



# PREPARING SURVEY TENDER SPECIFICATIONS FOR PROJECT GIS DATABASE OUTCOMES

Presentation by

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# BACKGROUND

GIS databases now provide a more powerful tool for:

- Storing and managing data
- Data modelling, analysis etc
- Decision making

**SURVEY DATA IS AN IMPORTANT  
PART OF THE DATABASE**



## BACKGROUND

Most survey data or the deliverables provided by surveyors will become part of a GIS database.

Project documentation should ensure survey data deliverables maximise data intelligence.



# CONTENTS

1. Existing project survey deliverables
2. Future survey database deliverables from the Cadastral Editor process
  - The Cadastral Fabric
  - The Geodatabase
3. Survey Deliverables to a Project GIS Database
4. Case Studies



## EXISTING PROJECT SURVEY DELIVERABLES

Deliverables are project specific:

- Accuracy
- Feature representation – (line types, etc)
- Presentation

Database outcomes now need consideration of:

- Output data structure
- Data Interoperability



# EXISTING SURVEY DELIVERABLES

## MAIN TYPES OF SURVEYS

### 1. GEODETIC CONTROL SURVEYS

### 2. FEATURE SURVEYS

- Topographic
- Features
- Infrastructure

### 3. CADASTRAL SURVEYS

- Boundary Definition
- Boundary Creation





# EXISTING SURVEY DELIVERABLES

## GEODETTIC CONTROL SURVEYS

### DELIVERABLES

- Coordinate list

Imported into a database as points with fixed coordinates as attributes



# EXISTING SURVEY DELIVERABLES

## FEATURE SURVEYS

1. Topographic
2. Features
3. Infrastructure

## DELIVERABLES

- Hard Copy
- Layered Cad files

**Imported into a database as a Cad feature dataset with or without intelligent attributes linked**





# EXISTING SURVEY DELIVERABLES

## CADASTRAL SURVEYS

- Surveys for title creation, lodged at title registry
  - hard copy plans
- Surveys of site boundary redefinition
  - Hard copy plans
  - Cad formats



# CADASTRAL SURVEYS

Survey and cadastral data is generally managed in survey coordinate geometry software and the outcomes imported into a GIS as a Cad layer.

Cadastral features (parcels, etc) and property attributes are then defined to benefit from the database environment.

**CADASTRAL EDITOR CHANGES THAT PROCESS**



## THE 'CADASTRAL EDITOR' PROCESS

A process first conceived in Australia 20 years ago by Dr Michael Elfick to apply survey accuracy to GIS cadastral databases.

Released as CADASTRAL EDITOR - the cadastral management engine of Survey Analyst by ESRI in 2007.



# THE 'CADASTRAL EDITOR' PROCESS

**Survey Process with survey outcomes  
and GIS outcomes**

**Developed for the management of a  
survey database with cadastral  
outcomes**



## **THE 'CADASTRAL EDITOR' PROCESS**

**Survey measurement data becomes part of the geodatabase.**

**The decision making process of surveyors on the spatial location of a cadastral boundary is automated.**





# THE 'CADASTRAL EDITOR' PROCESS

New technology that provides surveyors with a higher level of survey data management.

Creates a survey database where parcel attributes include:

- The original survey title measurements
- All the cadastral intelligence required for a land administration system.

Creates a CADASTRAL FABRIC – The most accurate representation of the legal cadastre as it exists in the real world.





## **SURVEY DATA MODEL (SDM) PROCESSES**

1. DATA ENTRY
2. PARCEL JOINING
3. ADJUSTMENT

Each stage involves data checking and verification – as would be expected with a:

**RIGOROUS SURVEY PROCESS**



# 1. DATA ENTRY

## I. Manual data entry

- Highest rigour in outcomes

## II. Importing electronic survey data

- Efficient access to survey accurate databases

## III. Migrating existing cadastral database

- Quick way to build large database but spatially poor

# FLEXIBILITY



## **2. PARCEL JOINING**

**After data entry the parcels are selectively joined to the Survey Data Model (SDM) to force the outcome of a continuous fabric without overlaps or gaps.**

**This process provides data checking by reporting on the quality of the 'fit' of the new survey data into the existing model.**

**(see NSW LPI pilot for checking electronically lodged survey plans)**



## 3. THE ADJUSTMENT

The adjustment connects the SDM to the geodetic survey control and generates coordinates for the Cadastral Fabric.

The adjustment report provides the tool for troubleshooting the data for the highest precision in the fabric.



