

Māori land has a unique tenure system, often perceived as being a barrier to the effective utilisation of land owned by Māori. The current requirement to register RRRs in both the Māori Land Court and LINZ databases can mean that the satisfactory completeness and timeliness of the records is not met.

Other Crown agencies also maintain tenure systems where there is a statutory requirement to do so – the Ministry of Business, Innovation and Employment does so for Crown Minerals rights, and the Ministry for the Environment does so for the Emissions Trading Scheme.

While not a Crown agency, local government is empowered by statute and also creates interests in land which may have a spatial definition, such as a restriction on land use arising from flood protection, resource management designations, or 3D building envelopes.

Not all cadastral functions are managed in terms of the CSA02 - some are managed under other legislation such as that for Crown minerals. In those cases where the spatial definition of interests is not subject to the rigour arising from the CSA02 there is less transparency around standards and quality assurance in relation to risk and needs.

3.5 Surveys to populate the cadastre

Whether managed in terms of the CSA02 or not, any definition of the spatial extent of RRRs in land (such as the boundaries of a forest or a restriction on land requiring a building to be wholly contained within a 3D envelope) can be considered as cadastral information. For the marine environment the definition of the spatial extents of RRRs may potentially extend out to the continental shelf.

Currently surveys subject to the CSA02 may only be conducted by a licensed cadastral surveyor. However, for lesser rights in land, where the consequences of error are less, the skills of a licensed cadastral surveyor might not be needed to create suitable cadastral information. Such surveys may not need to be undertaken to the same high standards as those for the fundamental cadastre. The means of definition should still be consistent

with the geodetic and cadastral survey systems, but the method of definition may be implemented using spatial information and techniques such as a Geographic Information System (GIS) analysis that do not require field survey. In these less rigorous cases it is not always clear who creates this cadastral information, what standards are being met, or what accuracy was attained.

3.6 Broader uses for cadastral surveys

Cadastral surveys under the CSA02 are created with rigour and, when integrated with all other current cadastral surveys, form the 'fundamental cadastre'. This integrated fundamental cadastre (in combination with some tenure information) has enormous value for many other public and private purposes. For example:

- clarifying whose permission is required to go onto a particular piece of land
- clarifying where public access rights apply – and where they don't apply
- clarifying who is responsible, on a particular piece of land, for managing matters of public interest such as risks, hazards, noxious weeds, contaminated runoff, etc
- identifying which properties are within a council's boundary, within a ward, or in a Parliamentary electorate, and helping to identify who can vote in these areas
- connecting addresses with properties and residences and thus enabling these to be used for a wide range of purposes from postal and electoral purposes to emergency service response and disaster recovery
- identifying neighbours of a particular piece of land who should be consulted on proposed developments.

Therefore the cadastre is more than just a set of spatial data – it is a mechanism that supports the delivery of social, economic, and cultural benefits, and which relies on and contributes to the overall spatial data infrastructure and property rights system. Every council in the country utilises the cadastre in some way to underpin its land valuation, rating, administration, planning, electoral, and resource management roles. Non-government organisations, businesses and individuals also benefit from the fundamental cadastre when developing applications such as way-finding and route optimisation, and research and spatial analysis for social, cultural, economic and environmental purposes.

Advances in views of the Cadastre

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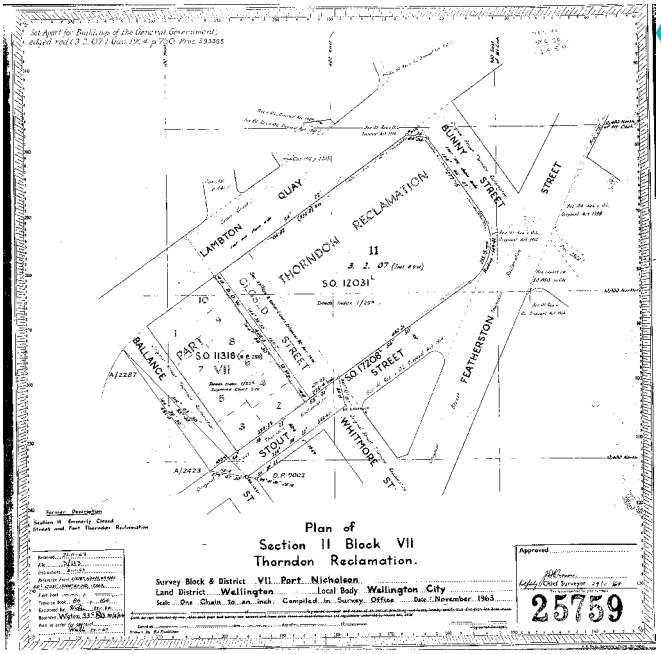

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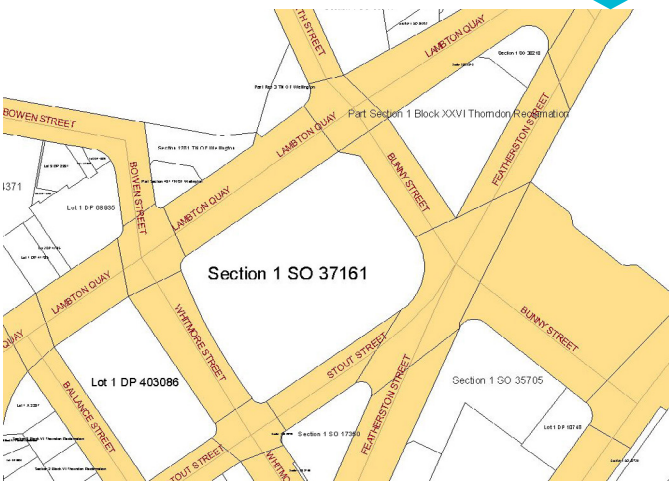

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1. Lambton Quay, 1963
2. Lambton Quay, Landonline
3. Lambton Quay, 2009, Google Earth

4 Strategic context and environment

There are a number of influences that impact on the development of the cadastre.

