Asset Management
Data Collection

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In addition to his surveying qualifications, Mike has a Master of Planning Degree and Management Development Program Certificate. He is a member of the Institution of Surveyors, serving on the Public Relations subcommittee, and has served as publications officer on the APAS executive committee.

Introduction

In accordance with the Australian Accounting Standard 27 (AAS27) Baulkham Hills Shire Council is, as a local government authority, required to disclose its assets in financial reports. This has resulted in Council actively collecting information about its assets. This has included the determination of location of these assets. I was required to investigate an appropriate method for achieving this location determination, acquiring the equipment, ensuring the effective operation of the equipment, and training those requiring to use it.

Simultaneous with the asset location has been the development of Council's GIS system. My involvement in this project has unfortunately been limited. I was belatedly invited onto a working party identifying Council needs and priorities with respect to the GIS. The satisfactory operation of the GIS will be integral to the management of Council assets, and I hope to become more involved with the development of the GIS.

I consider myself a novice both with GPS and GIS. This paper describes Council's experiences in acquiring information for its asset management program. I hope that it may encourage a sharing of similar experiences and knowledge. The paper has been prepared in conjunction with a paper prepared by Richard Webb, who has concentrated on management and administrative issues associated with asset management.

Assets

Assets have been defined as "service potential or future economic benefits controlled by the entity as a result of past transactions or other past events". Councils are required in terms of AAS 27 (Australian Accounting Standard) to report in financial statements assets, "including those which yield their service potential or economic benefit over long periods of time... provided they meet the following criteria:

(a) it is probable that the service potential or future economic benefits embodied in the asset will eventuate; and

(b) it possesses a cost or other value that can be measured reliably." (Waterhouse 1993)

Local Government assets have been classified into **operating** assets, which include land and building for administrative purposes, motor vehicles and equipment, and **community** assets which are further divided into infrastructure and heritage assets. Infrastructure assets include roads, bridges and drainage structures, while heritage assets include monuments, museums and their contents, and historic and cultural buildings or structures. (Waterhouse 1993).

The collection of information for asset management purposes became an urgent project with deadlines set for the recording of assets by the Asset Accounting Manual, which included:

*	Land and building	June 1995
*	Transportation and communication assets	June 1996
*	Drainage	June 1997

(Baulkham Hills Shire Council 1994).

The Stormwater and Parks and Reserves Managers were keen to investigate methods of quickly and effectively collecting the required information and I was required to investigate data collection methods.

Investigation

The investigation was almost exclusively of GPS systems. I was not aware of the Laser-Walkabout at the time (Con Terra Systems 1994), and photogrammetry was not considered to be suitable for both cost reasons and the need to provide attribute descriptions associated with an appropriately accurate location.

Specifications of the GPS system required were:

* Sub-metre accuracy (easting and northing).
* Ability to effectively log attribute descriptions.
* Compatibility with Council's Geodis GIS system.
* Software and hardware support
* Co-ordinates provided on ISG

The acquisition of a GPS system would largely depend on whether the specific asset management requirements could be met within a very restricted budget. Consequently my dreams of using the asset management importance to enable me to acquire a system providing survey accuracies had no chance of materialising! Much examining was done of budgets of the departments who had expressed the need to acquire the GPS, and discussions were had with other departments (Forward Planning and Bush Fire Services) who it was considered may have a future need for the equipment. Ultimately the funds were found entirely from the Engineering department, which has avoided arguements about responsibility for the equipment.

Sokkia and Trimble offered systems satisfying Council's requirements for around twenty thousand dollars and were invited to demonstrate their respective systems. In my view the systems were similar and as the Sokkia system was slightly cheaper, and furthermore Council had used Sokkia surveying equipment for some years, I recommended the acquisition of the Spectrum and the system was purchased early in 1995.

While Council assets include buildings and roads, as well as the stormwater and parks assets, it has only been the stormwater and parks managers who have made use of the GPS equipment. Location of buildings have generally been adequately determined relative to the property boundaries from building plans, previous surveys etc. and no requests have been made for the use of GPS to locate these assets. Similarly as Council roads are supposedly located within road boundaries their general location has not required accurate determination with the GPS. Measuring wheels were used to determine lengths of road, and this means of measurement was considered adequate. If the GPS had been operating effectively before the roads data collection commenced, it may have been used, especially if the rover could have been mounted on a vehicle as has been achieved by other organisations. However as the person responsible for data collection for roads was on a fixed time contract, he needed to get on with the task with equipment available. He would probably also not have wished to compete with other managers for use of the equipment. It is recognised however that if an organised vehicle mounted system had been available, it would probably have been a more efficient means of data collection and updates of road information may be done in this way. (Rizos 1995).

