

Locating the positions of the original Cape farms of the 1660's – a demonstration of cadastral reconstruction using regular techniques and GIS cadastral fabrics

Jennifer WHITTAL, South Africa and Susan JONES, New Zealand

Key words: historical boundary relocation, surveying, GIS, cadastral fabrics

SUMMARY

Despite the passage of time and advances in technology, there is still considerable uncertainty as to the location of the positions of the first freehold farms at the Cape, South Africa. These grants are now 350 years old and of historical interest to the cadastral community. Traditional relocation methods of cadastral surveyors can now be complemented by recent technological advances in GIS, both in terms of data visualization and recording. Initial research undertaken by two undergraduate students (van Niekerk, 2008 and Siebritz, 2007) is revised and extended using digital overlays, conventional cadastral reconstruction techniques, and cadastral fabrics. The subject of this research is the identification of original boundaries which survive in today's cadastre, and the reconstruction of two Liesbeeck River valley grants of 1660: Rouwkoop and Rodenburg. These are located in Rondebosch in the City of Cape Town, South Africa. Map overlays, noting sheet evidence, and diagram tracing indicate four original farm boundaries in Rondebosch which are possibly common to the current cadastre. A detailed cadastral reconstruction based on the most recent diagram evidence confirms three boundaries as retained in today's cadastre and establishes the most likely positions for the beacons of the farm Rouwkoop. The northern boundary of Rodenburg is also reconstructed. Cumulative survey inaccuracy and inconsistency over time limits the accuracy of reconstruction. Comparison with original beacons (if any were placed) is not possible since these been replaced in more recent subdivisional surveys. Estimates of accuracy are derived from the deductive process and comparisons against grant data. Reconstructed boundaries for Rouwkoop, and for the north and south of Rodenburg, are estimated to be accurate to within 1m, and are probably better than 0.5m. The importance of recording a chain of historical cadastral evidence is highlighted by the research and a cadastral fabric compiled for the area is demonstrated to be useful for this purpose.

The suite of methods and evidence used in this investigation yields results with demonstrated validity. These techniques are recommended as suitable for extension of this project to relocate the positions of other 1660 grants and for undertaking similar historical reconstructions.

Locating the positions of the original Cape farms of the 1660's – a demonstration of cadastral reconstruction using regular techniques and GIS cadastral fabrics

Jennifer WHITTAL, South Africa and Susan JONES, New Zealand

1 INTRODUCTION

Knowledge of the history of human development provides context for understanding the present and feeds essential curiosity. The origins of settlement at the Cape have been of interest mostly to the families who can trace their origins to early inhabitants. Such information is now identified as part of national cultural heritage and of interest to all citizens. The subject of this paper is the relocation of the first freehold farms in southern Africa, surveyed more than 350 years ago, using a range of methods and historical data.

The Cape was undeveloped and occupied by nomadic indigenous peoples prior to the arrival of European settlers and their slaves. With the decision of the Dutch East India Company (the VOC) to establish a refreshment station at the Cape in 1652 for their ships on route to Batavia in the East (Fisher, n.d.), came the first developments in European-style farming and development. By 1657, it was decided to test the area called Rondebosjen (Wagener, 1957) for farming. Farms were established riparian to the Liesbeeck River, their main water source. The Liesbeeck River flows from Table Mountain's eastern reaches through the well-known botanical gardens of Kirstenbosch, thereafter through the historic Rondebosch suburb (see Figure 1). It feeds into the Atlantic Ocean in Table Bay at the feet of the iconic Table Mountain.

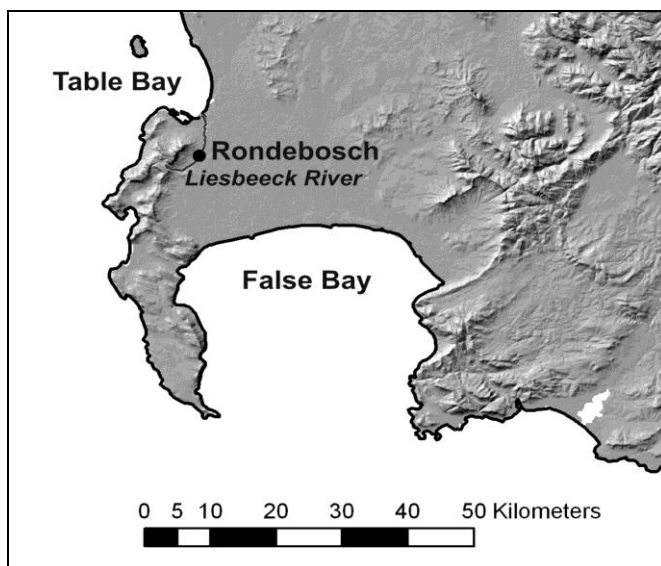


Figure 1 Location of Rondebosch and the first land grants

The first wave of freehold grants lasted from 1657 until 1679. On 21 February 1657, the first nine *frijburgers* were taken to the valley of the Liesbeeck to choose farm positions. Seventeen freehold parcels of land were granted between 1657 and 1660 by the VOC. Pieter Potter, from Holland, surveyed the parcels and is recognized as the father of the Profession of Land Surveying in South Africa (Fisher, n.d., West, 1971).