4.1 International perspectives

A number of initiatives in other countries are relevant to the development of the New Zealand strategy. Bennett et al, 2010 identify a number of features of a future cadastre:

- **Survey accurate** – the expected layering of different property-related interests (including those we describe here as being part of the broader cadastre) will depend on correct alignment of those legal interests through survey accuracy.
- **Object oriented** – a shift in emphasis expected from land parcels towards property objects. Land parcels are well defined in the fundamental cadastre but the extension to a broader set of property objects will require new ways of modelling the information.
- **3D/4D** – incorporating height and time into cadastral frameworks will be essential. Administrative friction caused by misinformation and poor understanding of property objects will be greatly reduced.
- **Real time** – future cadastres will be updated and accessed in real time. Surveyors will be able to measure and update the cadastre in real time while robust automated checking will ensure the integrity of the cadastre.
- **Global** – globalisation of economic systems, investment and land markets will require global systems of management. The Land Administration Domain Model will provide a potential solution.
- **Organic** – the cadastre will better model the natural environment, particularly those RRRs in the broader cadastre that have their extents based on natural and physical features and phenomena.

The vision of Cadastre 2014 (Kaufman and Steudler, 1998) was developed by a working group of the International Federation of Surveyors (FIG) from 1994 to 1998. As we approach 2014, Lemmens (2010) has proposed an extended and updated vision through to 2034. This considers the extent to which the objectives of Cadastre 2014 have been achieved. A number of contributors consider the six features proposed by Bennett et al, 2010. These features come from jurisdictions with developed cadastres (such as New Zealand) and may not be a priority for developing countries that do not yet have a fully functional property rights system.

Of relevance to this discussion are the ideas of De Soto (2003) that developed countries are rich because they have well developed property rights systems that encourage good investment and enable the creation of capital for further investment and innovation.

De Rijcke and Hunter, 2013 have reviewed the New Zealand consultation document on the 10-20 year strategy for developing the cadastre and have identified similar needs in Canadian jurisdictions. Differences and similarities between Canada and New Zealand are discussed. They identify three general principles for custodians of cadastral information:

- **Governance must be citizen-centric** - aligned with the New Zealand vision which is aimed at the needs of citizens rather than (necessarily) the outputs of surveyors.
- **Open and transparent governance** - enabling citizens to inform themselves through open access to information.
- **Facilitating innovation** – ensuring that there are opportunities for public and private innovation – especially for data that serves a public good.

Finally, the Intergovernmental Committee on Surveying and Mapping (ICSM) is currently developing a National Strategy for Cadastral Reform and Innovation for Australia (ICSM 2014). This is still in draft form but is aligned with the New Zealand strategy while recognising the different complexities in Australia with multiple jurisdictions, each with independent legislation and governance of their cadastral systems, but also with a known national need for national spatial data.

4.2 NZ Government policy direction

The Government's Better Public Services for New Zealanders priorities include two results of relevance to the cadastre:

- New Zealand businesses have a one-stop online shop for all government advice and support they need to run and grow their business (Result 9)
- New Zealanders can complete their transactions with the Government easily in a digital environment (Result 10).

The present form of the cadastral system is heavily influenced by the existing statutory framework. This includes the Cadastral Survey Act 2002, Land Transfer Act 1952, Land Act 1948, and Te Ture Whenua Māori Act 1993.

LINZ has a leadership and stewardship role, but not sole responsibility for the broader cadastral system. Other stakeholders within government, principally within the natural resources and justice sectors, also have responsibility. There is a strong thrust towards increased collaboration between government agencies and interoperability of databases. To give effect to the Ministerial priority for 'better property services' more seamless and consistent digital and online services from government will provide improvements in terms of timeliness, quality and cost effectiveness as well as enabling greater private sector innovation .

The New Zealand Geospatial Office provides leadership across the whole of government on the matter of geospatial data. Any development of the cadastral system must be consistent with the New Zealand Geospatial Strategy. Because the cadastral parcel layer has been identified by the Geospatial Office

as a fundamental dataset there will be a strong relationship between that strategy, the cadastral strategy and the emerging geodetic strategy.

The drive in the New Zealand Geospatial Strategy is to do things once to an agreed standard, and then to apply that information across a wide range of applications. This is consistent with the government's declaration on open and transparent government which governs the availability and release of government data. This principle applies to the cadastre and is of particular relevance given the broad public uses of the cadastre identified above. To support this declaration, the government asserts that the data and information it holds on behalf of the public must be open, trusted and authoritative, well managed, readily available, without charge where possible, and reusable, both legally and technically. Personal and classified data and information must be protected.

The professions, and in particular the surveying and legal professions, are intrinsically connected to any change with the cadastral system. While individual cadastral surveyors are licensed under the CSA02, the professional bodies are considered important to ensure the unique body of knowledge is maintained and developed through practice, research and education.

4.3 Land Information New Zealand strategic direction

LINZ has put location information at the heart of its long-term strategic direction, with a goal to create a world-class location system.