Getting Started

Now that Council had the necessary equipment there was much expectation that this 'magical' equipment would quickly solve Council's need to quickly locate its assets. Initial tasks required were the establishment of a base station, setting up the computing facilities for collection of base station data and post processing of rover data, designing and installing attribute libraries and training users of the equipment.

* Base Station

A base station was required which had little or no obstruction to satellite signals. This meant minimal obstructions 'above' a circle defined by a horizon ten degrees above the base station antenna. The location of the base station needed to be secure so that there was no need for personal attendance at the base station during operations. Furthermore the location of the base station needed to be situated such that cabling could be achieved from the station to the computer to be used for base station data collection.

During trial of the equipment we had operated a second rover station as a base station. This had been placed on a tripod in a convenient position. When we purchased the system we went for the fixed base station system, which required finding a suitable location which could be adequately surveyed and fixed without the need for a tripod. Fortunately a brick wall was found on the Council Chambers roof into which a 'bolt' with the required thread was glued (like an SSM). Established State Survey Marks exist in the roads surrounding the building so co-ordinating and heighting the mark presented no difficulty.

* **Computer connection**

A decision had to be made where base station data was to be collected within the building and thus who was going to be given the responsibility for processing of data. It was decided that a GIS officer who had shown interest in the data collection trials and had data input access to the GIS system was the most appropriate person. Cabling was thus carried out within the ceiling to his work station. We were advised to attempt to minimise the cabling distance as data quality could be affected with excessive cabling. This was another factor to consider in locating the base station antenna. Organisation restructures involving the moving of work stations is thus not recommended !

* **Attribute libraries**

To operate effectively and efficiently as an asset management tool it was essential for attribute libraries to be designed as quickly as possible, and before the data collection began. This required some explanation as it appeared that some managers expected the equipment to immediately be available to do the task required without any effort from them! Discussions were held between the relevant managers and GIS officers to ensure that appropriate coding and layers were established and ultimately the stormwater and parks attribute libraries were drawn up. A part of the stormwater library is illustrated in Annexure A.

* **Training**

Council has a very small survey section with only four personnel and consequently it was not possible for the section to take on the responsibility of data collection. It was thus necessary to train the likely users of the equipment. These staff members had no survey knowledge and initially little appreciation of the need to treat the equipment with care. They were also unaccustomed to calculator-like keyboards resulting in wrong keys being pressed. A staff member from each of the stormwater and parks departments was trained as well as one of the survey chainmen. The chainman, who was familiar with the Sokia SDR data collector used with the total station, quickly became the field 'expert' with the rover, and took on the role of training and assisting the other two. As the GIS officer who was to do the post processing had been actively involved in trial demonstrations, he had become familiar with the software and was able to resolve problems directly with the supplier.

Teething Problems

Council unfortunately experienced rather extensive teething problems which resulted in expected time frames having to be extended. These problems can be categorised as follows:

* data accuracy
* equipment failure
* computing problems
* GIS changes

* **Data accuracy**

Field checks were done on numerous established survey marks. Results were initially disappointing with an unsatisfactory proportion of observations (<50%) achieving the advertised sub-metre accuracy. Readings were also inconsistent with widely diverging results obtained on the same points and poor results being obtained in some ideal situations. While it is acknowledged that some of the points were not located in ideal spots for optimum GPS results, we felt that as the assets to be located were likely to be in similar situations, we considered it necessary to achieve the required accuracy in most instances. Obviously in totally unsuitable locations one could not expect to obtain satisfactory accuracy. While there has been significant improvement, recent accuracy tests still illustrate variable accuracies inconsistent with advertised standards, and furthermore there is no positive way of determining at the time of measurement, the level of accuracy likely to be achieved. To achieve the required sub-metre accuracy it is furthermore advisable to only obnserve when the PDOP value is less than four, and six satellites are tracked. Sub-metre accuracy is unlikely to be achieved in worse situations.

An illustration of the accuracies achieved early after acquisition is given in Annexure B.