# THE 'CADASTRAL EDITOR' PROCESS

1. A Cadastral Fabric Database as the deliverable product
2. A tool for surveyors to efficiently manage a project cadastral database



# MAPASIA GIS CONFERENCE



## AUGUST 2008

### Plenary Speakers

**‘Cadastre is the core of SDI’**

(Prof Ian Williamson-Dept of Geomatics, University of Melbourne)

**‘Accuracy is a future issue technology must address  
and only RIGOROUS TOOLS ENSURE FIDELITY’**

(Kaushik Chakraborty-Vice President-Asia Pacific, Leica Geosystems -  
Geospatial Imaging, India)

**‘Redundancy is a key factor in automation’**

(Alexander Wiechert - Business Director, Microsoft Photogrammetry,  
Managing Director, Vexcel Imaging GmbH, Austria)



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## **BENEFITS TO PROJECT SURVEYORS OF THE SURVEY DATABASE**

1. Storage of survey and cadastral data
2. Management of cadastre
3. Project data management rules



# 1. Storage of survey and cadastral data

Survey plans are currently used by surveyors to define the legal cadastre.

They identify legal and cadastral attributes (Parcel number, plan number, areas, dimensions, easement locations etc.) and they reflect the previous surveyor's decision on the location of title boundaries on the ground.

They also show extra survey information to support their (legal) decision and provide the registering authority with the evidence to guarantee that title.

# SURVEY DATA STORED IN THE GEODATABASE



**GEO DATA**  
AUSTRALIA Pty Ltd

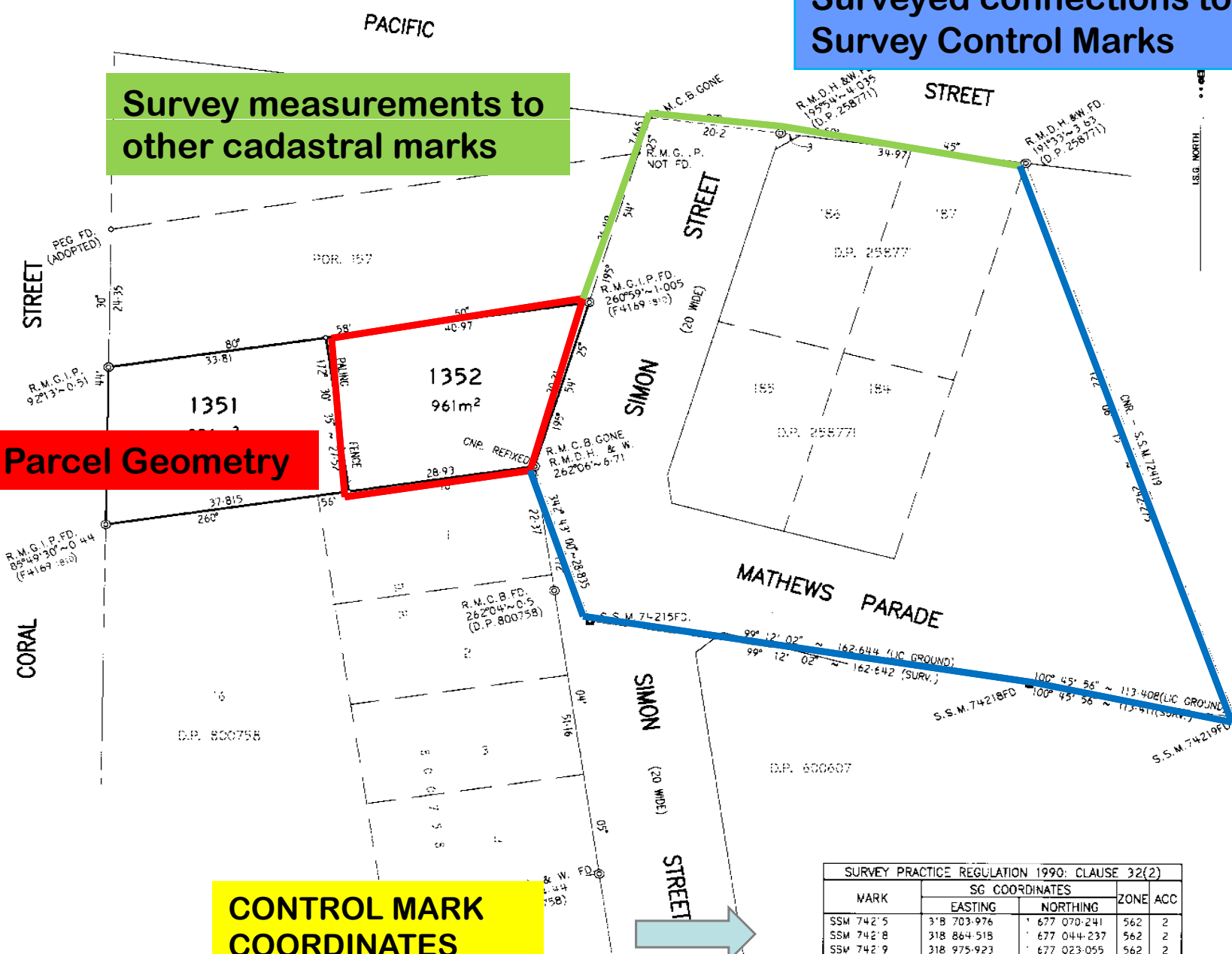
OFFICE USE ONLY

**Surveyed connections to coordinated Survey Control Marks**

**Survey measurements to other cadastral marks**

**Parcel Geometry**

**CONTROL MARK COORDINATES**



Purpose: SUBDIVISION  
 Ref. Map: Y1872-4  
 Last Plan: CROWN PLAN 3984.1810

PLAN  
 SUBDIVISION OF  
 LOT 135 D.P. 752820

Lengths are in metres. Reduction Ratio 1:1000

LGA: ULMARRA  
 Locality: CORINDI  
 Parish: CORINDI  
 County: FITZROY

This is sheet \* of my plan in \* sheets  
 (Delete if not applicable)