This location system will enable diverse sets of information to be related to each other through their location element. Knowing 'what's there and what's nearby' can greatly assist public and private decision making in a wide range of areas - using information and resources to their best use, whether for economic, environmental or for social purposes.

The cadastral system defines the 'where' of land-based property rights. Therefore this 20-year strategy will be a key part of LINZ's strategic direction and needs to be consistent with it.

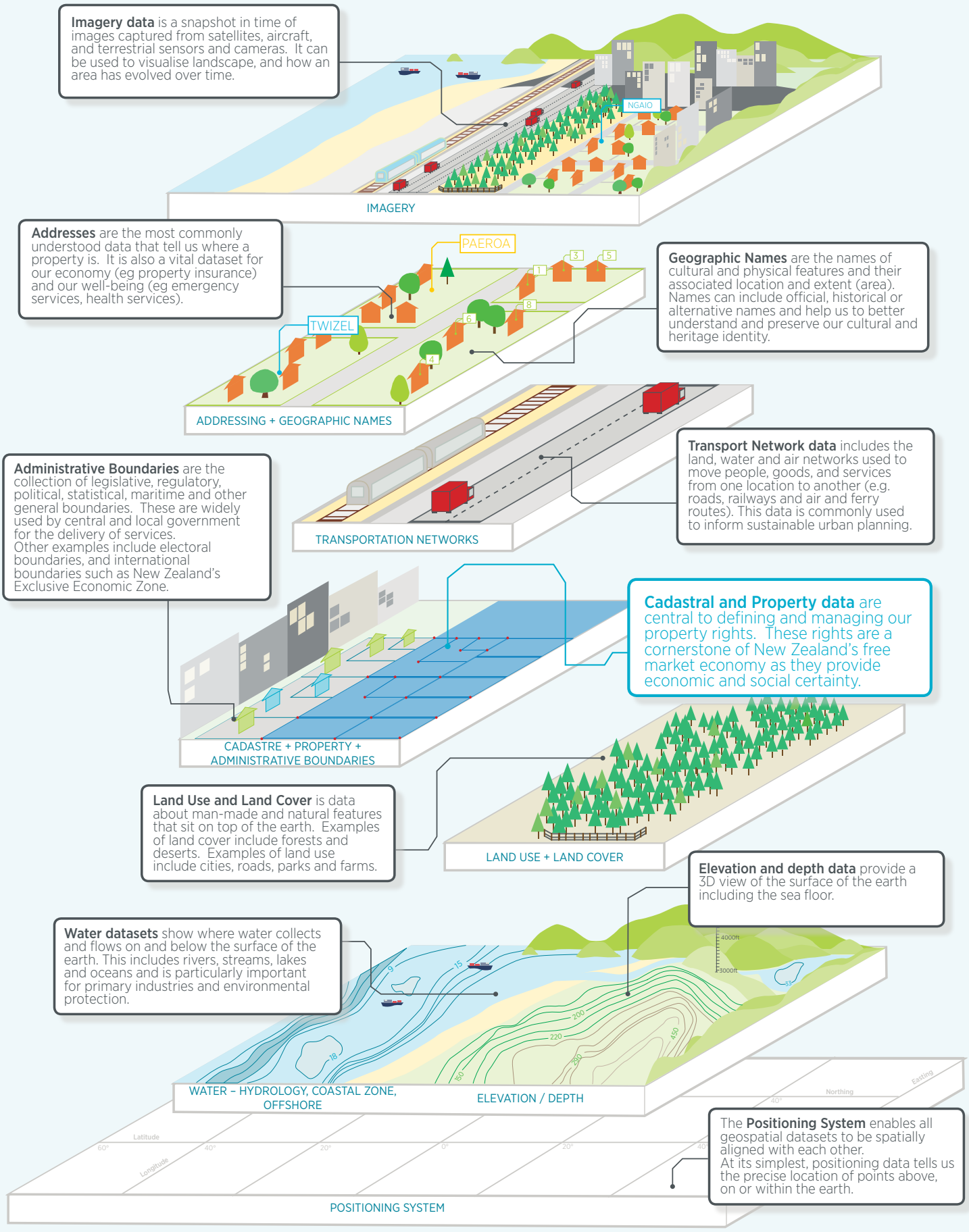
LINZ has also accepted the stewardship role for the 'Cadastre and Property' theme – one of the 10 fundamental spatial data themes. This strategy needs to support this stewardship role for cadastral and property data.

4.4 Societal demands

Modern society increasingly demands openness of process and information to help maintain trust in government and its agencies and to participate in government decision-making. The expectation of 'accurate information now' is an indicator of how society is demanding more from the cadastre. People (and this includes business, government and non-government sectors) want to integrate this information with other spatially related information.

This expectation also relates to the changing role of government in society. People increasingly want to use information and related tools to solve problems themselves, rather than rely on government action. Confidence in the cadastral system cannot be maintained if there is potential significant degradation in trust. The Surveyor General must ensure that public confidence in the cadastral system, at least in so far as the fundament cadastre is concerned, is not

Diagram 2: Fundamental Data Themes



undermined. Public confidence is also needed to some extent in the broader cadastre.

There is the opportunity for alternative standards and quality assurance to be set at a level appropriate to the related risk. Providing alignment of standards and data would help avoid conflicts, assist interoperability, and build public confidence.