This paper identifies 1660 boundaries common to the current cadastre in Rondebosch, and relocations two of the original farms: Rouwkoop and Rodenburg. This is no easy task as the original survey, being of virgin land, was referenced to geographical features, mainly the Liesbeeck River. Historical research methods, such as tracing of old maps, diagrams and deeds and reference to secondary sources such as books, are combined with digital overlays using GIS and techniques of cadastral reconstruction familiar to professional surveyors in South Africa. Through a process of evidentiary and methodological triangulation, the relocated boundary positions are verified. Accuracy estimates for the reconstructed boundaries are derived by comparing the results with data on the early plans. Comparison with field evidence of boundary beacons is not possible since these are no longer in evidence, if they were ever placed.

Compiling a cadastral fabric for the area is investigated as a means to produce a data model for dynamically managing surveys of different accuracies and surveyed over different eras, both to facilitate historical research and regular cadastral reconstructions. For the purposes of this research, and to ensure consistency over the duration of the research project, the 2005 cadastral layer is used and referred to as the “current cadastre”.

2 THE PLANS OF PIETER POTTER

The first grants in the Cape are depicted on four plans. Not all of these were signed by Pieter Potter, but the artistry demonstrated on the plans signed by Potter is rare and evident in all of these early plans, so his authorship is probable. He was also the official and only land surveyor at the Cape. The farm extents were drawn on these general plans showing more than one erf, and sometimes also appeared on the deed of grant. The following early cadastral plans were produced: a 1657 plan and a 1658 plan both showing erven and a scale bar; a 1660 plan (see figure 2) including erven up until the end of 1658 with a scale bar, shoreline, and an artistic mountain scene from an oblique aerial perspective; a 1661 plan showing erven up until the end 1660 or early 1661, information on farm owners and extents, a scale bar, and an artistic mountain scene as in the 1660 plan. Reconstructing the 1660 plan by overlay of the diagrams on the deeds shows consistency and a common scale factor (Siebritz, 2007). All diagrams on the deeds are drawn to a scale of approximately 1cm: 25 roods, or 1:30 000 (West, 1971).

Some farm boundaries were adjusted between the 1660 and 1661 plans. Of particular interest on the 1661 plan is the subdivision of farm 3 (1660 plan) into two portions. These were later known as Rouwkoop and Rodenburg (including Myrtle Grove). Modifications of the western boundaries also changed the subdivision shapes and sizes from the parent farm. These

modifications are also indicated in the grants. Confusingly, a copy of the 1661 plan in the City of Cape Town archives is labeled 1685, and a plan entitled “De Nederzetting aan de Liesbeeck” is thought to be a recent rendition of an original 1661 plan available at The Hague.

Original plans and diagrams are stored under controlled archive conditions. Microfilm copies from the Western Cape National Archives (WCNA), printed copies from the local municipal archives and analogue slide images of originals at The Hague (taken by Fisher), form essential research evidence. Transcribed and translated copies of the diagrams in the WCNA were made available by Penfold of the Surveyor-General’s Office in Cape Town. These are verified as consistent with the originals. Diagrams and plans were converted to digital form for georeferencing.

