Layered Landscape
The Swamps of Colonial Northbridge

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This study focuses on a very small area of land that forms part of the northern central business district of Perth in Western Australia. In investigating this microscale of human occupation, the use of Geographic Information System (GIS) was a research tool to investigate traditional historical sources not commonly thought of by historians as spatial. Changes, rediscovered through the agency of GIS, showed that the northern part of the townscape was intimately defined and cast in response to its swampland topography.

Keywords: swamp; town plan; colonial; Australia; Northbridge

This article examines “Northbridge,” a small part of the inner city of Perth, the capital of Western Australia (see Figure 1). Northbridge is adjacent to the central business district, drawing its name from two bridges which span the railway line that separates it from the city. The railway was laid in the late 19th century through the bed of a series of former swamps. Geographic Information System (GIS) has enabled the rediscovery of the former aquatic landscape of Northbridge and uncovered its relationship to the city.

Introduction

Perth was settled in 1829. Within the first year, the pattern of settlement in the town site was cast establishing the civic, administrative, and legal core. The earliest plan of the town (see Figure 2) was not published until 1833 (Arrowsmith, 1833). It showed a town defined by the Swan River to the south and east by a promontory to the west above the curve of the bay, with contiguous lakes to the north splayed across the landscape and labeled transparently as “Fresh water swamps with rushy margins.” A saddleback ridge ran east–west (punctuated by a “church site”), and the town plan was laid out in a grid pattern oriented to the Swan River.

This setting of Perth, facing the river and nestled into the curve of the bay under Mount Eliza, was the town depicted in the sketches and early paintings of the colony. Here were established the principal parts of the town: the governor’s residence, the government officials, the barracks, the largest buildings, and the finest homes. Although reclamation of the foreshore has subsequently created a large linear park and parts of the grounds of Government House, the street layout, with the exception of some development on the...
southern side, has changed little. The colonists of 1829, were they alive today, would easily recognize this part of Perth.

In stark contrast is the form of the northern part of the town plan, now called Northbridge. Originally characterized by a series of interconnected swamps, which, in wet weather, flowed one into the other to drain in the east at a curve of the Swan River at a point named Claise Creek, the area, described in early official records as “the back part of [the] Town of Perth” (Department of Lands and Surveys, 1830a), has undergone an almost complete transformation.

As the town grew, the topography of the town was incrementally altered by drainage and filling, releasing valuable land for horticultural, residential, and commercial purposes. The swampland became a ready resource for the growth of the town, abetted by a process of drainage that began in 1833. Within 25 years of the establishment of Perth, the swamps had been transformed through drainage and sold for housing, although intermittent flooding until the end of the 19th century vexed the landowners.

So how did GIS enable a finer reading of the impact of the swamps and their relationship to Northbridge? This was done in three stages: digitizing the representation of the swamps in the town plans of Perth between 1829 and 1855, reconstructing the colonial cadastre for the area under study from land transaction records, and mapping onto the cadastre the data contained within the records that related to ownership. Via GIS, the gradual but increasing extension of the town was mapped in a manner, which expressed and revealed the diminution of the swamps, the shape of the town, and the take-up of land in relation to the swamps.

Figure 1
Location Map of Perth, Western Australia

Note: Northbridge is located in the Perth CBD.
In doing so, it revealed that the swamps were, contrary to previous research, valued by colonists despite their diminution in official records and integumentation through drainage. It also allowed the spatial placement of historical paper-based records not previously cross-referenced to changes within the town plan.

Elements of the GIS

Documentary evidence of land transfer from Crown to private ownership formed the basis of this study. The records, although historical, were essentially filled with quantitative data records—names, locations, land area, values—and could be formed into a tabular data source without much difficulty. Their status as legal documents assured a degree of accuracy and consistency of components (Figure 3).
Basics

The desktop GIS software MapInfo Professional 5.5 was used to create the GIS together with a range of proprietary programs: Microsoft, Adobe, CAD, and Arc View. MapInfo databases were created as need arose and raster images and documents geocoded and imported. Word processing was undertaken with Microsoft Word, scanning and image manipulation by Adobe PhotoShop. The Western Australian Department of Land Information supplied 2002 spatial data in Microstation (CAD) and Arc View formats in AGD 84/AMG 84 and databases comprising cadastral and topographical information. Raster backdrops for the town plans of 1833, 1838, 1845, and 1855 were obtained from the State Records Office of Western Australia. A land ownership dataset was constructed by the writer using Microsoft Excel 97 from the analysis of some 2,700 land records dated between 1829 and 1900.