Privacy rights must be accommodated but all publicly funded information is expected to be readily available to the public for little or no cost, and in real time. Government data must be open, trusted and authoritative, well managed, and reusable, both legally and technically.

Elements of cultural sensitivity and inadvertent linking of data to reveal private or otherwise sensitive information must be carefully managed.

Efficiencies are expected across all sectors and duplication of effort is seen as wasteful.

4.5 Māori rights in land

The effective utilisation of Māori land is important for social, cultural and economic wellbeing. Māori also have customary methods for managing land-related rights. Increasingly, modern spatial techniques are being used to assist the management of not only Māori land but also other traditional resources. Any recording of culturally sensitive information, including waahi tapu, in the broader cadastre needs to be appropriately managed.

Concepts such as kaitiakitanga (guardianship) are increasingly embodied in statute. The cadastral system of the future should be sufficiently flexible to enable the fulfilment of Māori aspirations and Treaty obligations, and so return the benefits to Māori and New Zealand generally.

4.6 Technology

Information and communication technology is having a significant impact on society's expectations and continues to evolve rapidly.

Automation of the survey and title systems in Landonline provided a world leading step change and a fantastic platform for the future. However without further evolution it will not keep up with technological capabilities and societal expectations.

Technology will increasingly enable the use of up-to-date coordinates that accurately reflect real world boundaries and related information.

4.6.1 Crowd-sourcing

For the fundamental cadastre, all information is required to be lodged and certified by a licensed cadastral surveyor.

However, in some areas of spatial data management, web-based technology has enabled crowd-sourcing to play an increasing role. Crowd-sourcing (sometimes called volunteered geographic information – VGI) is a mechanism where individuals upload information to a central database, usually to be shared with others.

It is enabled by the ability of people with inexpensive navigation tools or smartphones to define their positions with reasonable accuracy using GPS, relate these positions to information on the map, identify errors or omissions on the maps, take geo-referenced photographs showing or proving the error, and upload this information to the organisation that maintains the map. A notable area of success for crowd-sourcing is OpenStreetMap which is a free crowd-sourced spatial database of streets and tracks.

A crowd-sourced cadastre is already being proposed in developing countries that do not have the benefit of an accurate and authoritative cadastral system like New Zealand. Research is being undertaken on technical and organisational issues related to the reliability of the data and the question of trust – for example, on reliable mechanisms for validating the information, or on the use of trusted intermediaries. The principle of crowd-sourcing does not necessarily demand the acceptance of information from anonymous members of the public.

But this trend means that there is likely to be an increasing expectation that the public can equip themselves with the means to locate boundaries and perhaps even to define certain less risky classes of boundary. For those RRRs not regulated by the CSA02, there is potential for the quality of cadastral databases to be based on other credentials and standards.

Crowd-sourcing works best for spatial representation of the physical world and where there is little personal advantage to be gained by providing incorrect information. This does not apply to the fundamental cadastre where boundaries may be invisible lines in space and where there are valuable property rights involved. Nevertheless, a key aspect of cadastral survey is the collection of physical evidence such as:

- the location of survey marks, and whether they have been damaged or destroyed
- the location and age of fences or buildings – and changes to these
- the location of water boundaries and their movements over time.

Also, there is increasing availability of highly detailed datasets of the physical environment which enable accurate measurements to be made or which provide images of the physical world. Digital building information modelling (BIM) is a growth area. Automated online services for 3D modelling, based on citizen collected photographs, is a reality. These are not collected or certified by licensed cadastral surveyors but have enormous potential to assist the task of collecting evidence about the location of boundaries.

4.6.2 Dynamic management of coordinates

There needs to be a means of relating the spatial extent of rights at the time they were created to their current position. In New Zealand we are particularly faced with the challenges of a dynamic earth influencing the meaningfulness of coordinates (as coordinates change over time).

The cadastral survey system therefore depends on a modern and effective national geodetic system in order to make the connection between the social and legal purpose of creating and defining the extents of RRRs, and the dynamic earth (the land) on which they are situated. Advances in positioning technology, combined with research in geophysics, are expected to increase our ability to model the earth and its dynamics to a sufficient precision to enable certainty in three dimensions to be maintained over time. This will be able to be used to maintain confidence in the up-to-date locations of boundaries recorded in the cadastre.

4.6.3 Heights and a 3-dimensional cadastre

Most rights in land have no specified height limit – they extend upwards into airspace and down into the ground. The spatial representation of these cadastral boundaries is therefore shown only in a horizontal plan form. For those rights that are height limited (e.g. strata titles) there has previously been no standardised digital way of representing 3D objects other than by traditional plans, sections, and elevations. However the representation of 3D spatial data is now being routinely applied in computer systems – Google Earth being an obvious example. Users increasingly expect land and building developments and associated rights to be viewable in 3D.

Even where ownership of land is, in theory at least, unbounded into airspace or underground, in practice resource and building consents will often impose height restrictions which affect the use of the property.

Augmented reality view of right and restriction boundaries in 3D

4.6.4 Relating legal spaces to the physical world

Users will benefit from the ability to directly relate the true legal position of the boundaries of their RRRs with the physical world that they occupy and can see in front of them (*see picture of augmented reality on previous page*). Most cadastral boundaries have no direct physical realisation and are invisible lines or planes in space.

Surveyors collect evidence to reconcile the legal boundaries with their physical reality. The complexity of this task may change in the future as we have increasingly accurate spatial databases that record changes in the world around us - particularly any evidence that can be used to locate boundaries.