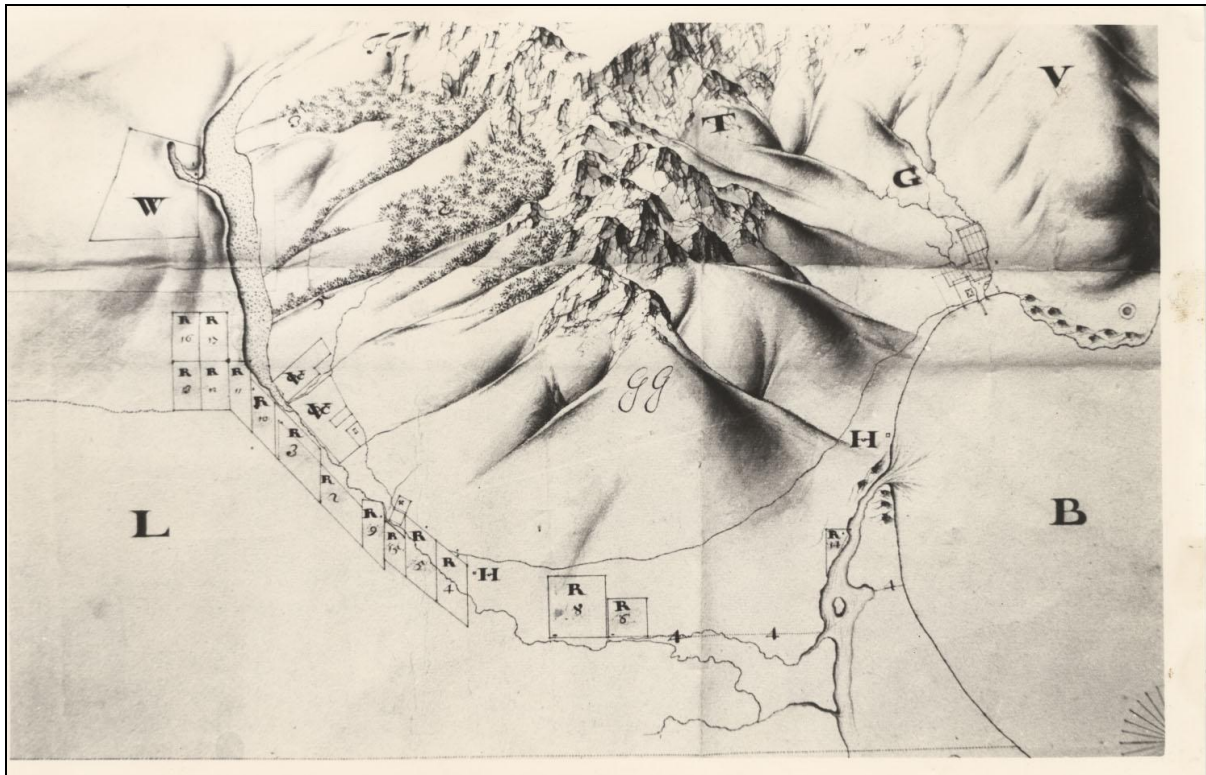


Figure 2: A portion of Pieter Potter’s 1660 plan showing land grants along the Liesbeeck River. North is directed to the right of the page.

3 TRACING DEEDS OF TRANSFER

Attempts to trace transfer deeds forward are problematic (Siebritz, 2007, van Niekerk, 2008, Cairns, 2008). All of the original deeds should be available in the WCNA, but their transfer records end in 1671. Transfer deeds from the early 1800s and later are held in the Deeds Office in Cape Town. Unfortunately, the Deeds Office only stored deeds involving surveys in the interim period. In addition, the numbering system employed in the WCNA is different from that in the Deeds Office. A calendar in Guelke (1990) could be another source but only

reflects the first transfers and not the first grants (Siebritz, 2007). The most useful information is a table (WCNA table reference Z-K-8-4-1), compiled by Cairns (2008), detailing the lineage of deeds from 1657 to 1764, as well as the detail of deeds from 1658 until 1752. Van Niekerk (2008) repeated the attempt to trace transfers forwards without success due to incomplete records. Despite tracing problems, he clarified that the first grant was farm number 1 (dated 16 August 1657) not number 9 as originally thought by the Deeds Office. Farm number 1 was subdivided into farm numbers 2 and 3. Farm number 3 was also subdivided into farm numbers 4 and 5.

4 GEOREFERENCING OF PIETER POTTER'S PLANS

4.1 Previous attempts at georeferencing

Georeferencing of Pieter Potter's plans has been attempted by Penfold and also by Britz, both from the Office of the Surveyor-General, Cape Town. The precision of their plotted farm locations on more recent plans is unknown and the results are unpublished. Georeferencing of the old plans, as accurately as possible, is required in order to compare original boundaries with the current cadastre.

4.2 Additional Data

The Old Cape Farm (O.C.F.) boundaries and their farm numbers are denoted by thick dashed lines on most noting sheets. Noting sheets are plotted compilations of cadastral data containing information which is unavailable in any other form apart from individual diagrams. For this reason noting sheets are an excellent starting point for historical reconstructions in the Cape.

Farm locations in the early 1800s are overlaid onto a recent street map in Wagener (1957). Even though many subdivisions took place between the mid-1600s and the 1800s, the location of farms prior to the current suburban layout provides a useful link. From the archives of the City of Cape Town, scanned copies of two maps of 1812-1813 and 1865 were obtained. The position of the Liesbeeck River on these plans provides a useful topographical link to the early plans since canalization was undertaken only in the 1900s.

4.3 Incremental georeferencing

Georeferencing the 1865 and 1812 plans was undertaken using common farm beacons in Rondebosch only in order to minimize errors in the area of interest. The 1865 plan displays more distortion than the 1812 plan over the full extent of the map in comparison to the current cadastre. Comparison of the position of the Liesbeeck River pre-canalization to its current canalized position indicates better agreement with the older 1812 plan than with the 1865 plan. The position of the river in 1812 is unchanged for most of its course. It is unlikely, given the terrain in the valley and the stability of the river course since 1812, that the river had changed its course much between 1660 and 1812 in the area of Rondebosch. Upstream, the old plans depict a wide marshy area between two river lines. The western boundary of this feature is thought to be the current position of the Liesbeeck River, while the marshy areas are not reflected in the 1812 or subsequent plans, and today are part of the suburban development.

The position of the Liesbeeck River in Rondebosch, particularly its kinks and tributaries flowing from Devil's Peak, provided evidence for georeferencing the 1661 plan to the 1812 plan. Farm boundaries were not used in this process of georeferencing in order to avoid incorrect identification and to achieve a satisfactory level of independence in the later identification of boundaries which survive in the current cadastre. The 1660 plan was then georeferenced to the 1661 plan using common farm boundaries since there is no confusion in identifying these on the two plans.

4.4 Comparison of plan overlays

Agreement between the 1660 and 1661 plans and the current cadastre is good in Rondebosch where the georeferencing was focused, but it degrades considerably over distance as indicated by the misalignment of the Liesbeeck River. Further georeferencing will be required upstream and downstream of Rondebosch as the relocation work is extended to other early farms. Georeferencing accuracy is affected by the lack of precision of the original surveys and plans, their small scale, distortions introduced in the conversion to digital format, and changes in topography over time.