Note: A typical land record for a town lot in 1838. The land ownership documents contained spatial information about the location and area of the town lot being transferred. As such, they were able to be formed into a dataset and mapped in GIS. The irregular focus of copy is a result of the memorials being microfilmed badly.
Source: Department of Lands and Surveys (1838c).
Creating the Boundaries

To create the colonial cadastral boundaries, raster backdrops of relevant town plans from 1829 to 1855 were imported into MapInfo and registered with AMG84 Zone 50 coordinates (the AMG zone for Perth) using points of commonality in the 2002 cadastre as the basis. The town plans varied in size, quality, and condition and did not contain information about their geographic location. As a result, they were not used to trace the cadastral boundaries of the town lots in the study area. Instead, the measurements in the land transaction documents were used, and drafting was undertaken on discrete vector layers that corresponded to the years of the town plans using “heads up” digitizing.

The town plan of 1833 was not available in a digital format and also did not contain sufficient points for registration against the 2002 because of a change in orientation. This plan was manually reconstructed by measuring from the known points in the southern portion of the town and extrapolating the measurements northward using information from the land records (see Figures 4 and 5).

On a separate layer, the outlines of the swamps were digitized by tracing the edges of the swamps as shown in the raster images of the relevant town plans. Ownership information, derived from the land records and compiled in Excel, was also treated separately as a data table. Text clarified the town lot numbers, street names, and the names of the swamps. Improvements, identified through documentation or other sources, were placed in another layer. Links to other sources, where relevant, were placed in the top layer. When completed, the GIS contained some seven main layers with subsets to express differing combinations of data from different years. Specific queries were run to extrapolate particular data for analysis including year of purchase, gender of constituents, and occupation. These were retained and viewed in association with the swamp layers to see the interrelationship of the swamps to the town’s growth.

Figure 4
Part of the 1833 Remnant Lots

Note: Traces of the 2002 cadastre in the 1833 town plan. This was the only point of commonality which existed. The construction of the 1833 cadastre was extrapolated using measurements contained in the land ownership records.
Wither the Swamps?

Of the early reports of the Swan River colony (Appleyard & Manford, 1980)—so critical of the colony and unenthusiastic of settlement—there was surprisingly little said about the swamps and nothing, when it was said, that was of a strikingly negative nature. In a colony heavily dependent on production of food at a local level, the acquisition of land proven to be fertile and productive was highly valued. Although initial reports of the swamp soils behind Perth had been disparaging, the colonists soon realized that the soils, with a little water, were highly productive and a resource “from whence wealth and commercial eminence may hereafter be derived to the settlement” (Cross, 1833, p. xiv). The swamp soils were fertile, had a good subsurface water supply, and retained a “permanent humidity” through the summer months when water was at a premium. As such, they were ideally suited for horticulture, pasture, and orchards and comprised some of the first land parcels for which specific requests were received with proximity to or inclusion of swamps as a favored outcome. Contrary to a paradigm of early 19th-century environmental understanding that was underpinned by fear of sucking swamp soils and miasma-bearing disease, requests by the colonists to the colonial administration specifically for swampland. Interest in the swampland was such that as early as 1831, land parcels were surveyed and released in advance of the orderly progression of the rest of the town plan.
After 1833, depictions of the natural landscape diminished on Perth’s town plans. Whereas, the 1833 plan plainly stated the presence of “Fresh water swamps with rushy margins,” commercial drainage facilitated by deep open cuts to power a mill in the southern part of the town, recast the swamps as a finite resource. From 1834, the swamps were increasingly defined by town lots ringing their perimeters—so much so that by 1838 they were formally absorbed into the town plan as “lakes” (see Figure 6).

By 1845, the swamps were shown as irregular, globular forms and over half had “disappeared.” By 1855, they were no longer depicted, although flooding continued until the late 1870s (Department of Lands and Surveys, 1855, 1859). In August 1855, the Government Gazette (Figure 7) and the Inquirer newspaper trumpeted: “rich garden land at the back of Perth reclaimed by the drainage of the lakes thrown open to purchase” with “ground highly suitable for garden purposes” (The Inquirer, 1855, p. 40).

