# CREATING SUSTAINABLE OPEN SPACES – USING COMPOST TO DELIVER LIVEABILITY, SUSTAINABILITY, RECREATION AND ECONOMIC OUTCOMES

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ABSTRACT

Urban green open spaces are under increasing strain from higher demand through population growth and increased participation in sport. Using compost product generated from green waste collection services to amend soils in sports fields provides a local, sustainable and practical solution.

Our investigations have shown that sports fields with compost amended soils have lower water demand and more fertile soils than fields built without any soil amendment. Furthermore, natural turf fields with compost and a high wear tolerant turf cultivar offer enhanced liveability outcomes and a lower whole of life cost than synthetic turf alternatives.

## INTRODUCTION

The sustainability and functionality of open green spaces in the urban environment cuts across multiple sectors and industries including, for example: sport and recreation, local government, environment, health and water just to name a few.

With multiple industry sectors having a partial interest and role in delivering sustainable green spaces it is easy for holistic solutions to be missed. This paper examines the use of compost product on sports fields and how it delivers triple bottom line outcomes across the community and multiple industry sectors.

## DRIVERS FOR CHANGE

There are many drivers for action in the urban green open space arena, stemming from multiple industry sectors and community interest areas. First, in the waste and local government sectors, an increasing number of Councils are moving to green bin services for either garden waste or food and garden waste. While this diverts material from landfill, there is a greater volume of compost product being produced and a critical need to develop markets for the finished product to create a circular economy. If compost product does not have a viable end use, then there is unlikely to be processors to transform green waste into valuable compost product. Should this occur, then the diverted material is likely to end up as landfill. For green waste, this is doubly disturbing as landfill emissions contribute to already rising carbon emissions and climate change impacts.

In the recreation sector, demand for, and usage of outdoor green spaces and sports fields is growing. There is population growth, rising participation rates, particularly in children's and women's sport, and increasing density in urban areas, with less private green space available for recreation.

Compounding the problem of rising demand is the fact that sporting facilities are struggling to cope with existing levels of foot traffic. A survey of 844 sports fields in NSW found that less than 20% were in good condition, with a staggering 45% being in poor or very poor condition. Having playing surfaces in poor or very poor condition increases the risk of injury, prevents skill development and inhibits participation in sport and recreational activities. This in turn, has consequences for physical and mental health.

Sporting associations are becoming increasingly vocal and active in their demands for playing surfaces that are in a safe and acceptable condition for play. This, along with more intense use (from growing demand), means the water demands of urban green spaces are higher as more irrigation is required for turf growth and recovery.

Furthermore, there is a need to prepare for and adapt to the impacts of climate change. Over the past 20 years there has been a climate shift in Newcastle, with sports field irrigation demand increasing rapidly (Figure 1). This is due to both a reduction in rainfall and an increase in evapotranspiration.

Finally, in response to the perceived inability of turf to deliver consistent and safe playing surfaces, sporting associations are leading a push towards synthetic playing surfaces. This is exacerbating the urban heating trends and the associated liveability issues in cities as heat sinks (natural turf fields) are replaced by heat sources (synthetic fields).

With all these drivers for change across multiple industry sectors, how can the situation be improved in an integrated manner to the benefit of the entire community? What is the role of compost in managing sports fields and turf open spaces? How does it deliver benefits to the community and the water industry? How does it promote and enhance liveable cities and create a circular economy?

This paper addresses these questions through a series of investigations and field testing, focusing on case study sites in the Newcastle/Lake Macquarie area, in the Lower Hunter region of New South Wales.

## PROCESS

Over the past 10 years, a number of sports fields have been constructed/reconstructed in the Newcastle/Lake Macquarie area. Some of these were rebuilt using composted garden organics under a compost trial program, while others were constructed/reconstructed without organics being incorporated to amend the soil. The compost was sourced from a commercial compost producer, with the compost derived from commercial and residential garden organics.

Field testing enabled comparisons to be made across the different construction/reconstruction methodologies. Infiltration testing was also carried out to address the commonly espoused view that compost is bad for drainage because it slows the infiltration rate.