Inspection of the georeferenced 1660 and 1661 plans shows the subdivision of the farm denoted as number 2 on the 1660 plan in two portions: Rouwkoop on the South and Rodenburg (including what were later to be identified as Rodenburg and Myrtle Grove) on the North. The western boundaries of these portions are also substantially adjusted altering the shape of the farms. Since the boundary adjustment took place early on in the farm history, reconstructions of the farms is to their positions as shown on the 1661 plan, and as drawn in the amended grants dated 5 January 1660.

5 IDENTIFYING COMMON BOUNDARIES AND BEACONS WITH THE CURRENT CADASTRE

Ideally, subdivisions of early farms retain the original boundaries which are only "lost" upon consolidation of land. Due to the age of the original farms, and the early readjustment of their boundaries, as well as generations of subdivisional surveys, this ideal is not expected in all cases. Four boundaries in the vicinity of Rondebosch are identified from the overlays of the 1660 and 1661 plans as potentially common to the current cadastre, and appear to follow current roads: along Belmont Road forming the northern boundary of farm 9 on the 1660 plan (later known as Ecklenburg South, a part of Ecklenburg); along Wilhelmina, Lulworth and College Roads separating farm 9 from Rodenburg to the south (northern portion of farm 2, 1660); along Rouwkoop Road forming separating Rodenburg from Rouwkoop to its south (Rouwkoop is the southern portion of farm 2 of 1660); along Dulwich Road forming the south boundary of Rouwkoop. The uncertainty in the georeferencing process and the small scale of the original plans, makes it impossible from overlays alone to determine which side of the road the original farm boundary falls, if any (the original could also fall in the road reserve).

6 TRACING SUBDIVISIONAL DIAGRAMS

Dr. Helen Robinson is an historian with an interest in tracing the estates of families at the Cape. She provided van Niekerk (2008) with tracing back to the 1800s for the historical farms of Ecklenburg, Rodenburg (Myrtle Grove section) and Rouwkoop. Following on from Siebritz (2007), and using Robinson's tracing, van Niekerk (2008) established the lineage of erven for Rouwkoop forward to the current cadastre. The tracing exercise confirmed the georeferencing of the 1660 and 1661 plans and confirmed three of the identified boundaries as common to the current cadastre: the south side of Wilhelmina, Lulworth and College Roads, the north side of Rouwkoop Road, and the north side of Dulwich Road. Along Belmont Road the boundary position is as yet undetermined and it appears that the boundary may be wholly lost; further data collection and detailed investigation is required.

7 CADASTRAL RECONSTRUCTION OF BOUNDARIES AND CORNERS

Cadastral reconstruction of the boundaries and beacons was undertaken initially by van Niekerk (2008) and more recently by author Whittal. The Old Cape Farm (O.C.F.) boundaries on the noting sheets proved vital in this process. The value of reflecting historic boundaries is one of the main objectives of proposing the use of cadastral fabrics in GIS later in this paper.

7.1 Reconstruction of Rouwkoop:

The length of the sides and angles of Rouwkoop farm are not given on the amended grants of 1660 or on the 1661 plan. The angles of the farm were most likely to have been 90° at A and B to the west, and 140° at E, and 40° at G, to the east. The scale factor on the diagram (Erf 46510 Cape Town) was used to determine the lengths of the sides to a precision of only 3m. A combination of O.C.F. data on the noting sheets, the probably location of farms corners from GIS overlays of the old plans and the current cadastre, as well as historical and current cadastral diagrams, were used in the reconstructions. Each farm corner was reconstructed using the most recent data of, or in the vicinity of, these cadastral corners. The southern boundary near the SE corner (E) is lost due to the failure to retain a kink upon subdivision of erven along that boundary. Table 1 shows the reconstructed corners of Rouwkoop as well as an embedded comparison of sides and angles with data determined from the diagram.

7.2 Reconstruction of Rodenburg

The amended 1660 grant and the 1661 plan showing Rodenburg are, like Rouwkoop, devoid of the length of the sides and the angles. The angles of the farm were most likely to have been 90° at J and K to the west, and 140° at G, and 40° at H, to the east. A diagram of the original Rodenburg farm does not appear to exist and so sides and angles are derived from the small diagram in the amended grant. Precision of sides are scaled also to only 3m. More recent data comparison is made to the diagram of Erf 46637 Cape Town, called Myrtle Grove.