MICHAEL FRANCIS JAMONT  
 of RESOURCE DESIGN & MANAGEMENT P/L  
 P.O. BOX 929 COFFS HARBOUR 2450  
 a surveyor registered under the Surveyors Act 1929, hereby  
 certify that the survey represented in this plan is accurate, has  
 been made in accordance with the Survey Practice Regulations  
 1990 and was completed on 28th AUGUST 1996.

(Signature)  
 Surveyor registered under Surveyors Act, 1929  
 Datum Line of Orientation SSM74215 - SSM74218

Plans used in preparation of survey/compilation  
 D.P. 25877  
 D.P. 800758  
~~F3984-1810~~  
 F3984.1810

PANEL FOR USE ONLY for statements of  
 intention to dedicate public roads or to create  
 public reserves, drainage reserves, easements,  
 restrictions on the use of land or positive  
 covenants.

SURVEY PRACTICE REGULATION 1990: CLAUSE 32(2)				
MARK	SG COORDINATES		ZONE	ACC
	EASTING	NORTHING		
SSM 742 5	318 703.976	677 070.241	562	2
SSM 742 8	318 864.518	677 044.237	562	2
SSM 742 9	318 975.923	677 023.055	562	2
COMBINED SEA LEVEL SCALE FACTOR 0.999994				
SOURCE: ISG COORDINATES ADOPTED FROM LIC ON 5th MAR., 1997				



## **SURVEY DATA STORED IN THE GEODATABASE**

The extra survey information (outside parcel boundaries) in the database adjustment provides more expansive accurate data and redundancies for checking.





## 2. Management of cadastre

### **Geodatabase rules:**

- **allow only specified users access to the amend the cadastral fabric. (preferably surveyors or experienced GIS professionals)**
- **allow one person at a time to amend a specific 'packet' of cadastral data**





## 2. Management of cadastre

**The level of rigour in Cadastral Editor limits its effectiveness to ideally adjusting smaller sections of a cadastral database. (<2000 parcels)**

**For 1000 parcels there are approx 5,000 unknowns which require over 12,000,000 terms in the normal equations to be solved. This increases by the rate of the square of the number of parcels.**



# **A MANAGEMENT ROLE FOR SURVEYORS**

## **The Survey Analyst / Cadastral Editor Process:**

- 1. Holds the extents of a localised set of cadastre fixed (packet).**
- 2. Extracts it from the geodatabase**
- 3. Update and adjust.**
- 4. Returns to the geodatabase**
- 5. Records all adjustments to the cadastre to allow cadastre dependent layers to be moved accordingly**



# CADASTRAL EDITOR AS A TOOL FOR SURVEYORS

## CADASTRAL DATABASE MANAGEMENT

- Historical role undertaken by surveyors managing survey data.
- Recently, managing a cadastral database has generally become a GIS management role because adjusting databases has been a higher level mathematical process.



# CADASTRAL FABRIC MANAGEMENT

**Survey Analyst / Cadastral Editor allows project surveyors or GIS professionals to better manage a cadastral database .**



## **CADASTRAL FABRIC MANAGEMENT**

**Once a Cadastral Fabric is created, there are high levels of efficiency in updating cadastral changes and precision within the geodatabase environment.**

**All legal cadastral attributes become immediately available to geodatabase deliverables – Land Titles, property reports, etc**





### **3. Project data management Control**

**The geodatabase allows better management of cadastral updates and versions.**

**Control of authorized persons to amend the cadastre.**

**More powerful tool for end users to validate cadastral model versions.**

**REDUCTION IN LIABILITY FOR PROJECT MANAGEMENT**





## **SURVEY DELIVERABLES TO A PROJECT GIS DATABASE**

**1. File Geodatabase**

**2. Cadastral Fabric**

**3. Metadata**



# 1. File Geodatabase

1. Holds the complete cadastral fabric database ranging from a small project to a State or Federal government database.
2. Most efficient way to store and manage a database



## **2. Cadastral Fabric**

- 1. Data entered manually for highest rigor**
- 2. Survey data imported or cadastral databases migrated to a fabric for cost effective outcomes**
- 3. Supply of adjustment reports, etc to validate fabric spatial quality**



## **3. Metadata**

### **Data deliverables**

- **Data history available for all project users**
- **Currency of data – amendment status**



# PROJECT MANAGEMENT ROLES

**Documentation defining the survey and database deliverables should be prepared by persons experienced in the Survey Analyst and Cadastral Editor process.**

**Experienced surveyors / engineers / GIS professionals understand what they require for their project, but may not recognise the efficiencies and outcomes of the CE process.**





# PROJECT MANAGEMENT ROLES

Project managers or surveyors who are not familiar with Cadastral Editor process are uncertain that the 'up front' costs associated with creating a cadastral fabric for a project are sustainable.