During the previous Lake Macquarie compost trial project, a number of sites had the turf established using alternatives to traditional turf sod. This allowed for a differentiation between the impact of compost on infiltration rates from the impact of turf sod (and the turf farm from which it was sourced).

Field testing was undertaken at six locations within each site, representing low, medium and high wear areas. The field testing involved:

- Collecting soil samples for chemical analysis in a laboratory (to determine soil fertility);
- Measuring surface hardness with a 2.25 kg Clegg Hammer (the reading on the 3rd drop represents the impact felt by an adult player falling on the surface). This provides insights into soil compaction (which affects turf health) and potential issues for player safety from hard surfaces (e.g. injuries from falls or jarring);
- Measuring infiltration rates using a quasi double ring infiltrometer (infiltration rates are one indicator of how quickly a field is likely to return to play after rain).

The project also involved an examination of irrigation water requirements for sports field soils amended with compost versus those without amendment. This included a direct comparison of metered water use in the first 12 months across two different sites. Broken water meters and a lack of sub-metering on individual fields within several multi-field precincts precluded additional comparisons of actual water use.

The final part of the project was a lifecycle cost comparison of options for reconstructing existing fields or building new fields. The options considered were:

- Synthetic turf fields
- A natural turf field built with a high carrying capacity using compost to amend the soil, irrigation and a turf cultivar (variety) capable of handling high levels of wear;
- Traditional build for a natural turf field with irrigation, slit drainage, and using the cheapest available turf and soil with no soil amendment.

Case study sites for the lifecycle cost analysis were drawn from the Newcastle, Lake Macquarie and Sydney metropolitan areas.

## OUTCOMES

Amending soil with compost increases the amount of organic matter in the soil profile. This improves the soil structure, increasing its resistance to compaction as well as increasing soil fertility by increasing the soil's ability to retain nutrients. Fields with compacted soils will not only be harder under foot, but will have a lower water holding capacity. Furthermore, because compost keeps the soil structure open, it increases the ability of the soil to capture rainfall, meaning less water is required for irrigation. The soils of existing fields can be amended with compost by applying the compost to the surface and then mixing (incorporating) the compost throughout the soil profile with a blecavator. The turf surface is then re-established from existing material (if the turf variety is suitable) or a new turf surface is established using an appropriate turf cultivar for the expected usage at the site.

Table 1 compares the surface hardness and soil fertility results for compost amended fields versus those that have been rebuilt without using compost. It shows that compost amended fields have superior outcomes; they are softer, with higher levels of all key turf nutrients (nitrogen, potassium, calcium, prosphorus and sulfur). Furthermore, compost amended soils have a higher cation exchange capacity (CEC), which means they can retain more nutrients for plant growth. The differences between between soils with the compost amendment and those without were statistically significant at the 5% confidence level, except for sulphur, phosphorus and potassium (p value for potassium was 0.0562).

Compost amended fields also have superior water demand outcomes, with water savings of 10-20% compared to those with unamended soils (Table 2). To put this in perspective, across 100 fields of 1.5 hectares each, the savings amount to 40-90 ML pa.

Table 3 compares the metered sports field water use (ML/ha) of two sites, one with compost amended soils and the other without. In this case, the water savings from using compost were above 50%. If this was replicated for 100 fields of 1.5 hectares each, the water savings are around 690 ML per year. The dramatic difference maybe be due to psychological factors, as turf that is struggling without obvious disease or insect damage is perceived to require more water (i.e. more irrigation). Other causes such as nutrient deficiencies or soil problems (e.g. hydrophobic soils) are rarely considered.

In addition to requiring less water during normal conditions, fields with compost amendment had superior drought resilience. Figure 2 compares the “survival watering requirements” for turf at two sites, one with compost amended soil, the other without any compost amendment. The survival watering requirements of the compost amended field are approximately a quarter of those of the unamended site. This has significant implications for the amount of water that is required to sustain green spaces during drought and the volume of demand reductions that could be achieved during restrictions.

