WATER EFFICIENCY FROM A LOCAL GOVERNMENT AND CUSTOMER PERSPECTIVE

Paul Lamble [1]

1. Lake Macquarie City Council, Speers Point, NSW, Australia

ABSTRACT

Lake Macquarie City Council services approximately 200,000 people, covering the southern half of the Newcastle metropolitan area. The Lake Macquarie community expects that Council will maintain or improve levels of service while improving its environmental and economic efficiency.

Over the past 5 years, Council has implemented a range of water efficiency projects across a diverse range of sites; including holiday parks, swim centres and sports fields. Each of these facility types has unique challenges including complex water demand patterns, long-lived infrastructure, and high customer/community service expectations.

This paper reviews Council's internal water efficiency projects and distils the crucial drivers and lessons learnt to present water efficiency from the perspective of a customer who provides services to the community.

INTRODUCTION

Lake Macquarie City is situated in the Lower Hunter Region of New South Wales, approximately 150 kilometres north of Sydney. The City has a population of approximately 200,000 people, covering the southern half of the Newcastle metropolitan area.

Over the last 30 years, the Lower Hunter Region has been fortunate to receive sufficient rainfall to keep water storages relatively full. This has meant that the Lower Hunter community has not had to deal with severe water shortages that arose in many parts of Australia during the Millennium Drought. The region has not experienced significant water restrictions since the early 1980's.

As most of Lake Macquarie City is situated in Hunter Water's area of operations, Council does not have a statutory water supply role, nor obligation to promote water efficiency projects across the City. However, through its own sustainability commitments, Council does have a strong interest in improving water use efficiency, both internally and externally. For its own operations it has set a target of 10% reduction in mains water use by 2018, which will have the added benefit of reducing Council's water utility costs, whilst showing practical leadership to the community. Through a partnership with Hunter Water, Council is also working to reduce mains water use across the City.

This paper reviews Council's internal water efficiency projects and distils the crucial drivers and lessons learnt to present water efficiency from the perspective of a customer who provides services to the community.

PROCESS

As part of its integrated strategic planning framework, Lake Macquarie City Council has 10 year, 4 year and 1 year plans that document strategic priorities for delivering community services. These priorities reflect a quadruple bottom line approach to environmental, economic and social development as well as civic leadership.

Council's Environmental Sustainability Action Plan 2011-2018 (ESAP) is the prime mechanism by which environmental actions are prioritised and coordinated. Under the ESAP, Council has a target to reduce mains water use in its own operations by 10% from 2007-08 levels (~400 ML) by 2017-18.

With strong competition for funds across the organisation, a business case built upon simple alignment with one strategic priority was unlikely to be sufficient. Furthermore, the Lake Macquarie community expects Council to maintain or improve community services. Therefore, water efficiency projects needed to demonstrate a wider value to Council and its ability to deliver services to the Lake Macquarie community.

In building the portfolio of water efficiency projects and individual business cases, a number of approaches and techniques were used including:

- Baseline data analysis to identify priority areas for action over the short and long term;
- Technical analysis to demonstrate that the project will deliver outcomes that are significant and improve or maintain levels of service;
- Financial analysis to demonstrate value for money;

- Close consultation and liaison with colleagues from across Council to ensure water efficiency projects align with wider strategic priorities, plans and possible funding sources (i.e. "left hand knows what right hand is doing"); and
- Implementing a diversity of projects, from small, short-term projects delivering "early wins", to long term strategic projects, that inform and influence large and long-lived capital investment decisions.

Baseline data analysis

Council had water meter and consumption information in a number of disparate spreadsheets maintained by different departments for their own purposes, including finance, asset management and operations. Furthermore, Council received water consumption data in both electronic (bulk uploads) and paper formats. The existing information from various sources was compiled into a single water account and meter database. The data was verified through site inspections and discussions with long serving staff. This process was invaluable in identifying numerous master/sub meter relationships and understanding the configuration of water supply systems.