Table 1 Reconstruction of Rouwkoop

Rouwkoop	Cape Datum		Hart94 Datum		Cadastral Beacon	Survey E-record	Erf	Diagram
	y	x	Y	X				
	0.00	3700000.00	0.00	3700000.00				
A (SW)	49097.76	59985.01	49160.59	60285.21	Not beacons	E1873/66	110211	5175/1975
<i>AB</i>	<i>199.3 metres</i>	<i>Angle at A: 90.30.44</i>			<i>Cadastral boundary is common to three erven: 98222, 46636, and 110211 Cape Town.</i>			
<i>1660/1 AB</i>	<i>196 metres</i>	<i>Angle at A: 90°</i>						
B (NW)	49164.77	59797.76	49227.60	60097.96	Not beacons: component lines on diagram	E1157/93, E2753/93, scaled	Along north boundary of 152235	General plan 8010/1993
<i>BF</i>	<i>703.8 metres</i>	<i>Angle at B: 89.04.10</i>			<i>Northerly side of Rouwkoop Road (Rouwkoop Road is included) Cadastral boundary exists today</i>			
<i>1660/1 BF</i>	<i>727 metres</i>	<i>Angle at B: 90°</i>						
F (NE)	48498.38	59571.42	48561.22	59871.61	1/2" rip	E654/40, E583/60, E3258/92	47019, 47022; reconstructed from 47021	
<i>FE</i>	<i>304.0 metres</i>	<i>Angle at F: 40.06.28</i>			<i>Cadastral boundary lost</i>			
<i>1660/1 FE</i>	<i>314 metres</i>	<i>Angle at F: 40°</i>						
E (SE)	48655.53	59831.60	48718.37	60131.79	Not beacons: kink noted on 46842 and General plan 21a not retained.	E496/79	Corner "A" on 46842, 46841, Corner "G" on 112122; Reconstructed direction 252.13.00 and distance scaled off General plan R21a.	87/1826, R21a, 1606/1979
<i>EA</i>	<i>468.1 metres</i>	<i>Angle at E: 140.18.39</i>			<i>South by Dulwich Road. The exact South Boundary is common with Erf 96660 Cape Town which is the remainder of Mariendahl and forms a strip of land in Dulwich Road. Cadastral boundary exists today to the west of the railway reserve. To the east of the railway reserve the boundary is lost</i>			
<i>1660/1 EA</i>	<i>487 metres</i>	<i>Angle at E: 140°</i>						

Table 2. Reconstruction of Rodenburg

Rodenburg	Cape Datum		Hart94 Datum		Cadastral Beacon	Survey E-record	Erf	Diagram
	y	x	Y	X				
	0.00	3700000.00	0.00	3700000.00				
H (NE)	48461.82	59340.01	48524.67	59640.20	5/8" rip	E583/60	46998	2310/1960
<i>HG</i>	<i>226.0 metres</i>	<i>Angle H: 64.51.50</i>			<i>Cadastral boundary is common to three erven: 47021, 46998, and 47001 Cape Town</i>			
<i>1831 HG</i>	<i>223 metres</i>	<i>Angle at H: 65°</i>						
<i>1660/1 HG</i>	<i>297 metres</i>	<i>Angle at H: 40°</i>						
G (SE)	48480.22	59565.25	48543.06	59865.44	Not beacons	E654/40, E583/60, E3258/92	47019	2679/1882
<i>GJ</i>	<i>562.7 metres</i>	<i>Angle G: 113.22.35</i>			<i>South by Dulwich Road. The exact South Boundary is common with Erf 96660 Cape Town which is the remainder of Mariendahl and forms a strip of land in Dulwich Road. Cadastral boundary exists today to the west of the railway reserve. To the east of the railway reserve the boundary is lost</i>			
<i>1660/1 GJ</i>	<i>499 metres</i>	<i>Angle G: 140°</i>						
J (SW)	49013.22	59745.73	49076.06	60045.92	Generated from area of old farm			
<i>JK</i>	<i>187.3 metres</i>	<i>Angle J: 90.52.47</i>			<i>Cadastral boundary lost</i>			
<i>1660/1 JK</i>	<i>183 metres</i>	<i>Angle J: 90°</i>						
K (NW)	49076.02	59569.23	49138.86	59869.43	Generated from area of old farm			

<i>KH</i>	<i>655.6 metres</i>	<i>Angle K: 90.52.47</i>		<i>Southerly side of Wilhelmina, Lubworth and College Roads Cadastral boundary exists today</i>
<i>1660/1 KH</i>	<i>731 metres</i>	<i>Angle K: 90°</i>		

Apparent portions of Rodenburg are: Erf 46637 Cape Town (Myrtle Grove, SG Diagram 134/1831), which occupies the footprint of Rodenburg from the inner bank of the Liesbeeck River eastwards, and Rodenburg west of the river, which is larger than the footprint of the 1661 farm and extends from the inner bank of the river westwards to the Main Road (Erf 46520 Cape Town, SG Diagram 1/1790). The link between these “subdivisions” and the parent erf is not established. Myrtle Grove (east portion) has angles of about 115° (at G) and 65° (at H) based on its diagram of 1831. It is noted that these angles are substantially different from what the original angles should be; it is probably that a boundary adjustment took place between 1661 and 1831 on the eastern side of the farm. Boundaries KH and GJ are slightly off parallel and J and K were reconstructed to be as close to 90° as possible while holding the area as in 1661 fixed at 119764 m² (see Table 2). This assumes that the farm area was retained in the adjustment of the eastern boundary.

A further reconstruction of beacons along the Main Road, being the western part of Rodenburg, is shown in Table 3.