Not only does the compost amended field require less water to survive, but it also maintains vastly superior carrying capacity, particularly during water restrictions. Figure 3 shows that the compost amended field starts with about 60% more carrying capacity than the unamended field. Furthermore, the compost amended field maintained its carrying capacity throughout Level 1 and Level 2 restrictions, with only a 5% reduction in capacity under Level 3.

By contrast, the carrying capacity of the unamended field falls by 20% under Level 1 restrictions, 40% under Level 2 and 60% under Level 3 (no irrigation). This means the unamended fields have little capacity to cope with drought, with water restrictions likely to have severe implications on the amenity and functionality of these surfaces. Under severe water restrictions (no irrigation), the compost amended field can handle 3.5 times as much foot traffic as the unamended field. Hence, by amending sports field soils with compost, the water industry can significantly reduce the social and liveability impacts of drought in urban areas.

One of the commonly espoused views against using compost to amend sports field soils is that it is bad for drainage. This view was tested by measuring and comparing the infiltration rates. We found that this view was not supported by the data. There were large differences in infiltration rates across fields with these primarily related to turf sod and the turf farm from which it was sourced, not the compost (Tables 4 and 5).

The best infiltration rates were recorded on sites with compost amended soils where the turf was established using non-sodded alternatives (e.g. sprigs, turf recovering from existing material in soil).

A well-built turf field where the soil has been amended with compost and established with a wear tolerant turf cultivar offers superior whole of life cost outcomes compared to lower capital cost alternatives (no compost, cheaper turf) or synthetic fields (Figure 4). When the carrying capacity of each surface is considered, the well built turf field is vastly superior at one third to one quarter of the cost (Figure 5). Furthermore, the well built turf field provides a carrying capacity similar to a synthethic field and up to 2-3 times the carrying capacity of alternative turf options.

From a liveability and heat island perspective, a well-built, natural turf field has lower surface temperatures than a synthetic field, with synthetic fields unusable when the BOM temperature exceed 30 degrees Celsius (Figure 6). This has significant implications for the functionality of synthetic turf surfaces during the warmer months.

Furthermore, well built turf surfaces provide flexibility for passive recreational and informal community use (e.g. dog walking) that is not possible with a synthetic surface. However, a synthetic surface may be more readily playable immediately following heavy rain during the winter months. That said, a well constructed turf field can be designed to drain rapidly, providing important surface water management measures are implemented (such as sufficient cross fall and avoiding infiltration risks from traditional turf sod).

## CONCLUSION

Using compost to amend the soils on sports fields has been shown to improve soil fertility. The amendment of soils also reduces irrigation demand, with benefits to the water industry from water savings and increased resilience to drought. A natural turf field built with a wear tolerant turf cultivar and compost amended soil provides for more liveable cities and gives a superior economic outcome to synthetic turf alternatives.