With a single listing of water accounts and meters, Council was then in a position to approach Hunter Water to obtain comprehensive meter readings in electronic format. This data could then be analysed to provide useful information on Council's mains water use. This process identified that Council has approximately 400 metered properties, with a further 250 properties not having a water service at this stage.

As shown in Figure 1, Council's water use primarily occurs in playing fields (28%), swimming pools (19%) and holiday parks (16%). The remaining 37% of Council's water use occurs across numerous different categories, with no single category accounting for more than 10% of Council's total mains water use.

Analysis of the water use information at an individual site level identified that nearly all of Council's top 10 water use sites were in the three main water use categories identified above.

Based on this analysis, Council's playing fields, swimming pools and holiday parks were identified for further investigation and action.

Development of Analysis and Decision Support Tools

With considerable pressure to implement projects and deliver outcomes, there was a risk that investment would be focussed on highly visible but potentially ineffective projects. A project could be ineffective if it fails to enhance service delivery outcomes, has relatively poor financial returns and/or relatively small environmental outcomes (e.g. mains water savings). To address these risks, physical models (e.g. rainwater tank models) and financial models were used to assess the potential outcomes of specific projects. This enabled a robust and transparent assessment of projects.

Furthermore, with playing fields (or sports fields) accounting for almost 30% of Council's water use and the baseline (2007-08) water year being relatively cool and wet, it was highly likely that measured water use would rise in subsequent years simply due to changes in climatic conditions, rather than any other factors.

With climate being a potentially significant driver of sports field water use, the challenge was to ascertain the degree to which water use changes on sports fields are driven by climate, versus other factors (e.g. management). To address this problem, a climate correction model was developed for Council's sports fields. The essential elements of the model are as follows:

1) Daily rainfall and evapotranspiration data from the Bureau of Meteorology;
2) Plant Available Water (PAW) based on root depth and available water for various soil types;
3) Irrigation system efficiency;
4) Irrigation scheduling (based on allowed soil moisture depletion);
5) Daily water balance modelling based on inflows from rainfall and irrigation and outflows from rainfall losses, evapotranspiration and run-off. Due to the complexities involved in modelling water movement through the soil profile, deep drainage losses past the root zone were not considered and assumed to be negligible.

Through the daily water balance modelling, the irrigation demand for a one hectare sports field can be calculated using actual climatic data.

OUTCOMES

Water Usage

After correcting for climatic conditions, Council's water use has fallen by ~ 18,450 kL or 5% between 2007-08 and 2012-13. Hence, Council is on track to achieve its 10% reduction target by 2017-18.

Table 1 details the changes in water consumption from 2007-08 to 2012-13 across the main water use categories.

Table 1 shows that significant savings have been achieved at swim centres as well as other sites, while a significant rise in water consumption has occurred across Council's sports fields. The increase in water usage on sports fields is a direct result of the redevelopment of two major facilities. The redevelopment included additional sporting fields as well as the installation of pop up sprinkler systems. This example highlights how improving the provision of services to the community can increase the difficulty of achieving resource efficiency targets.

Amenities Retrofits

Hunter Water offers a subsidised audit to its business customers through its Business Water Savers Program. The audit is undertaken by a qualified plumber and encompasses kitchen and amenities fixtures including showers, taps, toilets, urinals and spray rinse valves. Following the audit, the customer receives a report, complete with recommended actions and costs. Council began its involvement in 2009-10 with audits of high profile facilities, particularly its Customer Service Centre and Works Depot. Following the completion of baseline data analysis, amenities audits and retrofits were undertaken at Council's Holiday Parks in 2010-11 and Swim Centres in 2011-12.

From the report recommendations, selected actions were implemented across the audited facilities. In general, shower and tap retrofits were undertaken while no changes were made to toilets. The main considerations in these decisions were ease of implementation and cost effectiveness.

Retrofitting water efficient showerheads and tap aerators was easy to implement, had no significant operational impact and were very cost effective (payback less than two years). By contrast, replacing existing single flush toilets with dual flush toilets was relatively expensive. Cheaper options, such as using cistern weights to reduce water used in toilet flushing would have required a significant and ongoing awareness program and would have increased the risk of blockages with a resulting rise in customer complaints. As a result, toilet retrofits are not a priority. Instead, water efficient toilets are installed in Council's facilities as part of new replacement or significant renovation works.