The traditional method of providing a physical representation of boundaries has been by the placement of boundary pegs. However, such boundary marks are not used for many lesser rights such as easements and covenants, and they cannot be used in some situations (particularly for 3D rights). In some cases physical features such as buildings are used to define the boundary.

4.7 Customer-driven and technology-enabled

It is anticipated that:

- accurate positioning will become available to everyone
- boundary and land parcel information will be able to be delivered directly to the public
- boundaries and rights associated with the parcel contained by those boundaries will be able to be visualised in a form that the layperson can readily understand
- evidence relating to boundaries (fences, buildings, water boundaries, survey marks) will be increasingly captured in spatial databases and available to all
- information systems technology will allow alignment of tenure and boundary information on the full range of land and real property rights, between central government agencies, local government and other authorities (such as iwi) who create, record and manage those rights.

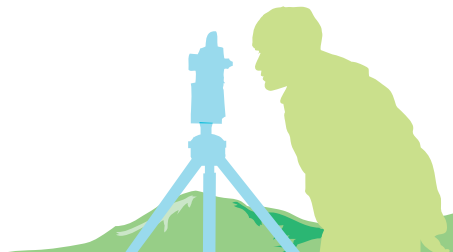
View of legal property boundaries within a new subdivision

5 Vision for the cadastral system

Based on the context provided in the previous sections, the following vision statement for the cadastre in 10-20 years time is presented:

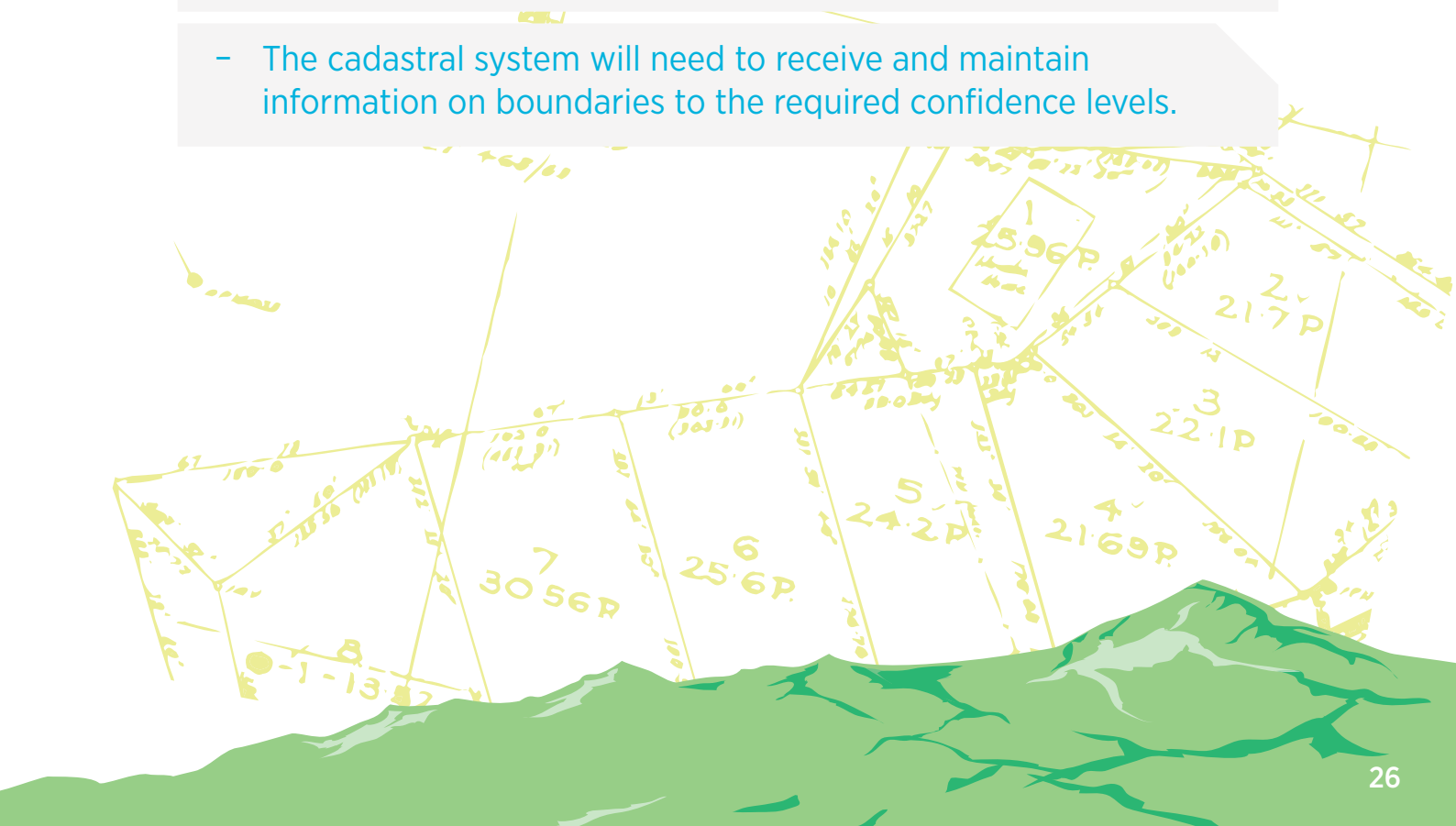
The vision -

A cadastral system that enables people to readily and confidently identify the location and extent of all rights, restrictions, and responsibilities related to land and real property.