Table 3 Reconstruction beacons along the Main Road for Rodenburg west of the Liesbeeck (1790)

Rodenburg W	Cape Datum		Hart94 Datum		Cadastral Beacon	Survey E-record	Erf	Diagram
	y	x	Y	X				
	0.00	3700000.00	0.00	3700000.00				
D (NW)	49112.00	59582.66	49174.84	59882.86	Not beacons: reconstructed from intersection	direction E2063/65 + E369/75; direction from E2462/92	46437	
<i>DC</i>	<i>241.3 metres</i>	<i>Angle at D: 131.17.02</i>						
<i>1790 DC</i>	<i>241.8 metres</i>	<i>Angle at D: 130°</i>						
C (SW)	49197.76	59808.21	49260.59	60108.41	tent peg in wall	E1157/93E2753/93	152234	General plan 8018/93
		<i>Angle at C: 50.28.33</i>						
<i>1790</i>		<i>Angle at C: 50°</i>						

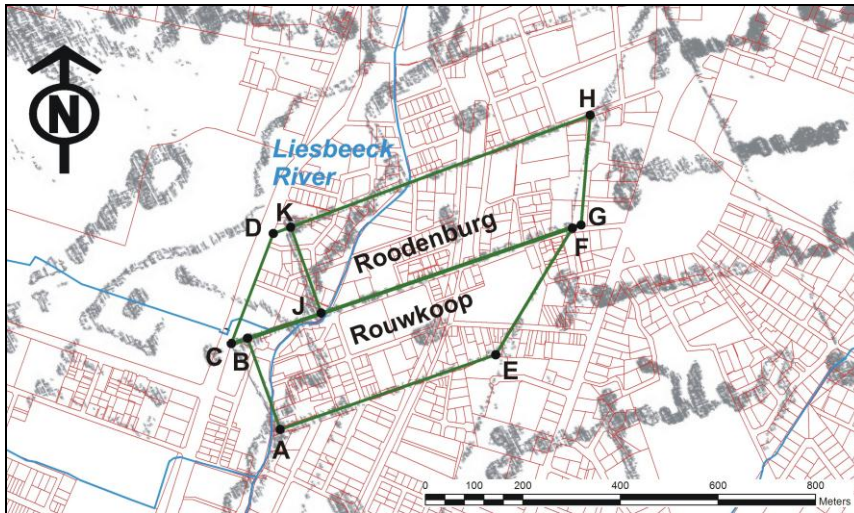


Figure 3: Reconstructed farms in the current cadastre compared to the 1661 plan

7.3 Analysis of reconstructions

Analysis of the accuracy of the above results ideally relies on finding the original farm beacons. The existence of these today is improbable, if any were ever placed. Beacons which form part of the current cadastre (C, F and H) have been replaced many times and are no longer the original physical beacons. Accuracy of the reconstructions can only be ascertained through comparisons against the areas, sides and angles of the original farms.

The angles in the reconstructed shape of Rouwkoop agree very well with the diagram angles measured at 90° , 90° , 40° , and 140° . The reconstructed sides agree to at best 3m (insignificant given the precision of the scaled sides) and at worst 23m with the original farm sides. The area of Rouwkoop as reconstructed is $115\,539\text{ m}^2$ and the grant area is 13 Morgen and 343 square rods, or $116\,246\text{ m}^2$ - a difference of 707 m^2 . This difference is a result of a combination of factors: the inaccuracy of the surveying methods used around 1660 and the maintenance of boundaries through consecutive generations of surveys and subdivisions. This is equivalent to a displacement of the longest boundary of about 1 metre. Spreading the 1 metre difference between all four boundaries reduces it to the sub-metre level, and the boundaries are probably reconstructed to better than 0.5 m.

Since only the northern and southern boundaries of Rodenburg, but not their extents, were relocated comparisons against the side and angles of the grant are impossible. The reconstructed northern boundary is probably similar precision to that of Rouwkoop, and the southern boundary is partly shared with Rouwkoop. The reconstructed east boundary is substantially adjusted since 1660, but agrees well with the 1831 diagram boundary. The overlay of the reconstructed beacons and boundaries on the 1661 plan in Figure 3 shows good agreement at J and K, but poor agreement of H and G, confirming the suspicion of a boundary adjustment on that side. The reconstruction of J and K assumes that this boundary adjustment retained the overall farm area. It is not clear whether this assumption is correct, but there is no evidence that it is incorrect given the good agreement between J and K and the 1661 plan positions.

The reconstructed beacons C and D along Main Road are highly consistent with the eastern subdivision of Rodenburg in 1790, both in the length of CD, and the angles at C and D. These positions shed no light on the location of the original Rodenburg farm corners, but do confirm the locations and orientations of the north and south boundaries of the farm.

8 USING CADASTRAL FABRICS IN GIS

An extension of the reconstruction of Rouwkoop and Rodenburg is to construct a cadastral fabric in order to ascertain the usefulness of this tool for cadastral reconstructions. A cadastral fabric is a continuous surface of connected parcels whose topology is defined by the corners of common parcels (Hodson, Leslie and Buscaglia, 2007). It is similar to the cadastral layer of shapefiles in the current cadastral layer in GIS, but survey precision remains intact. This overcomes the shortcoming of GIS in retaining survey precision. Without cadastral fabrics, data pertaining to different epochs is reflected as GIS layers with the likelihood of reduced quality from the original capture. The power of the cadastral fabric approach is the ability to store generational data together with an indication of the survey quality. The lineage of subdivisions and consolidations over time is maintained and all surveys remain independent entities. Cadastral fabrics are thus a powerful tool for modelling and retaining land transactions over time.

The cadastral fabric is a transactional business model of a dynamic cadastral solution. In South Africa, although there is some stability in the reference/control system, every cadastral survey can create mathematical gaps and overlaps since the physical beacons are given precedence over mathematical data. As long as physical beacons are correctly identified and surveyed, and the subsequent boundaries form no gaps or overlaps, there is no practical or legal problem. As such, cadastral data in South Africa is dynamic as the numeric evidence may change with each survey. Reflection of such a non-topological system is viable in a cadastral fabric. It has potential as a digital management tool to assist the surveying community in maintaining a chain of evidence through time and to execute their mandate of acquiring and assessing “all the evidence” for cadastral reconstruction.