* **Equipment breakdown**

Simultaneous with the data inaccuracies experienced, we had frequent occurrences of the equipment failing to operate satisfactorily usually by not receiving a signal for any logical reason. "Hot" and "cold boots" and "resets" were attempted frequently, but with little success.

Much trauma was then experienced in trying to locate the cause of the problems of both the inaccuracies and breakdowns with much testing of patience between Council and the suppliers. Various parts of the hardware were replaced at different times, software upgrades were rushed from the USA, and users were retrained including an emphasis on care of cables and the correct procedures. We eventually decided that data accuracy and equipment failure was partially due to user inexperience and lack of care. However it appears that most of the problems were as a result of purchasing a "lemon". After much heartache for both Council and the suppliers, the suppliers agreed to replace the equipment and since this replacement the data collection has taken place satisfactorally, with negligible equipment difficulties.

* **Computing problems**

Computing problems resulted largely due to the Councils computer network and attempting to hold too much software on the computer being used for base station data collection and post processing. We had hoped to be able to simply add the GPS software to our sytems and operate within the existing setup. Difficulties included network breakdowns while data was being logged resulting in field data collection being wasted. Post processing difficulties also occurred, probably due to overloading as they appeared to be resolved when files were transferred to floppy disks and then processed on a computer not linked to the network.

Initially base station data was down loaded onto a PC used by a clerk/draughtswoman who needed to use word processing and regular access to Council's property data register and other data registers on the network. It was hoped that the data could be collected in the "background" simultaneous with other uses. This was achieved, but it not only proved inconvenient for the draughtswoman concerned, but it was suspected that some problems with data processing were also caused when "background" collection ocurred. Eventually another PC was found which could be used more exclusively for GPS uses, and results improved and staff tensions were reduced.

As the ultimate location for the processed data was to be Council's GIS system it was considered desirable to use a computer linked to the network. Ideally a suitable PC (486 or better) should have been provided specifically for the asset management data capture, processing and transfer to the GIS. However this had not been budgeted for and was not provided, hence causing delays, stress and resurveys of some sites.

* **GIS changes**

Council currently operates a Geodis mapping system. It had been intended to develop this mapping system into an effective GIS system. When we purchased our GPS system data could only be transferred into the mapping system using DXF files. However attribute information could not be satisfactorally transferred to or accessed from the Geodis system. The GPS suppliers had given an undertaking to provide software for the effective transfer of data into the Geodis system, however a relatively new development has been the dropping of support for the system by the Australian suppliers. Consequently therefore Council is now investigating the acquisition of an alternative and more effective GIS system, which will hopefully also better accommodate the GPS data. Currently therefore GPS data is been stored until it can be satisfactorily input into a GPS system.

It will be apparent that Council's data collection, asset management and GIS systems have been somewhat unco-ordinated. This has been as a result probably due to Council's inexperience in the field, and budget and management problems as a result of the provision of these systems not initially been seen as a corporate organisational requirement, but rather as needs to be provided within individual departments' budgets and structures. This has belatedly been rectified, but rather late than never and hopefully systems will soon operate effectively together.

Associativity

Council required a data collection accuracy of sub metre, and it is anticipated that the location of the assets will be reflected in the GIS. Council's cadastral data base is the digitised data base purchased from the LIC in Bathurst. Comparisons of co-ordinates of marks surveyed on ISG have found inaccuracies in the digitised co-ordinates exceeding five metres. Council thus has the associativity problem discussed by Hepplethwaite and Wan and Williamson. (Hepplethwaite 1989, Wan and Williamson 1994). Thus locations of features located by GPS may be incorrectly portrayed in the GIS in relation to the cadastral boundaries, and could in extreme cases be shown to be in the incorrect property.

I am not sure how Council will resolve this problem if and when it arises. Locating occupations may help, especially in rural areas although this will add to the time taken to collect the data. If survey staff were used in the data collection selected survey marks could be located, and boundaries then calculated to replace the existing incorrect boundaries of the GIS. Alternatively, if during a GIS enquiry, some doubt is raised about the relative locations of the feature with respect to the boundary, surveyors could be requested to determine a more accurate boundary location, either by survey or by using survey data from plans from the closest survey done on ISG. Regardless of what method is eventually adopted, this anticipated problem will add to the time taken and cost of the project.