This may be valid if spatial precision and a future database is of no value.



# PROJECT MANAGEMENT ROLES

**Project managers or surveyors who are not used to working in a database environment do not recognise the difference between CE and creating a survey data model in a survey coordinate geometry package and importing a cadastral cad layer into a GIS.**

# CASE STUDIES



**GEO DATA**  
AUSTRALIA Pty Ltd

## THE SYDNEY METRO PROJECT

- Preparation of tender documentation for a major underground rail project in Sydney, Australia

## 100 KM PIPELINE PROJECT

- Hunter Valley, NSW

An extensive cadastral fabric created from various sources



# SYDNEY CBD METRO PROJECT

The Sydney CBD Metro Project is a proposed 6km Metro rail tunnel and stations to be constructed under the CBD and inner suburbs.

**\$ 4 Billion Budget**

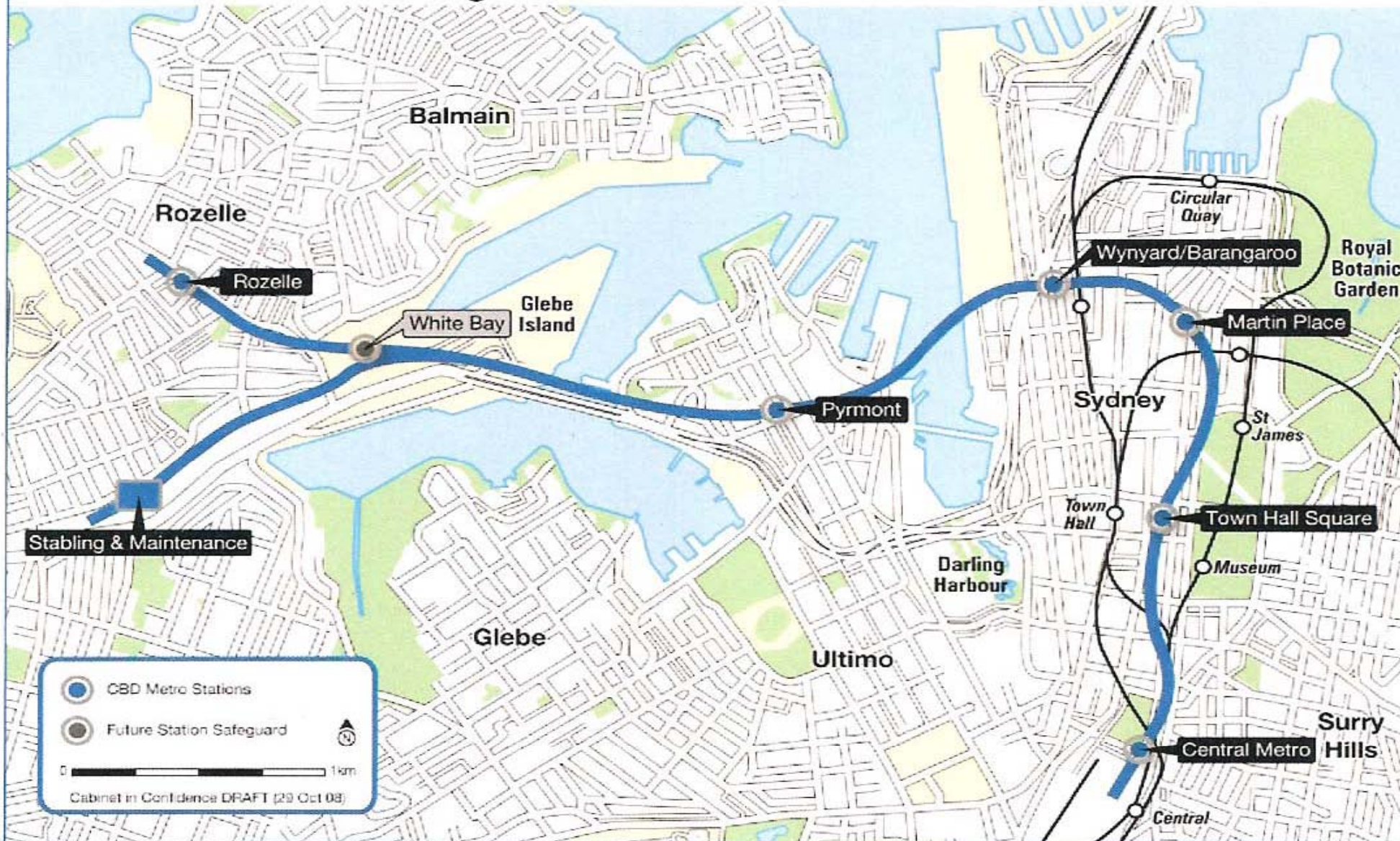
In Dec 2008 the initial survey tender documentation was released.