## ACKNOWLEDGMENT

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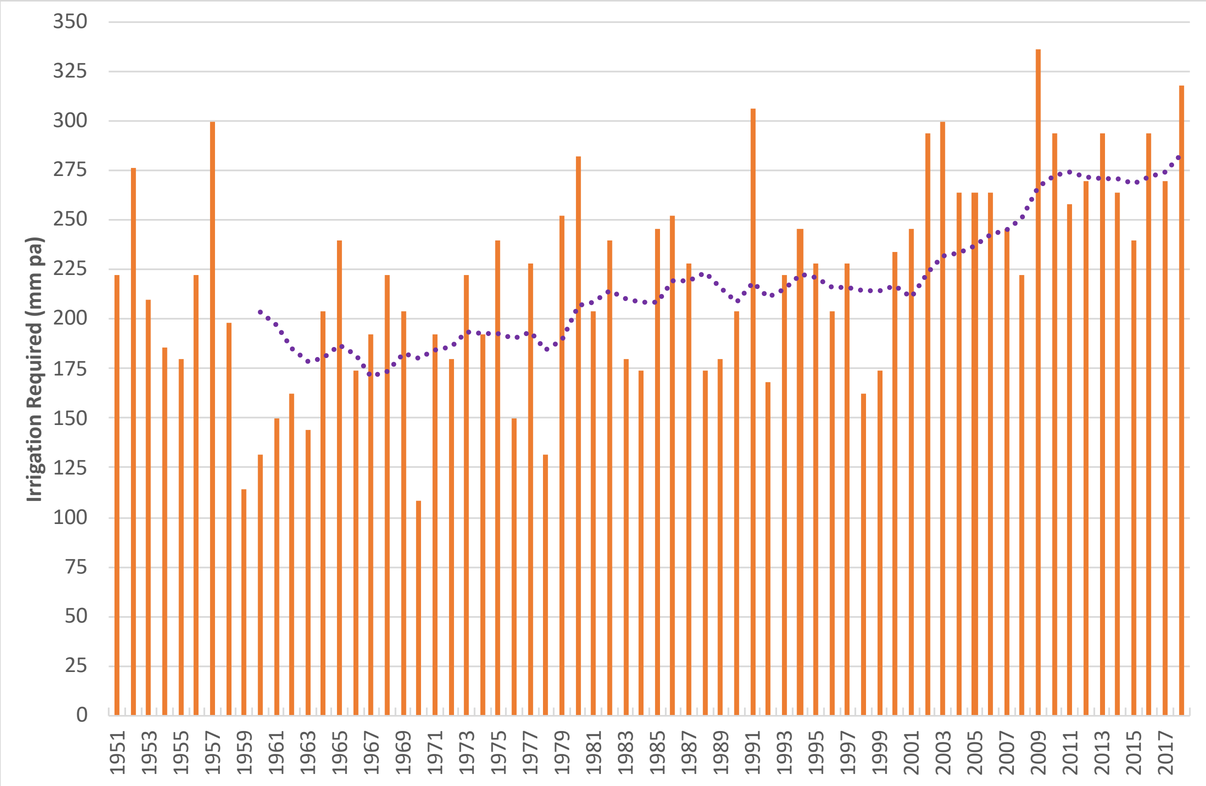


*Figure 1: Annual Irrigation Required (mm) with 10 year moving average*

*Table 1: Soil Hardness and Fertility for fields with and without compost amendment*

| Item | Compost | No Compost | Difference |
|---|---|---|---|
| % Organic Matter | 6.1 | 2.2 | 3.9* |
| Surface Hardness (Gravities, g) | 85 | 118 | 33* |
| Cation Exchange Capacity (CEC) cmol+/kg | 12.8 | 8.5 | 4.3* |
| Readily Available Nitrogen (mg/kg) | 24.2 | 6.5 | 17.7* |
| Total Nitrogen (mg/kg) | 2,886 | 970 | 1,916* |
| Exchangeable Potassium (mg/kg) | 278 | 162 | 116** |
| Exchangeable Calcium (mg/kg) | 1,916 | 1,168 | 748* |
| Phosphorus | 54 | 33 | 21 |
| Sulphur | 8.7 | 7.6 | 1.1 |

* Statistically significant at the 5% confidence level
** p value was 0.0562

*Table 2: Irrigation Water Demand (ML/ha) for different sports field soils*

| Item | Median Year | Wet Year (25th percentile) | Dry Year (75th percentile) |
|---|---|---|---|
| Compost Amended Soil | 2.93 | 2.34 | 3.38 |
| Unamended “typical” Soil | 3.21 | 2.60 | 3.75 |
| Unamended “poor” Soil | 3.55 | 3.02 | 4.02 |

*Table 3: Metered Water Use at 2 sports fields*

| Item | Compost Amendment | No Compost Amendment |
|---|---|---|
| Metered water use in first year (ML) | 11.75 | 22.96 |
| Water use per hectare (ML/ha) | 4.40 | 9.00 |