In terms of asset management, the relative location of assets to property boundaries may be more appropriate than absolute accuracies. If fences or occupations reasonably reflect property boundaries, it may prove more efficent and less problematic in the long run to rather determine locations relative to these fences by annotation rather than obtaining absolute locations with GPS or other methods. While fences in residential or built up areas probably reflect the locations of the boundaries, this is not always so in a rural environment and consequently annotation may prove difficult, time consuming and risky.

An illustration of problems resulting from inaccuracies of GPS datalocation and GIS cadastral data base is shown in Annexure C. GPS locations of drainage structures with respect to the cadastral data base shown in Annexure C1 is compared to the location of easements in Annexure C2.

Other methods of data collection

Various other methods have been investigated and used for data collection (not necessarily by Baulkham Hills Shire Council). These include:

* **The "Laser-Walkabout System"** (Con Terra Systems 1994).

I only became aware of this system after Council had acquired its GPS. Due to the higher cost of the laser system I am sure that Council would still have purchased the GPS. The laser system involves locating detail by means of distances measured with a laser "gun". A data logger is attached in which attributes are entered. The system requires having a known point on the site. An apparent weakness of the system is the method of angle measurement which appears to be similar to using a compass. Advantages of the system are the speed at which data can be logged, the non-reliance on satellite availability and the ability to log data in covered areas such as thickly vegetated areas or areas under roofs or in the "shadow" of buildings. The cost late last year was about $30 000.

* **Photogrammetry**

This method used by Sutherland Shire Council requires a significant capital outlay and also will probably require additional staff. Advantages are the availability of an actual image of the locality of the asset. Difficulties will obviously arise in heavily vegetated areas and in the shadow side of buildings. Attribute collection would probably still require an on-site inspection. Consistently high accuracies can be achieved for visible features.

* **Work As Executed Plans**

The position of features, as well as some associated attributes can be taken off work-as-executed plans in areas where these plans are available. Positions can be related directly to GIS co-ordinates of property boundaries thus avoiding associativity problems. It can be a fairly time consuming process, being quicker to simply relocate the position using GPS. A major problem is the availability of these plans and the quality of both the available copies and the data provided on them. Features described on older plans have in some instances been upgraded or replaced in later subdivisions. Thus some field annotation would be recommended.

* **Conventional surveys**

Assets can obviously be located relatively very accurately using conventional methods. Where the survey incorporates a boundary determination, either the "true" ISG can be used, or selected GIS co-ordinates can be used as a basis of the survey to reduce the associativity problem. Conventional surveys are relatively time consuming and require trained survey personnel to be achieved. As Councils generally have limited survey personnel, this method is difficult to fit in with other survey projects. Earlier detail surveys of roads and parks can nevertheless be used for asset feature locations. While annotation would normally be required both to confirm that changes have not been made and to note the required attributes, the use of "old" surveys could reduce data collection time and provide data of enhanced locational accuracy.

* **Annotation**

Probably the most common form of location determination of assets in Councils investigated has been the annotation of data from field trips. This could range from the manual taking of field notes and then re-entering this at a later stage into the appropriate records or information system, to the computerised annotation via a "pentop" type data collection. I have not seen this method, but believe that an image of the property boundaries in the area in which assets are being located is downloaded from the GIS into a laptop type PC. This image is then regenerated in the field and the asset located with respect to the occupations on the boundary is then "located" on the image in the laptop together with associated attributes. On completion of the field survey, the data is then simply input directly into the GIS.

* **Measuring Wheel or Odometer**

Measuring wheels or specially calibrated odometers have also been used, especially in pavement management operations in roads. Data is collected relative to a chainage similar to a chain survey project.

* **Audio visual equipment**

Audio visual (video) equipment has also been used in the data collection of assets. It is used in conjunction with a method of determining position such as vehicle mounted GPS or location by chainage from an odometer, and is used more in attribute rather than position definition. No councils which I have approached have used this method, but other organisations such as the RTA and Freight Rail have made use of video recording associated with position locations. (Greening 1995, Latella 1995).

* **"No location"**

One Council approached adopted a policy of specifically not determining locations of assets, as they believed that as changes ocurred so regularly it would not be possible to maintain an up to date record. Thus only the presence of assets and their attributes were recorded. I believe that as locations can be determined simultaneous with the attribute recording it is senceless not to collect this information. A record which may be out of date is better than no record at all.