# SYDNEY CBD METRO PROJECT



## Route Alignment and Stations: CBD Metro





# SYDNEY CBD METRO PROJECT



**GEO DATA**  
AUSTRALIA Pty Ltd

## Deliverables from the initial survey tender:

1. **Separate title to the tunnel stratum and surface infrastructure**
2. **3D modelling of all surface and sub-surface design constraints**
3. **A cadastral fabric of the route with all property attributes forming a survey accurate foundation for the ongoing project GIS database**

**NSW Lands Dept has supplied plans to the project on the basis the final cadastral fabric will be supplied to them (at no cost).**

**GEO DATA**



## GLOUCESTER COAL SEAM GAS PROJECT

A natural gas project in the Hunter Valley of NSW needs the construction of a 100km pipeline to deliver the product.

A file geodatabase cadastral fabric for the route was required for project planning, design and legal issues.

The required spatial precision varied for different sections of the route.



# 100 KM PIPELINE CADASTRAL MODEL

**CALCO SURVEYORS** based in the town of Gloucester (Population 2,600) are the project contract surveyors with a total staff of 6. They do not use GIS.

**GEO DATA AUSTRALIA** assisted CALCO in the preparation of the survey deliverables.



# 100 KM PIPELINE CADASTRAL MODEL

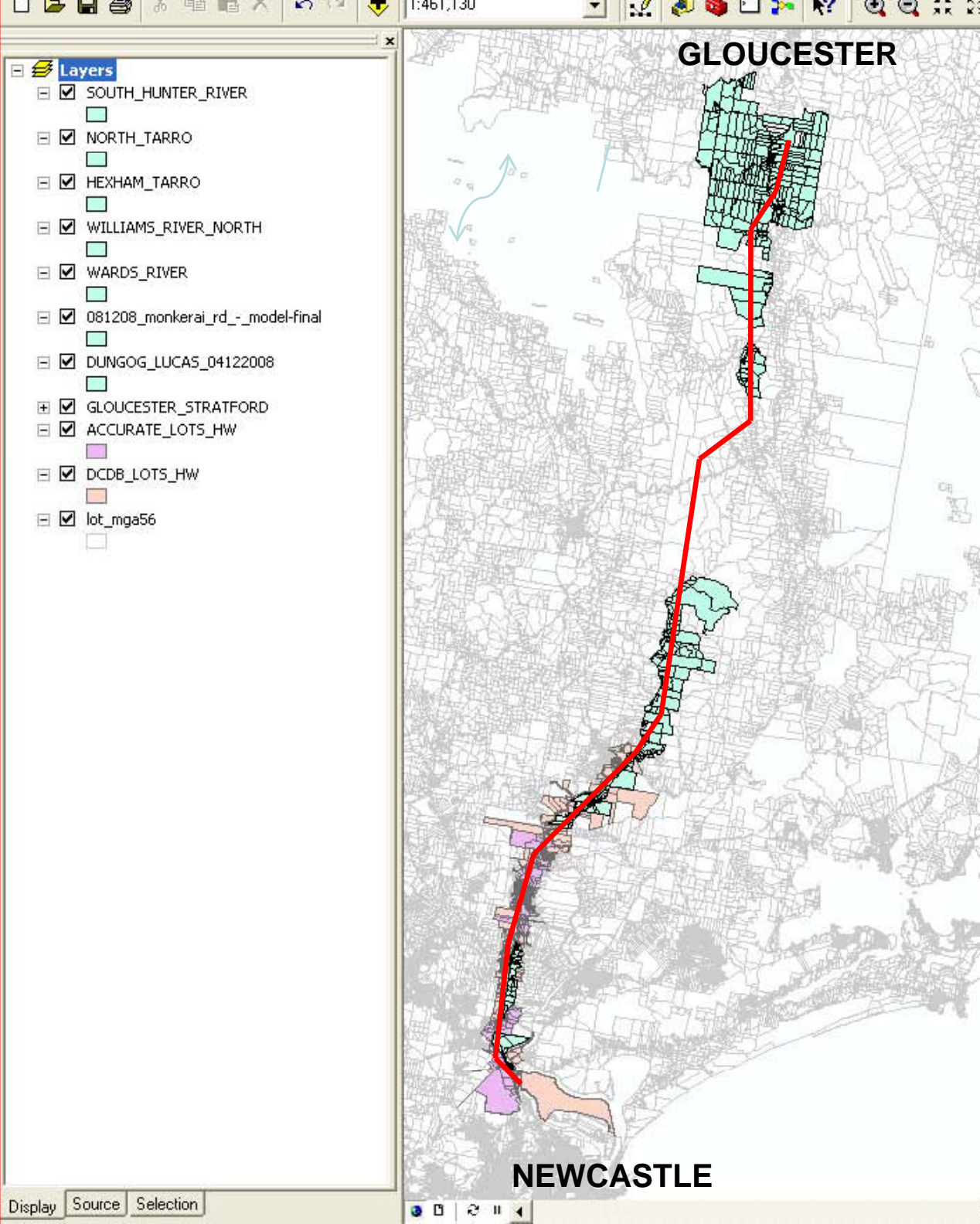
The route passed through 5 Local Government Areas (Counties), and the jurisdictions of at least 6 separate service utilities.