To achieve this vision:

- People will need accurate spatial positioning (expected to be delivered by advances in technology)
- People will need easy access to accurate and trusted spatial information on all relevant boundaries
- People will need information technology that enables them to visualise this boundary information relative to the real world or spatial information about the real world (expected to be delivered by advances in technology)
- The spatial accuracy of information about boundaries will need to match the needs of landowners and others for the definition of boundaries
- The cadastral system will need to receive and maintain information on boundaries to the required confidence levels.



6 Goals

To realise the vision the following goals need to be achieved by this strategy:

1. Maintain public confidence as the cadastral system is developed

Whatever changes and enhancements are made to the fundamental cadastre, the Surveyor-General will ensure that the public continue to have confidence in the integrity of the system. The system will be well governed, protected from emerging risks and future-proofed to accommodate new rights and needs of society. The extended focus of a broader cadastral system will be managed in such a way that it does not undermine confidence in the fundamental cadastre. This public confidence will also be extended to the broader cadastre. The confidence required for the RRRs in the broader cadastre may be at a different level but, to maximise the potential of the property rights system, governance, protection, and future-proofing will be extended at an appropriate level to these broader RRRs. Information and data related to the broader cadastre is not covered by the CSA02 so it is possible that a legislative change may be required.

1a. Governance

An appropriate governance structure will ensure that a strategic approach is taken to the management and development of the cadastral system, providing benefits to all stakeholders over the long term. Sustainable funding models based on and derived from the broader cadastral system will be in place.

The cadastral system will be sustained professionally. This is particularly important for the fundamental cadastre but also applies to the management of the broader cadastre.

Active leadership will be provided from within the surveying profession, surveyors and other land-related practitioners will be engaged, and cadastral surveying will be valued and attractive, ensuring skills and knowledge are maintained.

1b. Disaster protection and security

The cadastral system will be safe from interference or disaster over the very long term. Records with enduring value (whether digital or paper based) will be preserved, protected and recoverable. Security systems will prevent unauthorised access and change. The system will be recoverable following physical damage and disaster.

1c. Research and future-proofing

Research on cadastral systems will ensure that the system can respond to emerging needs and risks – especially those resulting from new technology. The research will be strategically driven and funded benefitting from collaboration where possible.

2. The cadastre includes the extents of all rights, restrictions and responsibilities

The RRRs relating to land and real property will be identified and appropriate information about their boundaries accommodated within the cadastral system. All types of tenure (Crown, Māori, land transfer, minerals, local government, etc.) will be in the cadastre. The cadastral system makes clear what rights are included.

3. Complete spatial representation of rights, restrictions and responsibilities

The cadastre will include the boundaries of RRRs in a form that allows them to be visualised in relation to each other.

Five sub-goals have been identified in relation to achieving this primary goal of achieving completeness.

3a All boundaries of rights, restrictions, and responsibilities are spatially represented

All boundaries of the RRRs that currently exist in the cadastral system but which only have a graphical or textual description will be spatially represented. In addition, all other rights in the broader cadastre will also have a spatial representation of their boundaries.

3b. The accuracy of spatial representation matches the accuracy of the boundaries

The quality of spatial representation recorded in the cadastre will match the accuracy standards of the defined boundaries of the RRRs. Goal 4 addresses the accuracy standards of the defined boundaries.

3c. Rights, restrictions and responsibilities can be spatially represented in three dimensions

Even though most rights have traditionally been captured in 2D form, they will be capable of being represented in a form that enables encroachments and conflicts at different heights to be readily identified.

The cadastre will allow the modelling of the spatial extents of RRRs, including those with defined height limits, to be closely related to the 3D physical world e.g. buildings, mining, air space, water space.

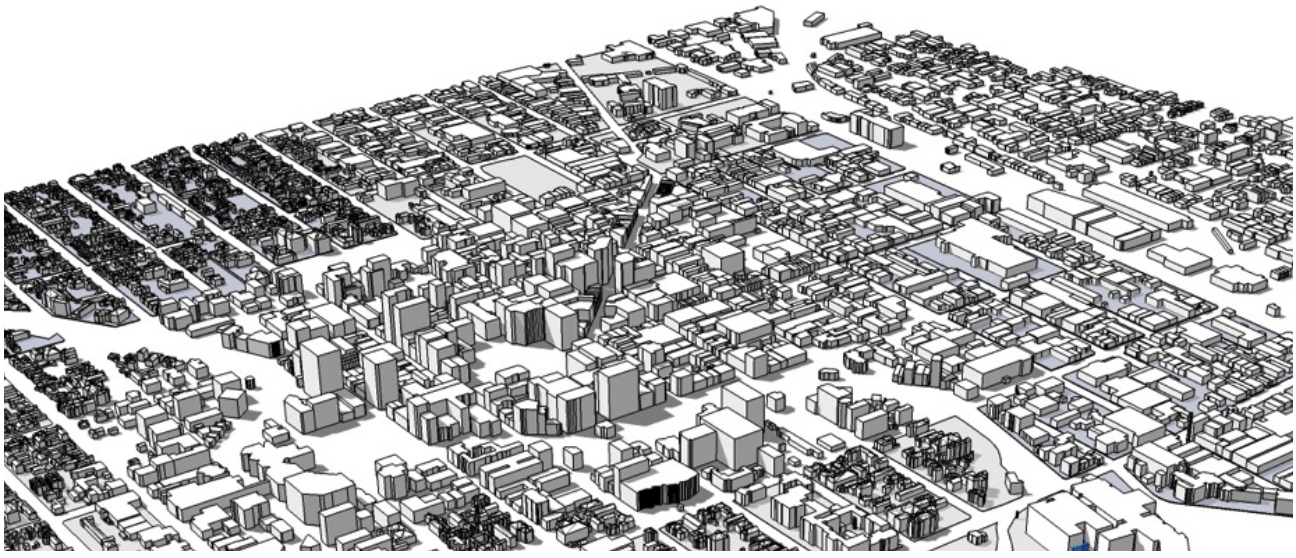
3d. Changes in rights, restrictions and responsibilities over time can be spatially represented

New RRRs are created and existing RRRs extinguished or modified over time. The spatial representation will reflect these changes including enabling an historic view of the cadastre at any time.