Council's participation in the Business Water Savers Program is estimated to have saved around 12,000 kL pa.

Smart Metering

Smart metering is a widely implemented water efficiency measure. The combination of timely and detailed water use data and operational knowledge can deliver significant gains. Council's smart metering program began in 2010-11 with 10 sites that recorded high water usage. Over the following 3 years, the program has been expanded to encompass 21 high risk sites. These sites have risk factors that could result in significant water use that would not be easily rectified or detected. High risk sites can be characterised by long, old and/or complex water supply network, high water consumption and/or irregular demand patterns. Swim centres and holiday parks are good examples of high risk sites. The high risk sites with smart meters installed include:

- Swim centres (6 sites);
- Holiday parks (5 sites);
- Sports facilities (8 sites);
- The former RAAF air base at Rathmines; and
- Council's main works depot.

In addition to these fixed smart meters, Council has two mobile loggers that can be deployed as required. These mobile loggers have multiple pulse probes and so can be fitted to many of the commonly installed water meters. The advantage of the mobile loggers is that they can be used to monitor sites on a short term basis where further investigations are required. The mobile logger can be used to investigate a problem (e.g. a leak or other excessive usage) without the need for multiple manual meter reads. The logger can provide information on the presence and size of any leak. The mobile loggers can also be used for hydraulic investigations, such as measuring flow rates on irrigation systems at different sites.

Since its commencement in 2010-11, the smart metering program has resulted in annual savings equivalent to around 45,200 kL pa. The cost savings from the early detection and repair of these leaks has meant that the program has already paid for itself.

Most of the water savings from smart metering have arisen from the prompt detection of new leaks, rather than pre-existing leaks.

Cost Savings - Meter Downsizing

Councils are always under pressure from the community to keep costs down. To identify cost savings, a review of the size of Council's water meters was included in the water efficiency program. The water and sewer service charges imposed by Hunter Water are related to meter size, with a significant increases in costs for larger (>50 mm) meters. Hunter Water's sewer service charge is also dependent on the sewage discharge factor, which is an estimate proportion of the metered water consumption discharged into the sewer.

While not delivering physical water savings, this project has produced significant cost reductions. Over two years, 16 sites had meters downsized, producing cost savings of about $67,000 pa. With an overall payback period of two years, the program has already paid for itself.

Following on from the meter downsizing works, a review examined the sewage discharge factors (SDFs) associated with 16 water meters servicing public open spaces (including sports fields). This review resulted in cost savings of about $18,000 pa, with no capital outlay.

The use of smart meters has been invaluable in building the case for changes to the SDF. The 15 minute interval data provided by smart meters enabled the clear delineation of irrigation and non-irrigation water use. The use of at-least 12 months of smart meter data from four sports fields with pop up sprinkler systems and data loggers provided a sound case for Hunter Water to adjust the SDFs of a further 9 sites where pop up sprinkler systems were installed.

Swim Centres

Lake Macquarie City Council has six swim centres, four of which are Council operated, with the other two managed under lease arrangements. The water demand at swim centres arises from pool use (e.g. filter back washing and pool make up), amenities, and other site usage. Swim centres are a highly valued community service and politically sensitive area. Therefore, water efficiency measures and investigations had to be managed around service delivery and operational needs.

At Charlestown Pool, the 50m pool did not have a pool cover, and as a result, closed down over the winter period (due to low operating temperatures). The installation of a pool cover has not only reduced water and heat losses, but has meant that the pool can now remain open all year round, providing a valuable and greatly appreciated service to the Lake Macquarie Community.

Sydney Water Corporation's (2011a) Best Practice Guidelines for Water Management in Aquatic Leisure Centres identified that the pool water make-up (e.g. balance tank operation, filter backwashing) can account for up to 36% of the water use at a swim centre. Other major water uses within swim centres include leaks (22%) and amenities (35%). Showers account for the bulk of the amenities usage (approximately 20% of site usage with the balance coming from toilets, basins and urinals).