Most authorities had their own cadastral databases with varied formats and spatial precision.



# CADASTRAL FABRIC MODELS CREATED

The existing Digitised Cadastral DataBase (DCDB) is utilised where no fabric model is shown







## 100 KM PIPELINE CADASTRAL MODEL

### Variable levels of precision:

#### 1. Remote rural areas

- utilise existing cadastre – 5-10m

#### 2. Rural areas adjacent to boundaries

- Create cadastral fabric, update existing county fabric - 0.2-0.5m

#### 3. Urban & light industrial areas

- Create cadastral fabric & utilise survey accurate local water utility cadastre - 0.1-0.2m

# GLOUCESTER

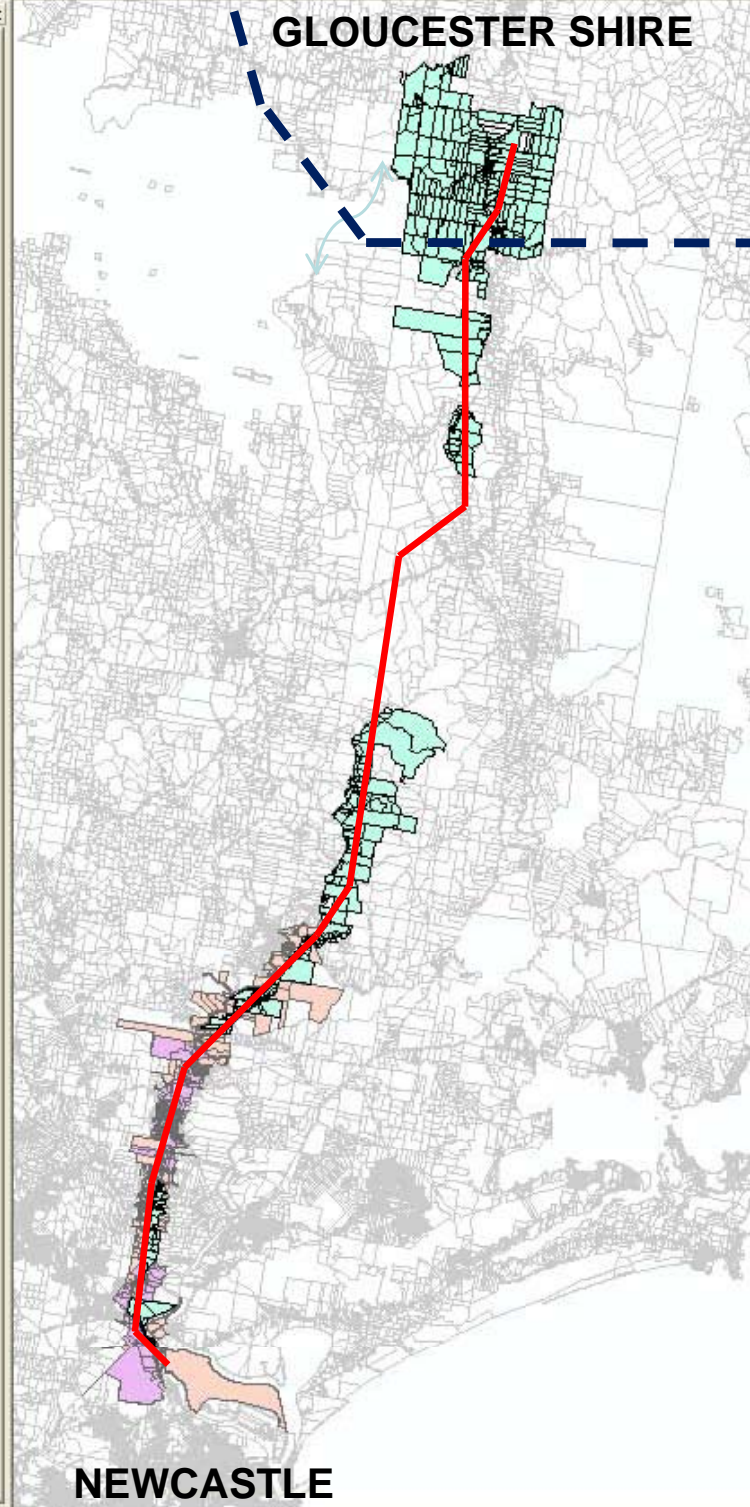


**GEO DATA**  
AUSTRALIA Pty Ltd



**Layers**

- SOUTH\_HUNTER\_RIVER
- NORTH\_TARRO
- HEXHAM\_TARRO
- WILLIAMS\_RIVER\_NORTH
- WARDS\_RIVER
- 081208\_monkerai\_rd\_-\_model-final
- DUNGOG\_LUCAS\_04122008
- GLOUCESTER\_STRATFORD
- ACCURATE\_LOTS\_HW
- DCDB\_LOTS\_HW
- lot\_mga56