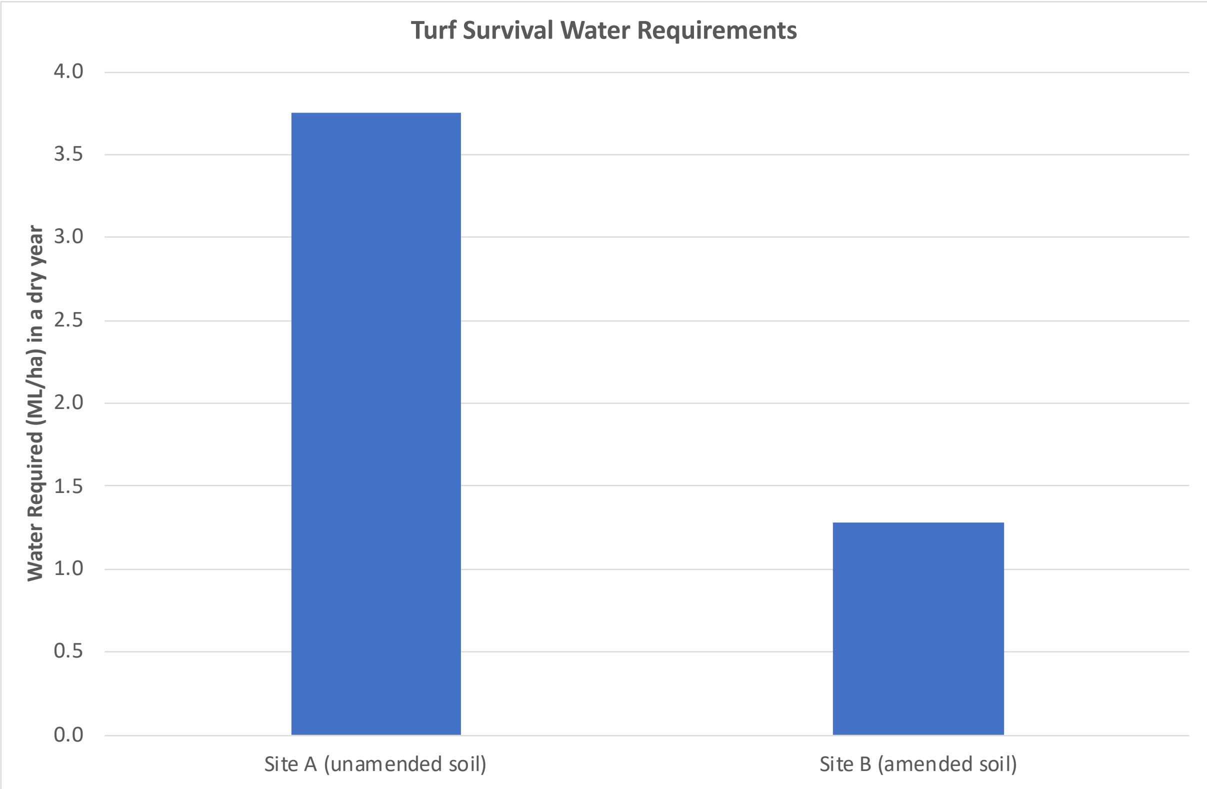


*Figure 2: Turf Survival Water Requirements for unamended and compost amended soil*