The diminishing representation of the swamps on the town plans can be read simultaneously as a bureaucratic response to this impetus in the context of a mid-19th century paradigm in which the subjection of nature was an indication of the progress of a society and also as a projection of the ideal town plan, supposedly unhindered by unwanted swampland.

Drainage

The extension of the town over the swamps raises the question of which came first—the drainage or the extension of the town? Although to a degree they marched hand in hand,
GIS revealed that official representation of the swampland on official plans ran in advance of need and in advance of the efficacy of drainage to ensure land free from flooding. Examining the town plans and landownership records in GIS, so that the relationship of the growth of the town to the presence of the swamps was not so clear-cut. Contrary to expectation, the town did not progress in an orderly fashion, marching across the high land and around the swamps. Instead, town lots were taken up around and on swamps in preference to the drier land. This resulted in changes in the orientation of the streets to accommodate the swamps.

In 1834, town lots were released around the perimeter of Lake Thomson. The lots did not conform to those of 1833 and the rest of the town to the south. Instead, they were skewed and, as such, heralded a radical shift in the orientation of the town lots by which the Northbridge town plan was irrevocably changed.

Disrupting the Grid

Lake Thomson was an irregularly shaped swamp about 10 minutes walk north of Perth. Town lots edged the lake across its northern shore, and town lots to its south continued in an
irregular pattern around the southwest and southeast corners of the lake. The orientation of town lots at Lake Thomson, although accommodating the form of the swamp, did not maximize the number of town lots with frontage to it. Importation of the plan as a raster layer enabled a temporary vector layer to be drafted to assess which orientation would have better suited the shape of the swamp. Viewed as layers, it was clear that a slightly more northwesterly orientation would have maximized the land with a frontage to the swamp (Figure 8). It was obvious, therefore, that the orientation of the town lots was determined by another consideration.

When the town lots at Lake Thomson were viewed in the context of the whole of the swampland, it was clear that the orientation was influenced by the form of Lake Kingsford farther to the south. Viewing the vector layer of the 1834 town lots over the raster image of the 1833 town plan, it became evident that the orientation, if continued southward, was laid out to align with the northern edge of the swamp closest to the town. The alignment of the town lots at Lake Thomson conformed to the alignment established by the southern lake and maximized the number of lots that could be placed along it (see Figure 9).

This, in turn, forced a change in the grid, determining the form not only of Northbridge but was to influence suburbs further north through the 20th century.

Viewing the layers in GIS showed an anomaly. Three of the town lots were positioned in such a way that they overlap the northwestern edges of three of the town lots created in 1833 (Figure 10). As it is not possible, in cadastral terms, to have “overlapping” lots and given that applications for these town lots documented in 1834 were available for application as

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Figure 8
Reoriented Lake Thomson

Note: The alignment that was implemented on Lake Thomson accommodated a swamp (Lake Kingsford) farther to the south.
Source: Department of Lands and Surveys (1834, 1836).
Figure 9
1834 Alignment to Lake Kingsford

Note: The town lots around Lake Thomson in 1834 displayed over the raster image of 1833 showing the alignment projected southward from the new town lots.
Source: Arrowsmith (1833).

Figure 10
Overlapping Town Lots

Note: The town form in the area of the swamps by the end of 1836 as seen in GIS. The overlapping lots pointed to a cartographic anomaly, which further investigation dated at 1834 as a direct response to the swamps.
Early as 1832, it was evident that the changes occurred prior to the publication of the 1833 town plan, which showed the different orientation.