The Best Practice Guidelines indicated that by upgrading filtration systems, significant water and energy savings could be made. However, any significant change to an existing plant room (e.g. upgrading filtration systems) could also have multiple consequential impacts, such as sizing and operation of pumps and pipes, as well as triggering additional works to meet current regulatory requirements (e.g. separation of water bodies).

Most of Council's swim centres are over 40 years old. Discussions with Council's Asset Management and Leisure teams identified that swim centre plant rooms and the associated water treatment and distribution infrastructure required attention. Furthermore, each site had different water treatment, heating and distribution infrastructure, increasing maintenance costs and risks across the organisation. Therefore, from an Asset Management perspective, it was timely to consider what technologies and options were available for pool plant rooms as well as compliance with regulatory (public health) requirements.

In order to meet multiple needs across Council, a strategic pool technology review was commissioned. External consultants were engaged to examine the pools and plant rooms at each of Council's swim centres. The review's scope included filtration, heating and disinfection systems for each of Council's swim centres and encompassed operational and regulatory issues. The review provided sufficient information to enable a detailed comparison across different technologies, which encompassed both operational and financial matters.

The Pool Technology Review enabled the most appropriate water and energy efficient technologies to be selected for Council's swim centres. Based on the information contained in the review, a comparison of filtration systems was undertaken. This comparison showed that water efficient filtration systems met multiple Council objectives, including:

- water savings (approximately 11,800 kL pa);
- energy savings (approx. 110,000 kWh pa, which is equivalent to 75 kW of solar PV panels);
- asset management benefits through a 60% increase in asset life;
- operational benefits by freeing up valuable plant room space; and
- financial benefits with an internal rate of return of 13.3%.

The project to upgrade the plant rooms at Swim Centres has commenced this financial year, with funding obtained from Council's Asset Replacement Reserves. The multi-faceted business case for water and energy efficient technologies was crucial in obtaining additional funds to utilise the more water and energy efficient options.

Sports Fields

Lake Macquarie's sports fields are generally managed by Operating Committees under Delegated Authority. These committees are volunteers. For most sports fields (about 85%), the irrigation is undertaken by volunteers using travelling irrigators or manually moved sprinklers fed from a water charged fence. At the remaining 15% of fields, an automated pop up sprinkler system has been installed.

The data available from Council's smart meters has shown that irrigation accounts for about 90% of the water use at a sports field. One option to reduce mains water use on sports fields is to imposing restrictions and or targets on water use. However, with most fields being operated by volunteers this was unlikely to be effective or well received.

Furthermore, the economic, amenity and community service values of well maintained turf sports fields and open spaces has been well documented in recent research (Sydney Water Corporation (2011b), Weller and English (2008), Fam et al. (2008)), especially following the Millennium drought, where numerous fields could not be watered due to severe water restrictions.

Therefore, it is vital that water efficiency measures for sports fields also seek to maintain or improve turf conditions so that service delivery to the community continues. With these dual objectives in mind, Council engaged external Consultants to undertake irrigation efficiency and soil assessments at over 40 sports fields. Hunter Water also provided funding assistance for investigations at selected high use sites.

The soil and irrigation efficiency assessments provided a number of key insights into the drivers of irrigation water use at sports fields, including:

- Prevailing weather conditions;
- Required turf growth rates (which is influenced by desired playing surface standards and foot traffic levels);
- Soil conditions as well as physical and chemical properties (such as texture, depth and bulk density);
- Irrigation system performance (including design, installation and maintenance);
- Irrigation management (including scheduling).

The sports field assessment reports for each site provided detailed recommendations to improve turf conditions and water efficiency at each site. These encompass soil amendment to improve water holding capacity, as well as short term and long term improvements to existing irrigation systems.