Other Councils

In Council's investigation of both suitable asset management data collection methods and GIS systems, the methods used by other Council's were determined. In addition in preparing this paper I have phoned local councils to discuss their methods and associated problems. While often a combination of methods have ben used I have listed the primary method used in Annexure D. It is interesting, and of some concern, to note how small a role surveyors are playing generally in the collection of data for asset management and GIS data. One should also be aware in comparing methodologies used that circumstances differ with respect to the Councils. For example, some Councils are fully developed with no rural lands, while other fringe Councils, such as Baulkham Hills, are still developing rapidly and have significant rural land.

Conclusion: If we were to start again we would...

In suggesting ways of improving how we could have achieved our asset management data collection, I have assumed that budgetary and staff constraints could not have been improved.

1. Co-ordinate data collection of all asset management managers, together with GIS cadastral base. Assign project management and responsibility to surveyor.

2. Prior to any data collection, determine what data has already been collected and its suitability for asset management purposes. Determine what information is available from earlier field surveys, work-as-executed plans or other sources. Estimate the time required to convert this data to ISG or GIS "co-ordinate system."

3. Thoroughly investigate all methods of data collection and associated costs. A fairly thorough investigation was undertaken; however with the benefit of hindsight and new products on the market, I believe this could be improved on by providing an in depth cost-benefit analysis of aspects such as the use of the "Laser-gun", use of a contractor to supply data by photogrammetric means, employment of additional staff for data collection from work-as-executed and other existing Council information.

4. Investigate how to resolve associativity issues and possible related costs. Should data captured be transformed to co-ordinates of GIS system, or should cadastral data base be upgraded to correctly illustrate boundary/asset relationships? Should relative accuracies be sought instaed of absolute accuracies with respect to the assets to be located? These issues should preferably be addressed before data is collected, so that where necessary boundary identification marks can be located simultaneously with asset data collection.

5. Set up an Inter-Council asset data collection forum where ideas and experiences can be exchanged to improve quality and reduce likelihood of problems being repeated.

6. Ensure that support equipment (and personnel) is available to allow for optimum utilisation of the data collection method selected. Management needs to realise that, for example, GPS systems will not operate well without adequate computer hardware and network arrangement. Thus necessary support items need to be included in butgetary considerations and provided when data collection equipment is acquired.

7. Ensure that the data collection system works adequately before purchase. Ensure also that the equipment and supplier meet their advertised criteria. I suggest that installation of the system be fully supervised by the supplier, who also then undertakes or supervises a full data collection survey which includes collection of data of survey control marks to confirm accuracy of equipment. The survey should then be fully processed on the system installed by the supplier at Council.

Baulkham Hills Shire Council is now well advanced with its asset data collection. Significant teething problems have been experienced, partly due to inexperience and ignorence, but bad luck also played a major role as it appears that the GPS initially acquired was an absolute "dud" system. Besides completing the data collection, other challenges which are stll ahead of us include the acquisition of a new and suitable GIS system, and resolving the associativity problems with the relationship between the cadastral data base and data collected.

References:

Baulkham Hills Shire Council 1994. *Assets - Infrastructure Strategy/Policy* Castle Hill.

Collis, Stewart 1994. *Bridging the GPS/GIS gap. Canterbury case study.* (Draft 16/11/94). Sydney.

Con Terra Systems 1994. *Laser-Walkabout* (Promotional pamphlet received from Laserquip Pty. Ltd. Sydney).

Department of Local Government and Co-operatives. 1993. *Asset Accounting Manual.* Sydney.

Greening, Steve 1995. *The Gipsi-Trac Project.* In Conference Papers of the 1st Association of Public Authority Surveyors NSW Annual Conference. Port Macquarie.

Hebblethwaite D. H. 1989. Concepts for Coping with a Shifting Cadastral Mode, in *The Australian Surveyor* March 1989, Vol. 34 No. 5. Sydney.

Latella, John 1995. *Rail Mapping Project.* In Conference Papers of the 1st Association of Public Authority Surveyors NSW Annual Conference. Port Macquarie.

Sokkia Technology, Inc. 1994. *SpectrumPC User's Guide.*

Wan, Wai Yee and Williamson I. P. 1994. Solutions to maintaining Associativity in LIS with particular reference to the needs of the utility industry, in *The Australian Surveyor* December 1994, Vol. 39 No. 4. Canberra.