The 1833 town plan documented town lots in which the continuation of the grid preserved “the regularity of the Line of Streets or roads of the Town and vicinity” (Colonial Secretary’s Office, 1830). However, between the time of its drafting in Perth and its printing in London, the importance of the swampland to the colony had been recognized and incorporated into the town planning—a radical shift from an orderly grid and one which has had ongoing ramifications for the northern town plan. The influence of the swamps on the orientation of the streets and town lots in the area were expanded and the 1833 town lots would be substantially modified. Particularly striking was the effect on town lots to the east. Whereas the 1833 plan showed the grid progressing over the lakes in a regular fashion, following the orientation of the south of the town except for a few lots, the town lots depicted in the 1838 town plan were skewed to the northwest. Departing from the pattern established to the south in 1829 and continued in 1833, the streets of the area were set at the same orientation as that established by the town lots created around Lake Thomson in 1834. Over 90% (77 of 85) of the town lots depicted in the 1833 town plan were changed. Streets were realigned, town lots redrafted, and boundaries reshaped. Streets were changed in orientation to run parallel with the newly drafted lots on the west. Only one street remained parallel to the original orientation of the rest of the 1833 orientation (Figure 11).

As a result of the seemingly minor modifications that had been made to accommodate the shape of Lake Thomson, regular form of the grid had been compromised. Future changes in Northbridge would respect this alignment, even after the drainage of the swamps in 1854.

**Figure 11**

Changes to 1838 Town Lots

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Note: The changes to the cadastre in 1838 show significant changes to the 1833 lots (lower right). They are easily seen in GIS whereas they are difficult to determine when using the original records.
Effects of Drainage

So what effect did the drainage have on the swamps? Two examples are pertinent to mention here—the diminution of the swamps over time and the take-up of the town lots in the vicinity of the swamplands. GIS enabled the data to be mapped.

By viewing the vectors layers on which the swamp outlines had been digitized, the contraction of the swamps between 1833 and 1845 showed an uneven drainage of the swamps (Figure 12). The form of the swamps was still evident, but their extent had been significantly modified. There had been a reduction in the size and shape of all the swamps and no continued representation of those in the east. The swamps to the east which were evident in 1838 (Lakes Thomson, Poulett, and Stone) are no longer depicted. Lake Kingsford is a “lozenge” having lost its northern arm; Lake Henderson had contracted west, as had Lakes Sutherland and Irwin. The remaining swamps were joined by drains and had lost their natural interconnectedness.

When permission to commercially drain the swamps had been granted a condition was that any land that was drained to a point of being permanently dry would be ceded to the government for release as town allotments (Colonial Secretary’s Office, 1830). Hence, it would be expected that the new town plan would show a steady encroachment on the vacant

Figure 12
1833 to 1838 Swamps

Note: The 1845 swamps (grey) shown over the 1838 (white) and 1833 swamps (dark grey). Only three swamps: Lake Sutherland, Lake Irwin, Lake Kingsford, and Lake Henderson remain intact.
land and that this would be driven, in part, by demand. With the 1845 cadastral layer the 1833 swamps layer open, there was depicted a tightly grouped grid predominantly in the east occupying the area previously occupied by the 1833 swamp system. Although the representation of the swamps on the 1845 town plan showed them diminishing, the main part of the northern town plan was not extended beyond the boundaries of Lake Kingsford. Whereas, to the west town lots “leapfrogged” to surround Lake Sutherland, with suburban lots marked out around its shore—an indication of the importance of the larger parcels of land for supplying food and pasture to the growing town (Figure 13). In 1834, land around the former Lake Thomson had also been allocated well in advance of the rest of the town grid with the orientation of its parcels causing a realignment of streets so as to ensure that southern lots, which were developed in 1838, would be aligned with the northern shore of Lake Kingsford. Although some town lots were drafted over Lake Kingsford in 1845, it would not be until 1855 that the whole of swamp was covered when not only Kingsford but also Lake Sutherland were drained and marked out for acquisition.

Although any discussion of the swamps needs to be read in the context of the fluctuations that occurred in the level and extent of the swamps; from “five feet above the surface” (Commonwealth of Australia, 1923, p. 580) to “dry during the latter part of last summer,”

Figure 13
1845 Swamps and Town Lots

Note: The 1845 town plan shown over the 1833 swamp system. Lots created in the west in advance of the grid capitalized on the fecundity of the swampland.
The plan shows a persistent assimilation of the swamps into the formal town grid albeit with streets angled to accommodate their form.

With the town lots marked out, it would be reasonable to assume that the reason for doing so was because of a need for more land. Such a need would be reflected by the number of land transfers. To test this, the take-up of the town lots until 1844 was mapped by querying the land transaction data in the GIS and displaying it against the cadastre to 1845 (Figure 14).