Overall, the soil and irrigation assessments found that:

- most (80%) of the sports fields assessed are significantly under watered rather than over watered;
- many fields had very limited water holding capacity in the soils, primarily due to limited top soil depth, high levels of compaction, low levels of organic matter and water repellency (on sandier sites);
- nearly all irrigation systems had been poorly designed, installed and/or maintained, resulting in poor distribution uniformity and therefore inefficient water application.

The general under watering of sports fields represents a latent risk of increased future water use (and costs) should watering regimes be adjusted to meet turf needs. Amending the soils at these sites to improve the water holding capacity reduces this risk as well as providing other benefits including improved turf (and playing surface) conditions and increased carrying capacity.

On the remaining 20% of sports fields which are not significantly under watered, water savings of 28,800 kL per annum have been identified. These savings arise from:

- soil amendments to improve water holding capacity - 11,900 kL pa;
- improvements to make irrigation systems more efficient - 10,600 kL pa and
- improved irrigation system scheduling - 6,300 kL pa.

Council has commenced implementing the recommendations of the soil and irrigation assessments, with further works planned as funding allows.

The amendment of soils in sports fields with composted garden organics also provides an opportunity for synergies from Council's waste management strategy. The beneficial use of composted organic material from green waste collection and processing means less material is deposited into Council's only landfill facility. This in turn, extends the life of the landfill and adds value to Council's investment in waste diversion and advanced waste treatment systems.

Improved Understanding of Irrigation Water Use

The modelling of irrigation demand through the climate correction model has delivered several benefits including:

a) The ability to benchmark actual irrigation water use against expected usage – which then can indicate at a high level whether sports fields are receiving too much or too little water;
b) The ability to correct metered use for climatic conditions and thereby ascertain underlying water use trends over several years;
c) The ability to provide a high level forecast of expected water usage (and therefore costs). With water bills arriving only three times per year, the ability to provide an early indication of likely irrigation usage can assist in budgetary planning processes.

Figure 2 compares actual and climate corrected water use across Council's sports fields over several water years. Figure 2 demonstrates that variations in water use for sports fields have largely been driven by weather conditions with underlying water use being relatively steady throughout

Figure 3 shows how the model takes into account the timing of rainfall. The annual rainfall for 2012-13 was the same as 2011-12, yet irrigation demand was much higher. Furthermore, in the summer period, the rainfall in 2012-13 was higher than

2011-12, yet irrigation demand was also higher. At first glance, these results appear to be counter-intuitive, as irrigation demand would be expected to fall as rainfall increased.

However, these results are primarily due to differences in the timing of rainfall through both years. The 2011-12 water year had relatively consistent rainfall throughout the year, particularly the summer period, resulting in relatively low irrigation requirements. By contrast, the 2012-13 water year was generally drier, particularly during spring and early summer. However, over a 5 week period from late January to early March 2013, over 500 mm of rainfall was received. This rainfall primarily occurred during three 48 hour rain events. Therefore, with a large volume of rainfall over a short time period most of this rainfall would have been ineffective in reducing irrigation demand. This example shows how the timing of rainfall is crucial for estimating irrigation demand and correcting for climatic conditions.

Alternative Water Supplies

In collaboration with Hunter Water, Lake Macquarie City Council has undertaken some preliminary investigations for stormwater harvesting and re-use at a small number of sites. These investigations have shown that such schemes have the potential to deliver significant benefits for the community. However, the capital cost of these works means that these projects require external grant funding.

Council has also investigated rainwater harvesting options across a variety of sites. These investigations have shown that in most cases retrofitting rainwater tanks is an expensive option that delivers minimal water savings for the money spent. However, for new buildings, rainwater tanks are included within a suite of stormwater management measures to deliver improved ecosystem health outcomes. These rainwater tanks then provide some water savings as an ancillary benefit.

Investment and Project Assessment

One of the key outcomes from the business development process has been organisational transparency around the basis for selecting particular projects, over other types of projects. Through the development and use of technically robust modelling tools and financial analyses, the risks of selecting ineffective projects have been reduced.