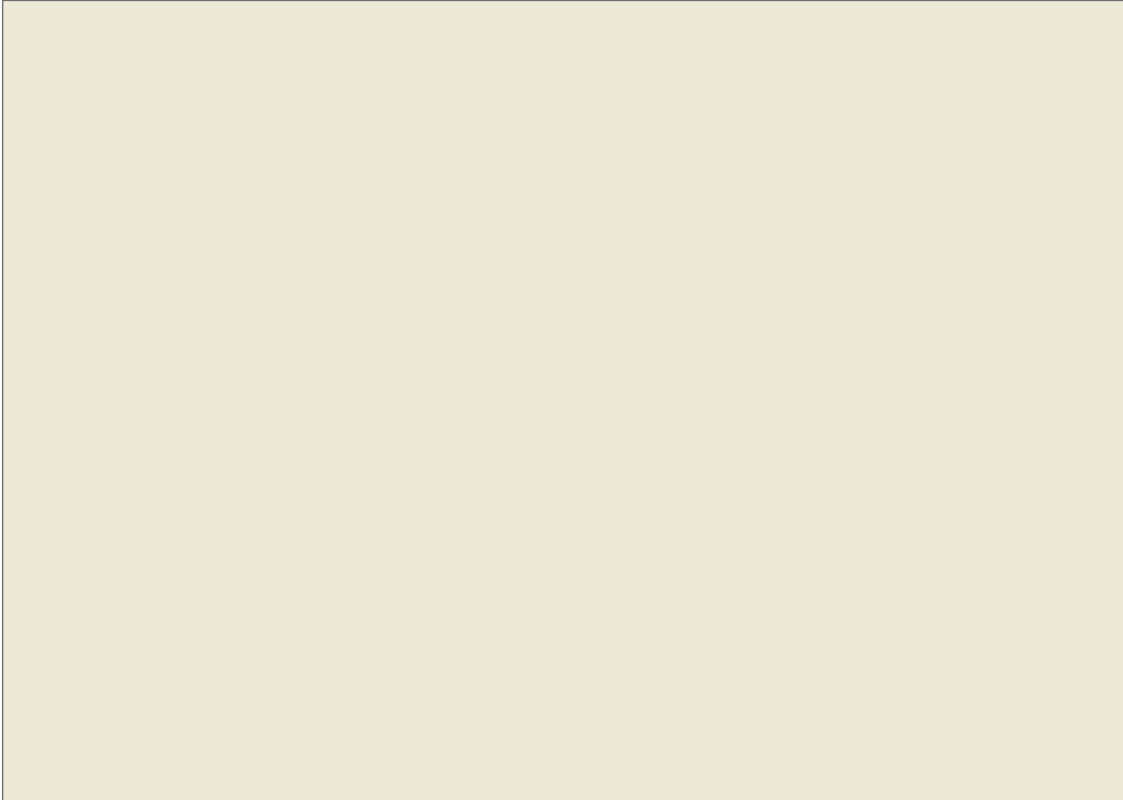


Figure 4: A cadastral fabric for Rouwkoop and Rodenburg

The cadastral fabric depicted in Figure 4 has been constructed from the individual diagrams obtained from the Offices of the Surveyor-General of the Cape. This holds the lineage of diagrams making up the Rouwkoop and Rodenburg farms with erven organized by the diagram number. Associated metadata to the survey is held at this level and more accurate surveys take priority over historical surveys. The cadastral fabric requires data to be recorded in a single spatial reference system. In the reconstruction of Rouwkoop and Rodenburg, data was converted or transformed into the current cadastral system near the farm corners and along the boundaries. Due to resource constraints in manually converting all the diagrams (current and superseded) within the original farm footprints into digital form, gaps in the cadastral fabric lineage remain. Nevertheless, the ability to trace the historical boundaries is clearly evident. The reconstructed farms are shown to align well with the current cadastre, although this is expected since the most recent cadastral data was used in their reconstruction.

9 CONCLUSION

This paper has demonstrated the relocation and reconstruction of properties 350 years ago using a range of methods, both graphical and mathematical. This is a difficult undertaking, particularly when the properties are located in undeveloped areas which had no history of formal land ownership and occupation. The traditional methods of boundary reconstruction employed by land surveyors are still preferred when all evidence such as old plans, original

title deeds and diagrams, and the lineage of cadastral development must be taken into account. Although these methods of reconstruction are well-known and often-used by Professional Land Surveyors in South Africa, it is unusual to attempt a reconstruction spanning centuries.

The use of noting sheets and GIS-based overlays played a vital role collating the evidence and corroborating results. Within the Rondebosch area a number of beacons and boundaries from the earliest grants in 1657-1661 are shown to be retained in the current cadastre. Although some corners are physically beacons and have published coordinates to 0.01m in the current cadastral system, the positions of the original beacons are unlikely to be that accurately retained over the many years of survey and subdivision. Cumulative differences in surveys, as well as inaccurate methods of original survey in the 1660's, prevent a good approximation of the accuracy of reconstruction. The relocation of the original boundaries of Rouwkoop is probably accurate to within a metre, and possibly to within 0.5 metre. Rodenburg shares one of these boundaries and its northern boundary is probably determined to a similar accuracy, but the reconstruction of the eastern and western boundaries is problematic and will be the subject of further investigation.