Surprisingly, very few of the land parcels had changed hands until the 1840s despite land parcels being available for selection since 1829. This was reflective, not of the undesirability of the swampland, but of turbulent economic times that the colony had experienced. A general malaise of the colony affected all of the land released in Northbridge from 1833 to the 1854 and the rate of transfer of the land parcels generally reflected the fluctuations in the colony’s fortunes. Of those lots that were taken up, the distribution of the land parcels was mainly on the site of the former swamps, eschewing the higher land parcels. Indicative of a desire for land that had subsoil moisture, it was in part the impetus for the release of land around Lake Sutherland, in 1845, in advance of the rest of the town.

**The Diminution of the Swamps**

The last representation of the swamps on an official town was in 1853 by which time the former aquatic landscape was almost completely transformed. Only three swamps
remained: Lake Henderson, Lake Irwin and Lake Kingsford (Figure 15). Lake Kingsford was significantly reduced in its extent and displayed a linear form. Lake Sutherland, the focus of the suburban lots of 1845, had disappeared.

In response to this drainage, the town plan was extended westward to join Lake Sutherland. The new lots were almost exclusively on high land, including the creation of a new town square. The square, generous in size and serviced by new roads, was to be a new prestigious heart for the area. With the colony newly recovering from a recession and an increasing population, what response was there to this new land availability? There had been a modest rise in 1843, but the effect of the depression saw land transfers falter, as investors lost confidence. The growth in the number of town lots transferred in the 1850s was a result of the colony beginning to make up some economic ground and substantial drainage works being undertaken in the swamps. Convicts, available to the government at little cost, were put to a range of sorely needed capital works in the colony, including draining the swamps which so inconveniently flooded.

Importing the layer with the vector representation of the 1833 swamps with those of 1853 showed an aquatic landscape significantly diminished (Figure 16). The images show a westerly contraction and Lake Sutherland, the subject of interest 8 years before, has been omitted.

By 1855, the swamps of Northbridge had all but disappeared. They were no longer depicted as such on the town plan but rendered as faint globular outlines under the canopy.

Figure 15
1853 Swamps over 1833 Swamps

Note: The aquatic landscape has been significantly diminished.
of town lots, indicative of their diminished importance and eventual demise. In the space of 22 years—from the town plan of 1833 to that of 1855—the swamps had been extinguished. Although the representations on the plans were both a record of an imposed reality on the landscape and a projected image of a progressive town, GIS showed, more clearly than could a comparison of the town plans, the contraction of the swamps.

**The Taking Up of Land**

To assess the acquisition of land in relation to swampland, land transfers were mapped from 1829 to 1875 (Figure 17).

Although two parcels of land were transferred within the first year, no land was transferred until 1838/39 and despite a short surge in the early 1840s, transfers were sluggish until the mid-1850s. When land sales did accelerate, it was not on the high land but in the bed of the former swamps. The fastest take-up of land occurred in those town lots released for sale in 1854 and documented in 1855. Within 1 month of drainage beginning at Lakes Irwin and Kingsford in 1854, the land was offered for sale. The rate of acquisition was faster than at any time since 1833, with most of the town lots settling in 1855.

The drained land, with its close proximity to Wellington Street and fertile soils, made it an attractive proposition for purchase. At the same time, other town lots of significantly larger sizes were advertised for 15 pounds each (Department of Lands and Surveys,
1838a, 1838b; *The Inquirer*, 1854) making 25 pounds per lot comparatively expensive land. It was commercial recognition of the value of the swampland in close proximity to the town. The next peak, in 1865, was not over newly released land but scattered over parcels throughout the area, some of which had been drafted and made available as early as 1834. The land west of Russell Square, although high and well serviced by roads, was not taken up in force until after 1875. Of the peak years, the land taken up in 1855 is predominantly over the area of the former Lakes Irwin and Kingsford.

By the end of 1855, 27 of the town lots on the site of the former swamps had been acquired and another 10 were sold in 1856 (Figure 18). Of the total 48 town lots sold in the area, 40 were transferred from the Crown by the end of 1858; the rest by the end of the 1860s. The patterns of sales soon slowed, taking 7 years to climb another six transactions and then growing steadily through to the early 1870s, being small and the land being wholly within the bed of the former Lake Kingsford.