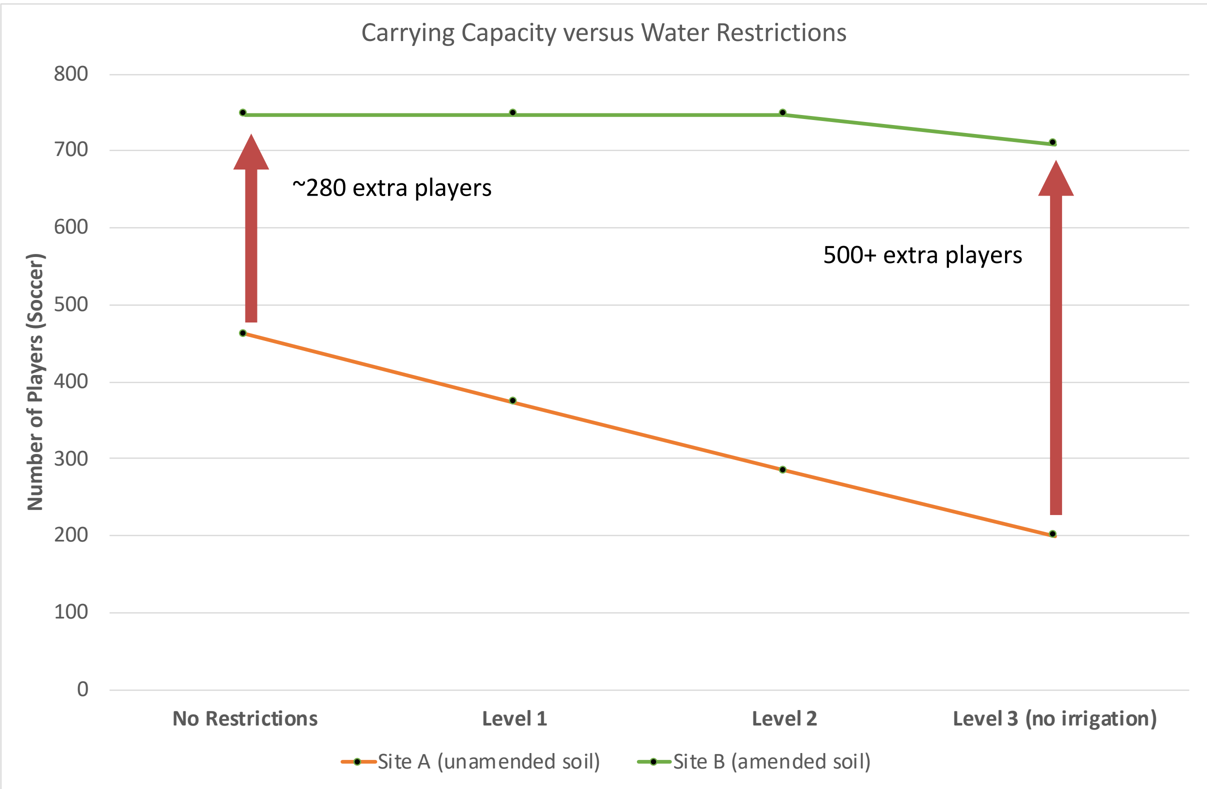


*Figure 3: Comparison of carrying capacity of two sites during water restrictions*

*Table 4: Infiltration Rate (mm/hr) on fields with different turf establishment techniques and soil amendments*

| Item | Turf - No Sod | Turf – Traditional Sod |
|---|---|---|
| Compost amended soil | 45 | 14 |
| Unamended soil | N/A | 9 |

*Table 5: Infiltration Rate (mm/hr) on fields with versus source farm for turf (traditional sod)*

| Item | Turf Farm A | Turf Farm B | Turf Farm C |
|---|---|---|---|
| Infiltration Rate – Traditional Sod | 2 | 28 | 14 |