Wan W. Y. and Williamson I. P. 1994. Problems in maintaining Associativity in LIS, in *The Australian Surveyor* September 1994, Vol. 39 No. 3. Canberra.

Waterhouse, Bill 1993. *Asset Accounting under AAS 27 and Implications for Baulkham Hills Council.* Baulkham Hills Shire Council. Castle Hill.

Annexure A

GEOGRAPHIC POSITIONING SYSTEM
STORMWATER ASSET LIBRARY

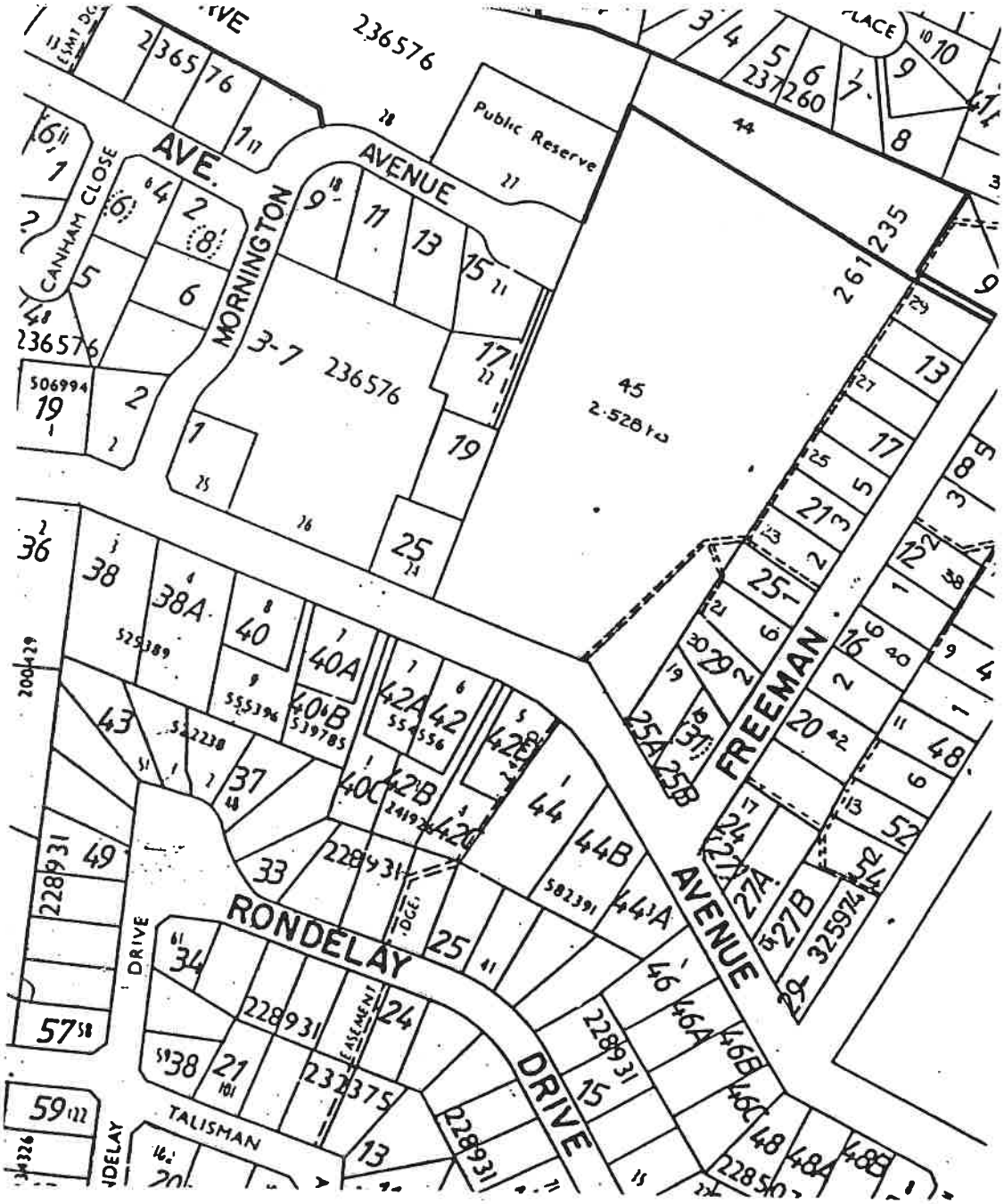
CODE	ATTRIBUTE	TYPE	DEFAULT
PIT	TYPE	Kerb Inlet Pit Sag Pit Surface Inlet Pit Headwall Inspection Pit Junction Pit None Converter Other Out direction	Kerb Inlet Pit
	PIT MATERIAL	Concrete Sand Bags None Other	Concrete
	GRATE	Gutter-Steel Gutter-Cast Iron 900 Flush-Single 900 Flush-Multi 900 Legs-Single 900 Legs-Multi Flush-Single Flush-Multi Legs-Single Legs-Multi None Trench-Cast Iron Trench-Steel Other	Gutter-Cast Iron
	COVER	None Concrete Slab Cast Iron Infill Circular-Conc Circular-C Iron	None