The rapid take-up in 1855 was not because of a scarcity of land in Northbridge. Nearly 400 blocks had been released in the area and 79 of those available for purchase were to remain unsold until after 1874 (Figure 19).
What is unusual is the almost complete absence of Enrollment activity in the eastern area, the area first opened to settlement. Whereas this land had been available for the longest period, there were only two town lots transferred, in 1840 and in 1848. Other than these town lots, the area was characterized by scant transactions, and the area, when it was referred to in the documentation, was subject to resumptions for road, drainage, and railway works.

Why were the land transactions across the whole area of Northbridge so uneven in their distribution except for those of 1855? By placing the land parcels within the context of their swamp environment, although predominantly a drained swamp environment, a different pattern emerges—that of the influence of the swamps on the rate of land acquisition from the Crown.

Around Lake Sutherland, over Lakes Irwin and Kingsford, next to the unnamed swamp near Stirling Street, and around Stone’s Lake, Lake Thomson, and Lake Henderson, town lots were consistently taken up in close proximity to the swamp soils. Moreover, they were taken up in preference to the land that was higher (the land around Russell Square in the west). In the east, where the land between Stirling and Lord Streets was not part of the swamp, it, too, had a delayed acquisition. Given that price differentiation was not a factor, the take-up of the town lots is proof of the preference for swampland over other seemingly more desirable land on offer in the area.

There was little enrollment activity west of Russell Square although land had been taken up to the north and south of it. The town lots to the south had been taken up in 1852, with those to
the north being so at the end of the 1860s and beginning of the 1870s, but the land west of Russell Square (excluding Lake Sutherland) remained largely vacant except for four town lots were sold in 1875 to military pensioners, the retired soldiers who had been brought out to the colony to guard the convicts (Department of Lands and Surveys, 1875a, 1875b, 1875c).

Apart from these transactions, few sales were made before the end of 1875. It is a surprising result, as the land in this area was comparatively high, serviced by a good network of roads, closer to town than those north of it, and near Russell Square—one of the few urban squares in Perth. By 1875, there were still significant parcels of land that had not been taken up. Apart from two lots of high land that had been reserved by the government for the site of the Perth jail and other government purposes and two squares (Weld and Russell), the rest of the land was available for purchase.

Usefulness of GIS

The land ownership records mentioned the swamps in only one record (Department of Lands and Surveys, 1868), and, as we have noted, the depiction of the swamps was becoming increasingly opaque. As town plans are not easily collocated nor adjusted to the same

Figure 19
1838 to 1975 Land Enrollments and the Swamp System

Note: Land enrollments for the whole of Northbridge viewed in relation to the 1833 swamp system. Land transfer in Northbridge shows a consistent pattern—the predominance of the land transferred until 1865 is on the site of the swamps. The high land had several blocks of land that were free of transactions until after 1875. Source: Morel-EdnieBrown (2005f).
scale, the capacity to import them into a GIS and geo-code them to known points has provided a reasonable accuracy to assess the changes that took place from 1833 to 1853. Mapping the town lots against the swamp system in GIS enabled the relationship of the swamps to the town lots to be understood more clearly. Without GIS, subtle changes would have passed unnoticed, obscured by the rendering of the plans in their paper form. Furthermore, by combining the layers in the GIS depicting the swamps in association with the reconstructed cadastre, the assemblage of data enabled a better understanding of the purchase of land and the settlement of the town in relation to the swamplands. To analyze the records more finely, a residential analysis was undertaken to determine whether gender had a role in the pattern of land distribution.

Until the early 20th century, married women were unable to hold land in their own right. Unable to own or control land unless they were widowed or single, a substantial number of women were excluded from land proprietorship, except where granted permission to do so by their husband or through the provisions of dowerage.

To test where women purchased land in Northbridge, female gender was selected as a dataset and map against the cumulative cadastre to 1855. Of the land transactions that occurred, only a small fraction were granted to women in their own right (Figure 20).
There appeared to be no particular clustering of activity, with the land parcels fairly evenly distributed around the area. However, a more general query run to capture the involvement of women noted in relationship to a male in the land, showed a distinct clustering along two streets (Figure 21).