The 2005 cadastral layer has been used as an independent GIS layer (which lacks data quality indicators) to construct a cadastral fabric for recording the position and metadata of old and current erven. The usefulness of cadastral fabrics in recording the lineage of cadastral surveys through time, and in making historical boundary evidence more accessible, is demonstrated. A complete GIS cadastral fabric is proposed to be built up comprising the original Liesbeeck farms, historical transactions from the earliest grants, and the active erven. The process will be similar to that of Landonline, the digital Land Information transaction management system in New Zealand (Land Information New Zealand, 2009).

The location of the farms surveyed by Pieter Potter 350 years ago is now established in the vicinity of Rouwkoop. It remains to extend this work to other freehold grants depicted on his general plans. An approach using a combination of GIS overlays, noting sheet data, survey diagrams and cadastral survey reconstruction techniques, is demonstrated to be suitable. This combination of data sources and method of analysis may also be useful for more recent cadastral reconstructions, particularly the use of georeferenced digital overlays in cases where old diagram data is minimal. A cadastral fabric is a useful tool for recording and sharing historic cadastral data important in cadastral reconstructions. The use of this tool will be investigated in more detail in extending this research to other early land grants at the Cape.

REFERENCES

Cairns, M. (2008), Personal communication (Cairns is a local historian).

Elfick, M. (2006), Cadastral Surveyors - time to go forward digitally and coordinate accurately, ESRI User Conference, San Diego

Elfick, M., Hodson, T. (2006), Managing Cadastral Data in a GIS, XXIII FIG Congress Munich, Germany, October 8-13.

Fisher, R.C. (n.d.), Pieter Potter of Amsterdam: The First South African Land Surveyor.

Haanen, A., Bevin, T., and Sutherland, N (2002), e-Cadastrre - Automation of the New Zealand Survey System, FIG XXII International Congress, Washington D.C., USA, April 19-26.

Harper, I (2006), Survey Accurate GIS Cadastrre - County and Service Authority Case Studies, ESRI User Conference, San Diego

Hodson, T., Leslie, C., and Buscaglia, C. (2007), ArcGIS Survey Analyst Cadastral Editor, 2007 ESRI International User Conference Technical Workshops, June 18–22, San Diego, California.

Land Information New Zealand (LINZ) (2009), Landonline Bulk Extract Documentation, Download from <http://www.linz.govt.nz/docs/surveysystem/landonline-bulkdata/landonline-BDE-overview-v20-0.pdf>

Siebritz, L. (2007), *An Investigation into the First Freehold Land Grants in the Liesbeeck Valley from 1657 to 1660*, Unpublished BSc Thesis, University of Cape Town.

Van Niekerk, A.J. (2008), *The First Land Grants in the Cape in the Liesbeeck River Valley*, Unpublished BSc Thesis, University of Cape Town.

Wagener, F. J. (1957), *Rondebosch Down the Years*. Cape Times.

BIOGRAPHICAL NOTES

Jennifer Whittal is an academic staff member in the Geomatics Division at the University of Cape Town. She has a B.Sc. in Surveying and a M.Sc. in Engineering (specializing in the Global Positioning System) from the University of Cape Town. In 2008, Jenny completed a Ph.D. through the University of Calgary in Canada applying critical realism, systems theory and multimethodology to a case of fiscal cadastral systems reform. She is a Professional Land Surveyor and lectures advanced surveying and land law/tenure. Her field of research is land tenure and cadastral systems with specific interest in sustainable development for the urban poor and historical surveys.

Susan Jones is employed as a GIS Consultant at Eagle Technology Group Limited, the ESRI Distributor in New Zealand. She has both undergraduate and postgraduate degrees from the University of Otago. From 1994, Susan was employed the Council for Geoscience in Pretoria, followed by a spell at the CSIR in Stellenbosch focusing on using GIS to manage groundwater resources. Since then, Susan has worked for an ESRI Distributor. Susan's current interest is looking at the feasibility of using the ESRI Cadastral data model as a framework for transactional parcel managements.

CONTACTS IN

Dr. Jennifer Whittal

Geomatics, School of Architecture, Planning and Geomatics, University of Cape Town,
Private Bag, 7701, SOUTH AFRICA

Tel: +27 21 650 3575 or 671 7710

Fax: +27 21 650 3572

Email: jennifer.whittal@uct.ac.za

Web site: www.geomatics.uct.ac.za

Ms Susan Jones

Eagle Technology Group Limited

Epsom Stand, Alexandra Park, Auckland, New Zealand

Private Bag 93211, Auckland 1151, NEW ZEALAND

Tel: + 64 9 6390614

Fax: + 403 284 1980

Email: susan_jones@eagle.co.nz

Web site: <http://www.eagle.co.nz>

ACKNOWLEDGEMENTS

The following organizations are gratefully acknowledged for their support:

The University of Cape Town

In particular, BSc Geomatics thesis students Andre van Niekerk and Lindy-Anne Siebritz

Eagle Technology Group Limited