Furthermore, the prioritisation and implementation of water efficiency projects is not a straight forward process as there are many factors to consider. Some of the considerations in prioritising or selecting water efficiency projects (in no particular order) include:

1) Ease of implementation, including the likely time frame to completion;
2) The implications or benefits for other Council Departments and service delivery across the organisation as a whole;
3) The impact or benefit to the community or user groups;
4) The cost of the project and the type of funding required (e.g. operational or capital funds);
5) The volume of water savings;
6) The size and value of other environmental benefits (e.g. carbon emissions reductions);
7) Financial benefits of the project;
8) The project plans of other Council departments which may complement or hinder the proposed project; and
9) The availability of complementary funding sources such as grants or specific purpose funds, (e.g. asset replacement or waste management reserves).

CONCLUSION

The Lake Macquarie community's expectation that Council will maintain or improve levels of service while improving its environmental and economic efficiency means that water efficiency projects must meet multiple strategic objectives. A strategic and collaborative approach, underpinned by strong financial and technical analysis has delivered financial and environmental outcomes in the short term, while also laying the foundation for future gains as larger projects are delivered.

ACKNOWLEDGMENTS

The successful and ongoing delivery of Council's water efficiency projects would not be possible without the generous assistance and cooperation of numerous staff across Lake Macquarie City Council. The author also acknowledges the financial and technical assistance provided by the water efficiency team at Hunter Water.

REFERENCES

Fam, D., Mosley, E., Lopes, A., Mathieson, L., Morison, J. and Connellan, G. 2008. Irrigation of Urban Green Spaces: a review of the Environmental, Social and Economic benefits. CRC for Irrigation Futures Technical Report No. 04/08.

Sydney Water Corporation 2011a. Best practice guidelines for water management in aquatic leisure centres. NSW, Australia.

Sydney Water Corporation 2011b. Best practice guidelines for holistic open space turf management in Sydney. NSW, Australia

Weller, S., and English, A. 2008. The Socio-economic Impacts of Water Restrictions on Turf Sports grounds in Metropolitan Melbourne. Centre for Strategic Economic Studies, Melbourne, Australia