Of 69 transactions involving a woman, there was a heavy concentration around two eastern streets, one of which was a major thoroughfare from the city. The area was closest to Perth and had the driest direct connection to the city, so its convenience—as well as being visually attractive with a broad northern street—may have been more appealing to families seeking to invest in property. For the balance, there seems no obvious explanation for their geographic proximity as the types of involvement of women classified as owner, seller, or purchaser, does not suggest the preceding death of a male, unlike other classes of widow, beneficiary and executrix, which would be a natural outcome of longer held parcels of land.
This suggested that the concentration may have been related to convenience of access for families to the town or could have had a commercial aspect. To test whether this so, the dataset was queried and returned a subset relating to extract those occupations cited as “merchants” and “storekeepers” (Figure 22).

When merchants storekeepers were mapped, there was a similar clustering in the streets to the east, although there was a small concentration to the southwest. The clustering reflects the importance of the streets as major thoroughfares and retail centers as well as the role that women, as spouses and daughters, played in the establishment of small businesses in the area. As the preponderance of town lots in which women had some influence was concentrated on the retail sector, it was likely that they were involved in supporting a husband in business or the recipients of business interests, although not necessarily ownership, as widows. The clusters predated the gold rush construction and retail boom that
would see streets further to the east develop into the commercial and retail hub of the area.

### Mapping Different Records

Further analysis of the two streets was undertaken on a map layer extracted of the two streets (Figure 23). The streets were selected manually using the selection tool and saved as a separate map layer.

The distribution of owners by name was queried through the dataset and mapped was against it (Figure 24). The resultant map was able to be correlated against other sources such as postal directories.

Postal directories are a valuable source for historical research, but in the early 19th century there was an absence of geographical information associated with the listings because the settlement was small and the whereabouts of individual houses known. As a result, the early postal directories merely listed those residents in Perth en bloc without any distinguishing features, whereas the later directories indicated location within each block, defined loosely by cross streets but without numbers. Thus, in a street in which there were several vacant town lots, there was no way of knowing which town lots were occupied by people nor, indeed, if they occupied more than one. As a result, the best that could have
Figure 24
The Spatial Distribution of Ownership

Note: The spatial distribution of ownership mapped against the selected streets. The capacity to collocate different historical records in geographical information system assisted in correlating the land ownership records and the postal directories and in providing a spatial identity to records that were imprecise in their spatial description.
been achieved if relying only on these sources would have been geo-coding the names to the center of the street block or averaging the number of listed residents against the known town lots. The result was unlikely to be historically accurate. However, by querying the ownership records from the land transfers and mapping these against the colonial cadastre within GIS, a spatial relationship was created that allowed names held in other sources, including the postal directories, to be cross-referenced accurately. Subsequent interests in the land were able to be mapped, including tenancies because there existed a common geo-spatial identifier. Although not yet fully developed, this has created a valuable resource for further investigation of the town’s residential patterns with implications for historical, genealogical, and heritage research.

“Geo-Clip”

As GIS allows sources to be bound together by their one immutable common denominator—that of their geo-spatial specificity, it creates—a effectively giant electronic paperclip whereby diverse sources can be collocated and used for integrated research. Although this is a crude analogy, this capacity to collocate information from diverse sources—which I term a “geo-clip”—overcomes a key problem when dealing with multitudinous sources over time, which may be obscure in their spatial identity. This is a key benefit for historical research because, whereas previously the corporeal nature of source materials limited what a researcher could physically access, digitization of records with the increased use of computing and the ease of transfer of information, has dramatically altered the availability of source materials. The capacity to link together sources from different periods through a “geo-clip” means that diverse sources can be collocated, pending further information. An example of this was land later used for the Perth Tannery. On August 20, 1830, a few months after the establishment of the colony, it was noted in the Lands and Surveys book that a tanner had selected land “near the east end of the nearest lake to Mount Eliza” (Department of Lands and Surveys, 1830b); however, the particular lot was not cited. Nine years later, on June 3, 1839 (Department of the Surveyor General, 1839), the Surveyor-General’s survey book showed a rectangular lot “No. 27” allocated on a swamp, but the town plan had not been extended so far west.