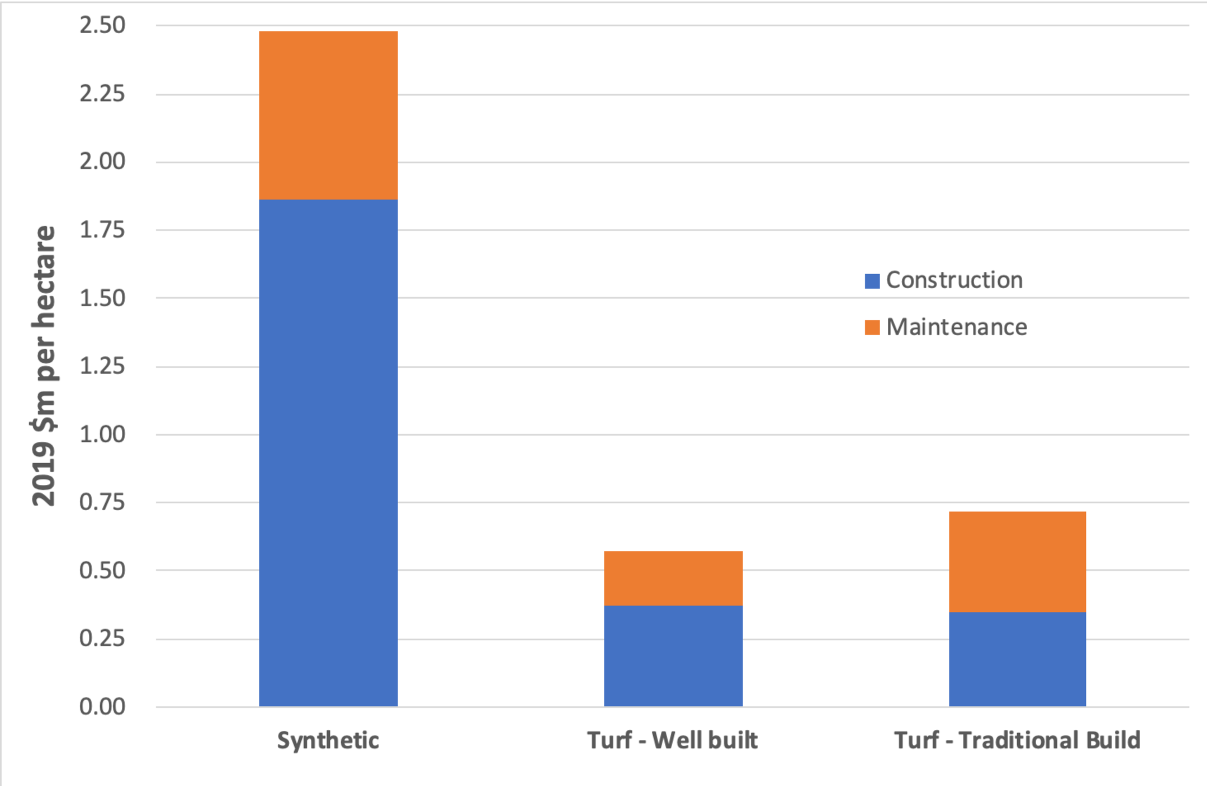


*Figure 4: Comparison of lifecycle costs (in $ million per hectare) for synthetic and turf fields. Three different types of turf field construction have been assessed*