3e. The spatial representation of rights, restrictions and responsibilities reflects changes in location over time

Some boundaries based on natural features may move continuously with that feature e.g. marginal strips under the Conservation Act 1987. In these cases the spatial representation will reflect the information currently available on that feature and the historical location. The spatial representation of title boundaries based on natural features will only move when the title is updated.

Changes in location arising from tectonic earth movement whether slow and continuous or as a result of earthquakes may result in boundaries moving. The spatial representation of boundaries will respond to available geodetic information enabling the location to be determined at the time the right was created or any subsequent time.



A view of Christchurch city using 3D procedural modelling software. Source: CERA

4. The quality of the boundaries of rights, restrictions and responsibilities matches the need

The quality of the boundaries of RRRs will be fit for purpose. Different accuracies will be used, depending on such factors as the type of environment and risk of conflict (e.g. rural vs urban vs maritime boundaries, underground utility services in urban areas, restrictions related to cultural or heritage values, etc).

5. The cadastral system efficiently receives information from sources with appropriate levels of trust

The spatial representation of RRRs in the fundamental cadastre will have tightly controlled sources and processes to ensure standards are met. In the case of the broader cadastre more flexibility may be appropriate.

The means of capture will be efficient, making the best use of technology. The source will be identified, allowing an indication of confidence. In all cases, principles of transparency, liability, and competency will be applied.

6. People have access to cadastral data which is able to be integrated with other data

Cadastral information will be readily available in real-time through channels that meet user needs. The delivery mechanisms will be sufficiently flexible to take advantage of technology and changing societal demands.

This does not mean that LINZ will necessarily be the holder of all information. Rather it suggests that a user can access information on RRRs from multiple sources, perhaps through tailored portals.

Any conflicts or uncertainty within the cadastre will be identified and transparent. Access to data will be limited only by security, privacy, and cultural sensitivity principles.

7 Gaps

In order to achieve each goal, a number of gaps need to be closed. These have been identified in the table below.

Goals	Gaps
1. Maintain public confidence as the cadastral system is developed	While there is public confidence in the fundamental cadastre, this does not extend to the broader cadastre.
1a Governance	**A** There is no coherent policy direction and framework across government agencies for all property related rights, restrictions and responsibilities (especially in the broader cadastre). **B** There is no robust governance model to sustain and guide the development of, and manage the risks relating to, the broader cadastre. **C** There is no agreed funding model to enable development of Landonline and initiatives to improve the broader cadastre. **D** There is a lack of strong cadastral leadership across the broad cadastral system function, especially for the future. **E** The professional support available to underpin the fundamental cadastre does not adequately extend to the broader cadastre.
1b Disaster protection and security	**F** The fundamental cadastre is highly regulated but as the cadastre broadens there will emerge a need to ensure the information is protected from disaster and is not exposed to undue risk from security breaches.
1c Research and future-proofing	**G** There is no strategic approach to investment and collaboration in research.
2. The cadastre includes the extent of all RRRs	**H** Many RRRs (especially in central and local government) are currently not included or are not readily accessible and interpretable.

3. Complete spatial representation of RRRs	The spatial depiction of RRRs is often absent, incomplete or not-up-to-date.
3a All boundaries of RRRS are spatially represented	**I** Some types of RRRs in the fundamental cadastre are not fully spatially represented, e.g. esplanade strips, marginal strips, easements.
	J Some RRRs in the broader cadastre are not supported by spatial representation of their boundaries.
3b The accuracy of spatial representation matches the accuracy of the boundaries	**K** The spatial representation of parcels in the fundamental cadastre often does not match the accuracy of the boundaries, e.g. in non-Survey-accurate Digital Cadastre (SDC) areas.
	L There is uncertainty in the accuracy of spatial representation of boundaries in the fundamental (non SDC areas) and broader cadastre.
3c. RRRs can be spatially represented in three dimensions	**M** Current systems are not sufficient to transfer, manage, and visualise 3D data.
	N There is a need for a vertical datum and geoid model of sufficient accuracy and usability to support all RRRs (e.g. the New Zealand Vertical Datum 2009 is not sufficiently accurate to meet all cadastral needs).
	O 3D rights cannot be easily related to other information and data, including GNSS derived data, partly because these rights are referenced to a variety of inconsistent datums.
3d. Changes in RRRs over time can be spatially represented	**P** Not all cadastral information is retained over time, particularly in the broader cadastre.
3e. The spatial representation of RRRs reflects changes in location over time	**Q** Cadastral coordinates are not dynamic so recorded positions may not match those on the ground or in other datasets. The rules for reconciling boundaries affected by deformation with ground marks are unclear.
4. The quality of the boundaries of RRRs matches the need	**R** There is a lack of accuracy standards, including standards for the definition of the extents of RRRs in the broader cadastre. The need for standards and the risks associated with a lack of standards are not widely understood.