To assess where the tannery had been situated, the coordinates cited in the Survey Book were mapped on a separate layer and overlaid with the layer containing the vector outlines of the 1833 swamp system so that the relationship to the swamp system was clarified (Figure 25). When the layer containing the 1845 cadastre was imported and the information viewed, this position of the tannery was discovered to be across suburban lots 26 and 27 in the 1845 town plan. Its relationship to the 1833 swamp system was clearly delineated; water being an essential requirement for tanning.

Subsequently, documentary evidence from 1877 for three town lots further south described a “water course” used for the “flow of surface and tan water” to a drain in a nearby street. Even though there was, by 1877, a drain depicted on the town, there is no representation of any “water course,” the 1833 swamp system, in GIS, showed it to be in close proximity (Department of Lands and Surveys, 1877; see also Figure 26).

The use of GIS thus enabled the earlier records to be placed within a geographic context and, by doing so, collocated disparate documentary evidence in one place, allowing new
Figure 25
1833 Swamps and Suburban Lot 27

Note: Although suburban lots 26 and 27 were not formally documented until 1845, the relationship of the tannery to the water on which it relied is clearly illustrated.

relationships to be drawn, revealing a geographic connection between primary sources. This connection, in turn, enabled the documentary evidence to be read differently, contextualizing the water course as part of the earlier swamp system and confirming that, despite a lack of transparency in the official records, the swamps were still exerting their influence in the area.

Conclusion

This article has traced the development of the town of Perth over the swamps to its north and used GIS to map findings from the land ownership records against a reconstructed colonial cadastral. In doing so, it was discovered that the development of the town evolved in response to the swamp system, a geographical impetus that had hitherto not been explored. The swamps, far from being maligned, were valued for their swamp soils and convenience. Requests by the colonists were made to the colonial administration specifically for swampland, despite the prevailing wisdom that such places were miasmatic, the distress of flooding, and inconvenience of mosquitoes. The desire for the swamps was such that, even when higher, drier, and potentially more attractive land, from a town-planning perspective, was released, purchasers consistently preferred the swampland.
As the town grid reached northward—initially around and, later, over the swamps—the town responded to their presence in subtle ways. Streets were modified, town lots recast, and the growth in the area determined by their presence in the landscape. The topography of the swamps influenced the form of the northern suburbs of the town, realigning major roads as far north, and creating anomalies in the town grid.

By 1855, the town plan showed sites of the former swamps not covered by town lots but as empty spaces. Had one not been aware of the swamps of Perth, the subsequent town plans would not have betrayed their existence overtly. With the representations of the swamps on the town plans diminishing and no official documentation of the swamps after 1855, GIS was able to visually reconstruct the aquatic landscape, revealing first the diminution of the swamps in the first years of the colony and their former position and their gradual demise.

Use of GIS to map historical information in a geographic context provided a means to spatial conceptualize documents not usually thought of as spatially resources by historians. Explicit information about land holdings, in conjunction with other resources integrated into GIS, provided implicit information by exposing spatial relationships between the former colonial landscape and landholders and the relationship of the swamps to the land.

Figure 26
1838 Swamps and Suburban Lot 27

Note: Suburban Lots 26 and 27 from the 1845 town plan overlaid with the 1838 swamp formation in GIS to reflect the state of the swamp system when the lots were documented in 1839. Subsequently, the relationship of 1877 town lots (subject to the use of water and drainage of surface and tan water from the tannery) were also able to be assessed in relationship to the former swamp system.

holdings. Thus, GIS provided different ways of reading the landscape. In doing so, it enabled the mapping of information about the growth and development of the north part of central Perth and exposed the causes of historical change in the city. It allowed an instant and visual connection to be made between the town plans, land ownership records, and the form of defunct swampland.

The ability to examine historical resources of different periods, scale, and size within GIS freed them from the constraints of the physical characteristics of the source materials. Traditional sources (town plans and land ownership records) were used in untraditional ways and new readings undertaken of existing sources because GIS facilitated permutations of data to be easily explored. The methodology has facilitated the creation of maps to render historical records visible and provided a means to better understand the impact of topography on the development of urban form in Perth.

Human activity, particularly in urban settings, inexorably changes the landscape. GIS has, in part, allowed this study to uncover those changes and rediscover an historical landscape and the connection of the development of a small part Perth to its geography.

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