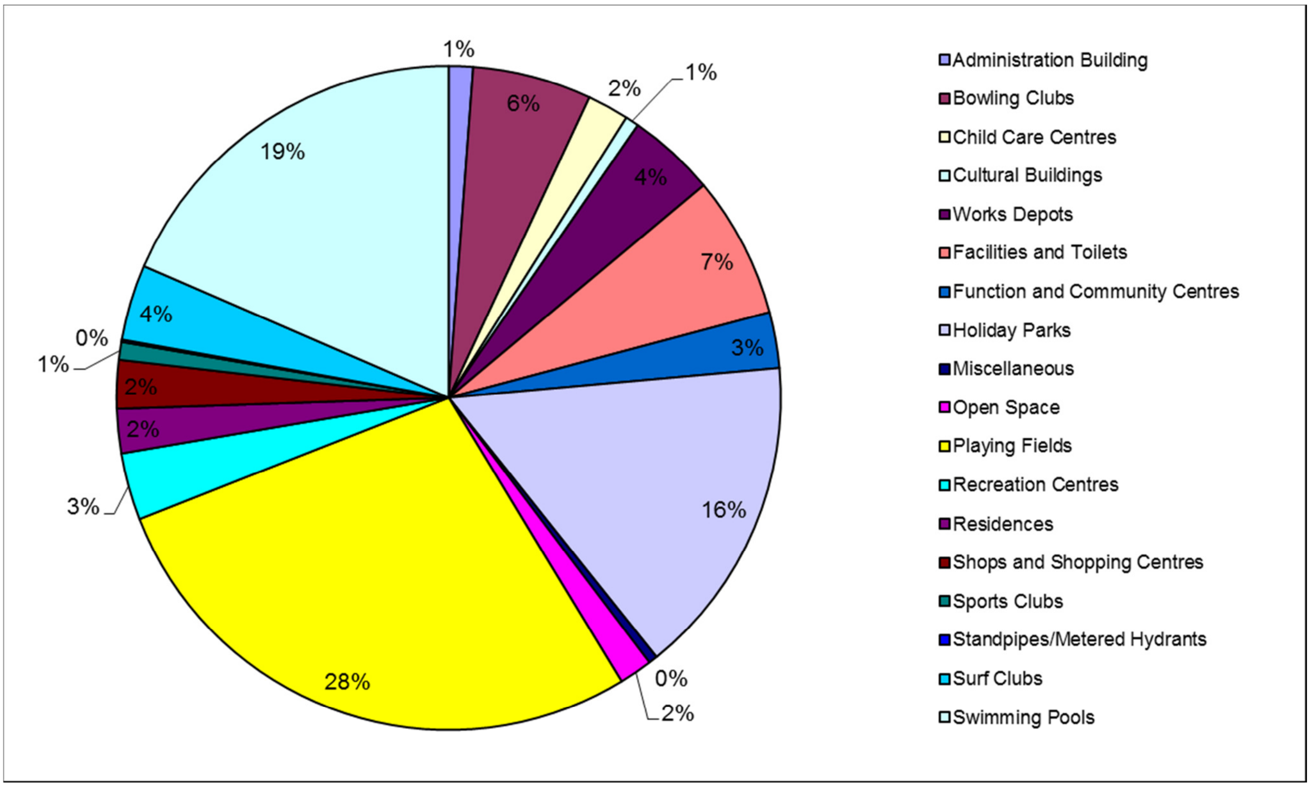

Figure 1: Breakdown of components of baseline (2007-08) Council reticulated water consumption (total consumption 398 ML)

Table 1: Changes in Council reticulated water consumption from 2007-08 to 2012-13

Category	**2007-08 (baseline) use (kL)**	**2012-13 climate corrected use (kL)**	**Change in use (kL)**	**% change**
Playing Fields	110,535	126,662	+16,127	+15%
Swim Centres	73,636	54,663	-18,973	-26%
Holiday Parks	62,363	62,734	+371	+1%
Other sites	151,413	135,441	-15,972	-10%
Total	**397,947**	**379,500**	**-18,447**	**-5%**