Goals	Gaps
5. The cadastral system efficiently receives information from sources with appropriate levels of trust	**S** There is a limited link between cadastral development and international standards including ISO19152:2012 (Land Administration Domain Model). **T** There is a lack of, or inadequate, validation tools relevant to the capability of the data provider (for data from both trusted sources and other sources). **U** Non-Landonline databases do not have access to live Landonline data, resulting in duplicated and often unnecessary effort to maintain those databases. **V** There is a lack of, or poor, systems for holding the data in the broader cadastre (from both trusted sources and other sources). **W** The authority and reliability of data in the broader cadastre is often unknown, especially where the data is not from a trusted source.
6. People have access to cadastral data which is able to be integrated with other data	**X** People seeking cadastral data cannot access it directly or seamlessly from various cadastral systems, especially in real time. **Y** It is difficult for the custodians of land-related and cadastral data to maintain linkages between datasets, e.g. via parcel ID. **Z** Static database coordinates of boundaries do not enable the alignment of data collected at different times, and recorded positions do not align with those in other datasets.

8 Strategic Actions

To achieve the goals, a number of high level strategic actions are needed to close the gaps identified in the strategy document.

These actions shown in the table below provide a guiding framework that LINZ will take into account when developing its Statements of Intent and business plans.

Strategic Actions	Gap #
Maintain public confidence as the cadastral system is developed	
1. Develop principles[4] and a coherent policy direction and framework for defining the spatial extents of all land and real property related RRRs.	**A, D**
2. Develop a governance structure to deliver sustainable cadastral outcomes that satisfy the expectations of central government, local government, and Māori, in synergy with wider stakeholder interests.	**B, D**
3. Develop a sustainable funding model that covers the programme for implementing a long term action plan.	**C**
4. Agree on mechanisms for engagement, investment, and collaboration with all agencies, local government, Māori, and stakeholders that facilitate the implementation of the Action Plan and its broader concept of the cadastral system.	**G, D**
5. Encourage professional sustainability of the cadastre, including active leadership and engagement across the spatial professions, so that cadastral surveying is valued and attractive.	**E, D**
6. Establish a strategic approach to research that is joined up across the sectors and enables collaboration.	**G**
The cadastre includes the extent of all RRRs	
7. Develop criteria for which RRRs should have their extents represented in the broader cadastre and develop proposals for capture and maintenance, and prioritise for action. Define the cadastre in more detail; confirm whether the Land Administration Domain Model (ISO 19152:2012) will be utilised.	**H, I, J, S**
8. Encourage the retention and management of all data relevant to the cadastre over time.	**F, P, V**

[4] Principles might cover provision of access, use of authoritative data sources, freedom from interference, participant responsibility, trust, etc.

Strategic Actions	Gap #
9. Develop systems for holding non-fundamental cadastral data (from both trusted sources and other sources) which may require a change in legislation.	**F, U, V, W**
10. Research geospatial standards including ISO 19152:2012 and, if necessary, develop principles and standards to enable non-spatial linkages between cadastral datasets, such as unique parcel identifiers.	**S, X, Y**
11. Record the government department or Crown agency that is responsible for managing a parcel of land.	**I**
Complete spatial representation of rights, restrictions and responsibilities	
12. Develop and implement proposals and rules for the spatial depiction of newly created RRRs, and the retrospective capture of RRRs according to agreed criteria including 3D.	**I, J**
13. Develop and implement a geodetic strategy that supports a dynamic 3D cadastre (including a dynamic datum).	**N, O**
14. Improve the accuracy of the vertical datum and geoid model to support 3D RRRs backed by adequate vertical control networks.	**N, O, Q**
15. Develop a system of dynamic coordinates so: • recorded positions match those on the ground, whether caused by slow ground movement or catastrophic deformation • recorded positions can be accurately aligned with those in other datasets • universal tools to manage the coordinates (especially for cadastral use) can be included • GNSS use is enabled.	**O, Q, Z**
16. Develop tools to create, transfer, manage, visualise and depict 3D cadastral data.	**M, Q**
The quality of boundaries of RRRs matches the need	
17. Develop standards, especially for accuracy, for boundaries in the broader cadastre.	**R, S, W**
18. Improve the accuracy of the parcel fabric in non-Survey-accurate Digital Cadastre (SDC) areas.	**K, L**

Strategic Actions	Gap #
The cadastral system efficiently receives information from sources with appropriate levels of trust	
19. Record the authority and reliability of cadastral data no matter what the source, and enable reporting.	**W**
20. Develop readily accessible cadastral specific validation tools for cadastral data including those relating to the broader cadastre.	**T**
21. Enable data from a range of sources to be recorded, with an appropriate level of quality assurance and professionalism related to purpose and risk to ensure public confidence is maintained.	**T, V, W**
People have access to cadastral data which is able to be integrated with other data	
22. Custodians of cadastral data make it readily available to third parties and each other, consistent with the New Zealand Geospatial Strategy (standards, interoperability, stewardship principles, discoverability, etc.). This needs to recognise the need for some access limitations based on security, privacy, and cultural sensitivity concerns.	**F, X, Y, Z**
23. Ensure that the public have access to cadastral data that can be integrated through channels and interfaces that meet user needs. Develop protocols so users understand the completeness or otherwise of the data in relation to RRRs.	**X**

9 Further reading and references

The following references have assisted the development of this document.

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