Annexure B: Illustration of early accuracies achieved - July 1995

S.M	Q	GPS EAST	GPS NORTH	SM EAST	SM NORTH	DIF EAST	DIF NORTH	TRUE DISTANCE
62672	1.5	298795.502	1266571.216	298794.393	1266569.952	1.109	1.264	1.682
	1.5	298794.139	1266571.231			-0.25	1.279	1.285
	1.5	298792.391	1266569.572			-2	-0.38	2.038
62665	1.3	298843.982	1266411.39	298846.138	1266411.989	-2.16	-0.6	2.238
	1.4	298844.828	1266411.487			-1.31	-0.5	1.402
	1.4	298844.383	1266413.138			-1.76	1.149	2.098
62194	<1.0	299054.284	1266480.891	299054.522	1266481.329	-0.24	-0.44	0.501
	1.4	299056.914	1266482.942			2.392	1.613	2.885
	1.3	299057.881	1266479.595			3.359	-1.73	3.774
52860	1.6	299219.383	1266488.685	299216.76	1266488.498	2.623	0.187	2.63
	1.3	299218.618	1266488.922			1.858	0.424	1.906
	1.3	299221.757	1266490.79			4.997	2.292	5.498
62192	1.5	299317.876	1266422.847	299318.452	1266420.278	-0.58	2.569	2.633
	2	299317.752	1266422.817			-0.7	2.539	2.634
	1.8	299317.226	1266419.921			-1.23	-0.36	1.259
62191	<1.0	299446.327	1266314.197	299447.354	1266315.705	-1.03	-1.51	1.826
	2.4	299446.064	1266316.036			-1.29	0.331	1.332
62190	2.1	299343.023	1266178	299343.973	1266175.37	299343	2.632	2.798
	<1.0	299344.916	1266174.894			0.95	-0.47	1.06
	1.3	299343.471	1266175.697			299343	0.329	0.6
62668	1.4	299277.052	1266205.791	299275.737	1266206.562	1.315	-0.8	1.524
	1.3	299277.479	1266204.941			1.742	-1.62	2.379
	1.3	299279.4	1266204.989			3.663	-1.57	3.985
62667	<1.0	299047.995	1266362.083	299045.924	1266363.001	2.071	-0.92	2.266
	1.5	299044.912	1266361.097			-1.01	-1.9	2.153
	1.4	299045.482	1266363.03			-0.44	0.029	0.443
62666	2.6	298896.603	1266324.522	298892.213	1266323.67	4.39	0.852	4.472
	<1.0	298893.026	1266322.571			0.813	-1.1	1.368
	1.4	298893.625	1266326.864			1.412	3.194	3.492

Annexure C: Illustration of associativity problems
Annexure C1: GPS location of drainage structures in GIS

Annexure C2: Cadastral sheet showing location of easements:



Annexure D - Other Councils.

Baulkham Hills	Mainly GPS (Sokia) and measuring wheel.
Canterbury	Part GPS (Trimble) (see Collis 1994).
Fairfield	Measuring wheel and annotation for roads, "no location" for others.
Hawkesbury	Vehicle mounted measuring device and annotation
Hornsby	GPS (Leica) and others.
Kyogle	GPS (Sokia) and others
Parramatta	Largely annotation with respect to street address.
Penrith	GPS, measuring wheel, and annotation.
Ryde	Master plan annotation with Sydney Water GPS inclusions.
Sutherland	Photogrammetry and others.
Wollongong	Annotation ("pentop").