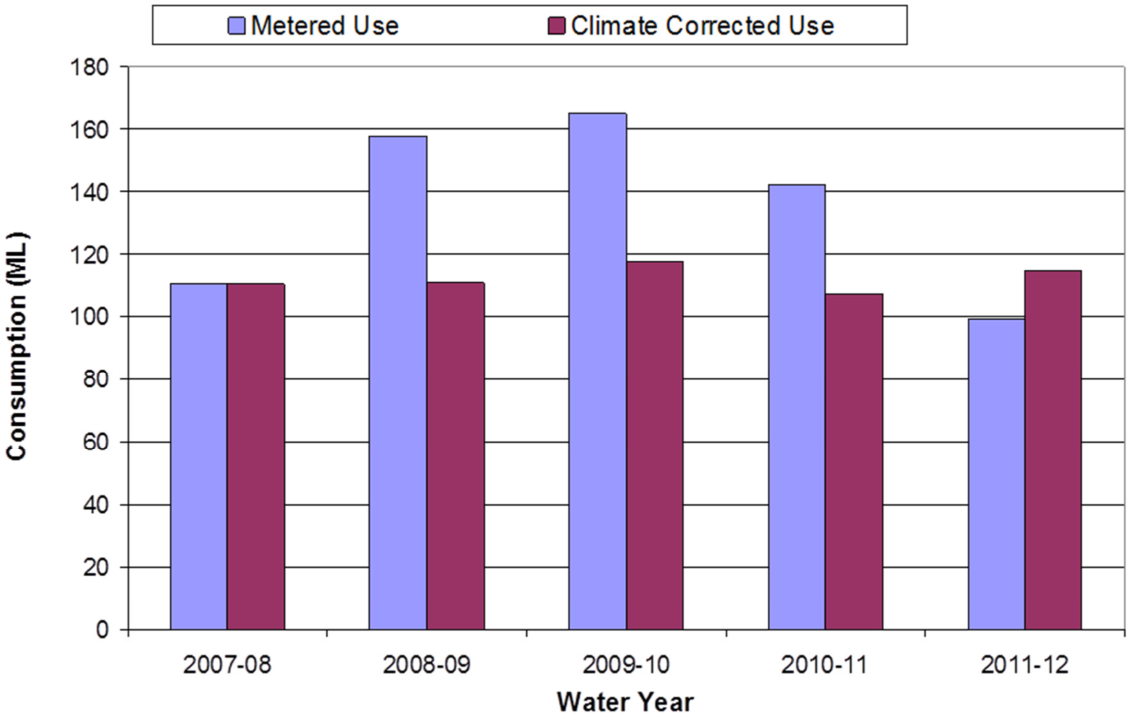

Figure 2: Comparison of Metered and Climate Corrected Water Use for Council's Sports Fields

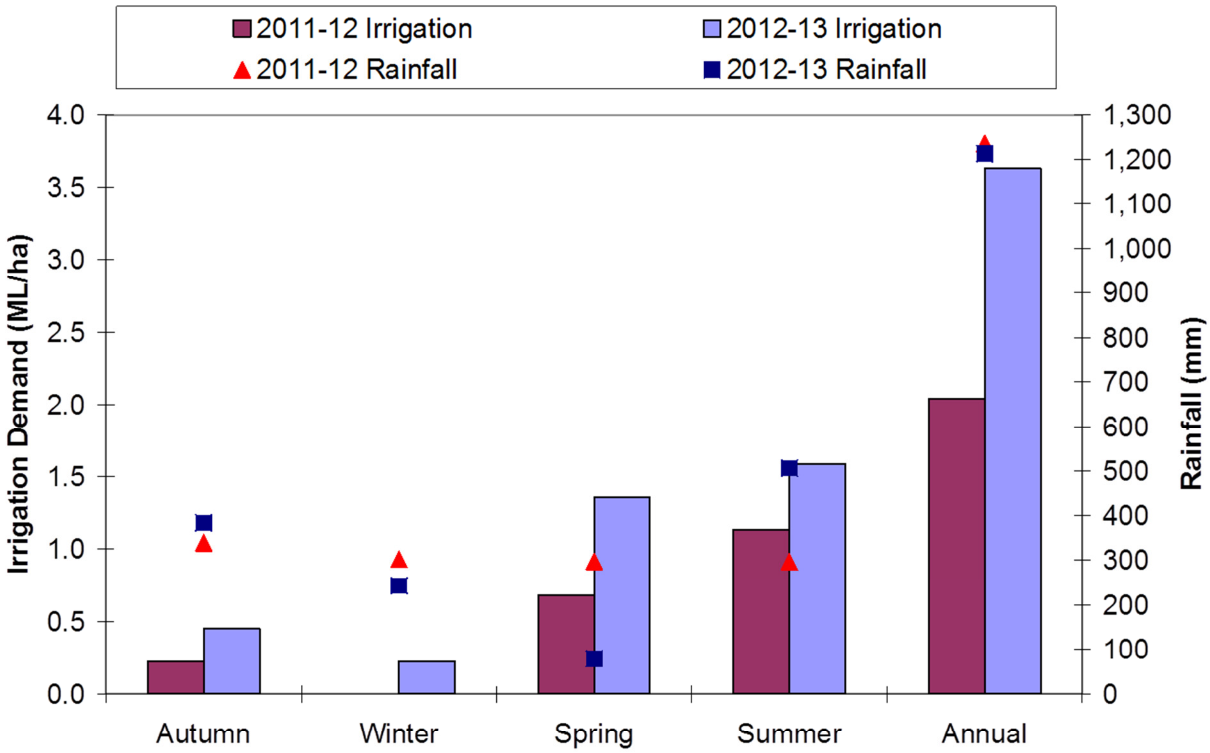

Figure 3: Comparison of Rainfall and Irrigation Demand over the 2011-12 and 2012-13 water years