## Pipeline upgrade

The original cadastral fabric was created in 2004.

In Dec 2008 the model was upgraded along the 10km route for a proposed pipeline.

In several critical areas (rail and highway crossings) no survey plans existed thus the existing fabric showed no information.





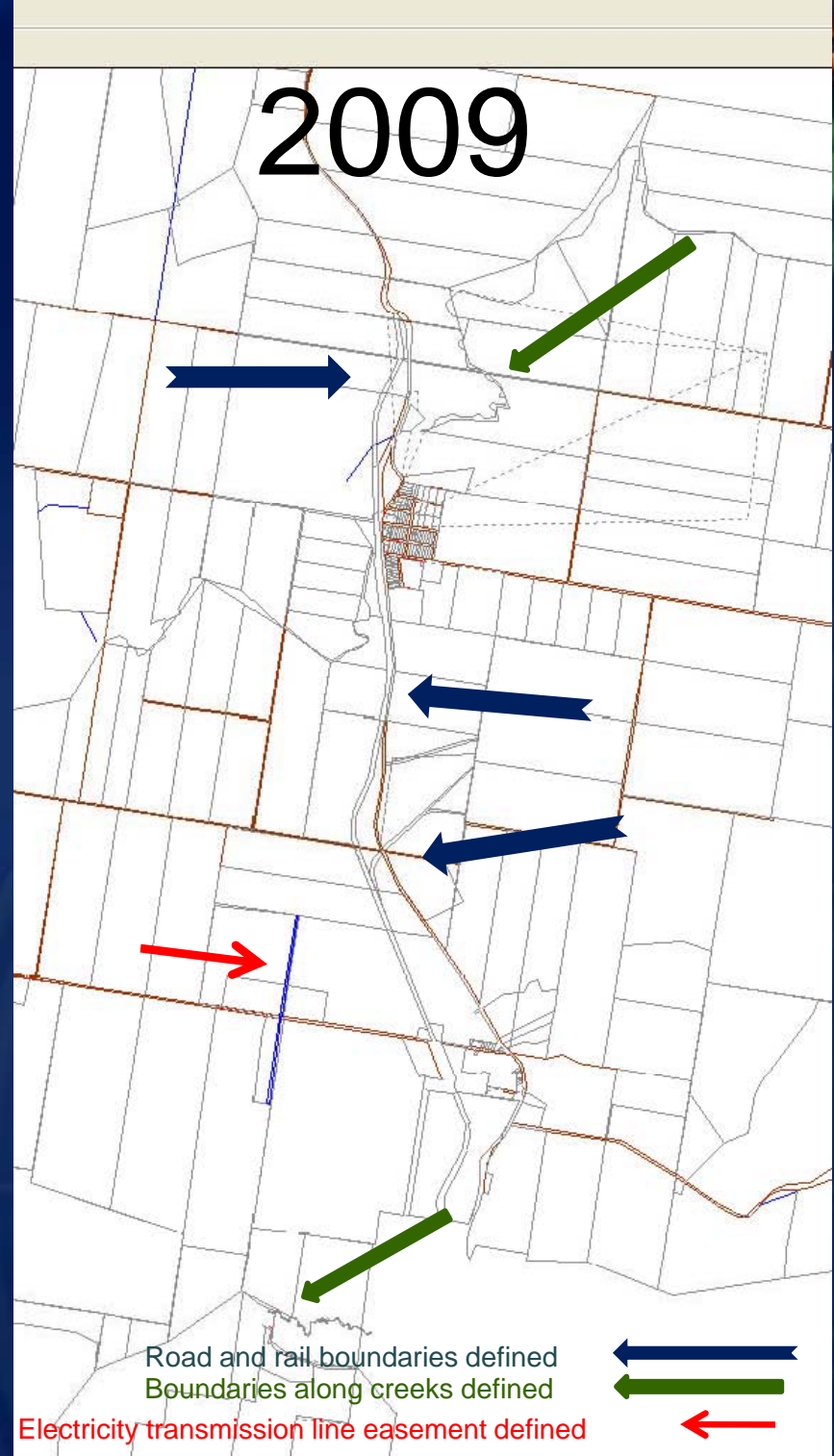
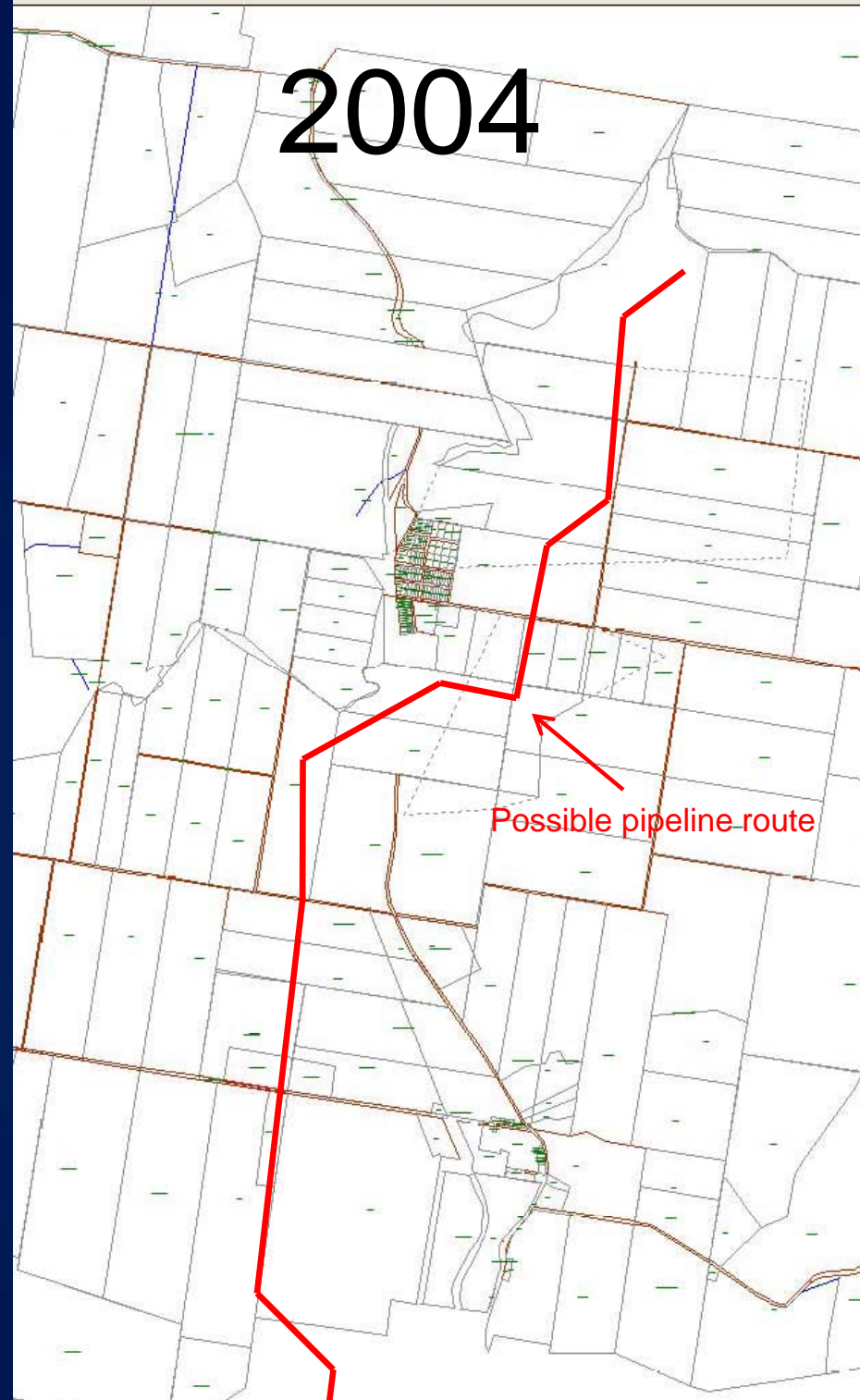
# 2004

Possible pipeline route

# 2009

Road and rail boundaries defined  
Boundaries along creeks defined

Electricity transmission line easement defined







## **GLOUCESTER SHIRE COUNCIL – Pipeline upgrade**

### **CADASTRAL OUTCOMES**

The original cadastral fabric created in 2004 was provided by Gloucester Shire Council and used as the project database foundation.

Several recent survey plans were added to the model and 2 days GPS field work provided ground-truthing and survey information in areas where old plans or no survey information existed.

The pipeline route and adjacent cadastral fabric was upgraded and returned to Council at no cost.



# DEFINING PROJECT DELIVERABLES

1. **PROJECT GEODATABASE**
2. **CADASTRAL FABRIC**  
Areas nominated for specific levels of cadastral precision.

# **ACKNOWLEDGEMENTS**



**GEO DATA**  
AUSTRALIA Pty Ltd

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Department of Lands  
[www.lands.nsw.gov.au/land\\_titles/eplan](http://www.lands.nsw.gov.au/land_titles/eplan)*

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*ESRI Australia - ACT*

**GEO DATA**