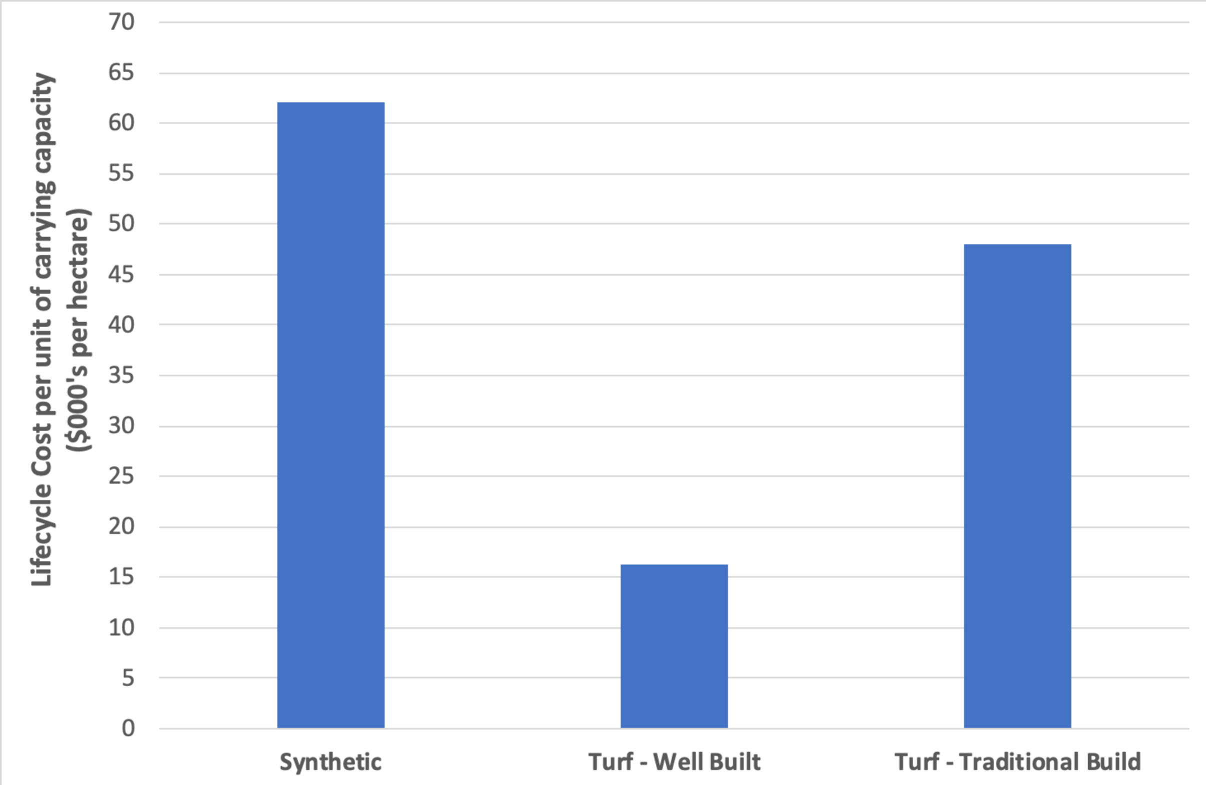


*Figure 5: Comparison of lifecycle costs ($000's per hectare) per unit of carrying capacity for synthetic and turf fields. Three different types of turf field construction have been assessed*

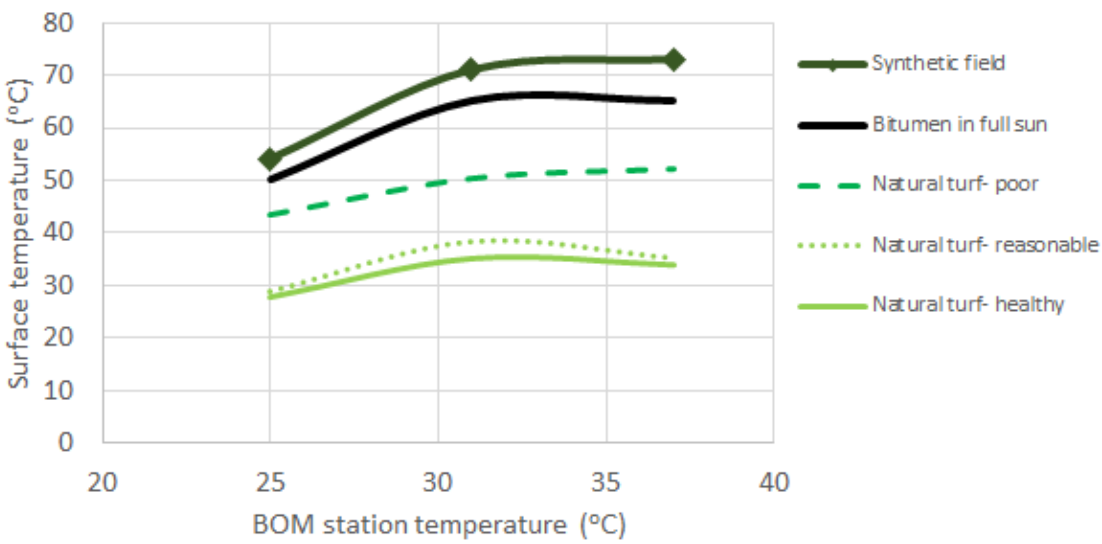


*Figure 6: Impact of air temperature on the surface temperature of sporting fields at Bernie Mullane Sports Complex at Kellyville. The synthetic field has a white to translucent coloured infill, with the surface likely to have been significantly hotter if a black rubber infill had been used as has occurred on other facilities*