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University of Southern Queensland
Faculty of Engineering and Surveying

Irrigation performance and water use efficiency of turf production

A dissertation submitted by

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Abstract

Turf water requirements on the Darling Downs have never been analysed and it is the purpose of this project to find the minimal water requirements to grow turf for production use. The water quantity will be measured from the initial bare soil to the date of cutting the turf. The minimum water requirement is the amount needed to sufficiently provide the sustained growth at a certain quality needed to sell the turf to the public. The irrigation application rates must be small enough that there is no water lost through deep drainage. The two turf species that were investigated were wintergreen couch and kikuyu.

The project was designed to remedy many issues, the first was the low distribution uniformity produced by the in ground solid set sprinkler system at the business of Cabarlah Park Turf. Both Cu and Du figures were found by performing a number of catch can tests while pressure performance at pump and nozzle. Recommendations of how to fix the low uniformity were then put forward to the grower. These recommendations were carried out and further catch can tests were carried out to see what kind of improvements were made to the distribution uniformity of the system. Using the catch can data, each part of the trial site had a known amount of irrigation application per hour.

The required irrigation times were calculated using daily ETo figures from the on site weather station. From this point the value was multiplied by a relative crop factor and

the application amount was able to be received. The amount of hours that the irrigation was run was logged and the quantity of water that each part of the trial site received for the entire growth period was calculated. The turf was evaluated using a one to nine scale for strength and colour. Evaluations on which turf received the greatest ratings at the lowest water quantity were undertaken.

The results showed a low distribution uniformity of 52.4% which was improved to 57% after the distribution enhancement recommendations were carried out. The wintergreen couch was able to be grown with a minimum water requirement of 392mm over a period of a month and a half. The kikuyu trial had to be abandoned due to a pump break down for most of it's growth period therefore there was no minimum water requirement found for kikuyu during this project.

The project showed that there could be significant savings in water use by initiating an irrigation application rate derived from ETo calculations. Soil moisture meters showed that there could be further improvement to water saving, for the purpose of turf production. The results showed that uniformity must be increased to see any decrease in yield loss.

Acknowledgements

There are a number of people that provided help and encouragement throughout the duration of this project. Firstly I would like to thank Geoff Hindmarsh who provided his business, Cabarlah Park Turf, as the trial site for the project. I would also like to thank Dan Corfe of the QTPA who provided much technical help throughout the project. Mark Dunn from the NCEA should also be acknowledged for his help with the electrical aspects of the project.

Most importantly I would like to thank my supervisor Steve Raine, whose help and structure has guided me throughout the entirety of this project. Also I would like to thank Rod Smith for taking over as my supervisor after Steve went on leave.

Ben Muller

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1. Introduction

Turf is produced for a number of uses however the majority of turf sold is for ground cover for lawns around house blocks. Turf is also laid on the banks and beds of both man made and natural waterways to control erosion. Another use is that of parks and sporting fields, especially golf courses. Along the edges of concrete paths and roads councils use turf for not only reduce erosion but also dust control. The average price of turf in Qld is $\$3/m^2$ but does vary greatly depending on species and location of the turf farm.

The Turf industry in Australia employs around 80 000 people and produces approximately 6500 hectares of turf per year equating to $450 million dollars in revenue (TPA, 2006). In Queensland alone the turf industry is a $112.5 million business. In the USA, where most of the worlds turf research has been undertaken, the turf industry produces over 20200 hectares of turf per year, generating $40 billion into the economy (The National Turfgrass Research Initiative, 2006).

In Queensland alone there are 152 turf farms with an average farm size of 16.6 hectares employing 320 full time employees with a similar number of casual employees (Queensland Turf Producers Association, 2004). The majority of turf farms are situated within a 200km radius of Brisbane, as the warmer winters in these areas protect the turf from frost in the winter periods.

The main species of turf grown in Queensland are conquest couch, buffalo, wintergreen couch and Queensland blue couch. All species of turf are grown over the entire year regardless of seasonal changes however some grasses do perform better in cooler or warmer conditions. Some turf farms in Queensland may be frost affected in winter however the turf is still grown regardless of the leaf burn due to the frost. The water requirements for turf production in Queensland are uncertain however research in America believes turf water use is a matter of crop evapotranspiration minus rainfall and runoff multiplied by a deficit of 0.7 (Duble, 2007). At present no research has been completed into turf water requirements on the Darling Downs. With the on going water shortage, the Queensland government has raised concerns over water use in the Turf industry. As a result, a grant has been given to the Queensland Turf Producers Association and an Industry Development Officer has been employed to investigate turf water use. Since the start of this study it has been identified that Queensland turf farmers have been over watering and also using irrigation methods that are inefficient.

The aim of this student project was to identify opportunities to improve the efficiency of turf irrigation by evaluating irrigation scheduling techniques and improving sprinkler system uniformity. The project also evaluated the effect of irrigation non-uniformity on turf growth. Another aim of the project was to prove whether turf requires a larger quantity of water during the establishment phase than when an adequate ground cover has been produced. In conjunction with the already stated aims it is the purpose of the project to find the minimum water requirements for sustainable turf growth for the purpose of sale. The two species of turf that the trials will be conducted on are Wintergreen Couch (Cynodan Dactylon) and Kikuyu (Pennisetum Clandestinum).

1.2 Overview of the dissertation

Chapter two will consist of a literature review of previous research on the subject. The purpose of chapter three is to provide a detailed explanation of the materials and methods, an insight into how the project was planned. The following two chapters will consist of the results received from the student project and an in depth discussion of what has been derived from these results. Recommendations into how to improve the irrigation system, scheduling techniques and accurate crop coefficients will also be given in this chapter. The final chapter will provide a conclusion to the study and give an insight into further research that could be continued in this field.

2. Literature Review

Knowledge of past and present research by other evaluators is vital when endeavouring to improve upon information laid down in the past. A proper appreciation of what others have attempted in the past and the problems they faced is vital to ensure successful design criteria. The following subject matter will be analysed in this literary review.

2.1 Turf Production Issues and Water Requirements

2.1.1 Turf quality

Turf quality is an important factor during the growth process, however it is a vital factor during harvesting and being marketed for sale. In past trials, quality has been measured using a variety of methods. The accuracy of these methods has weighed heavily on the available funding for the trial which affects the capacity to purchase expensive precision measurement tools. As stated by Kevin N Morris of the NTEP “Turf grass quality is not a measure of yield or nutritive value. Turf grass quality is a measure of aesthetics (i.e. density, uniformity, texture, smoothness, growth habit and colour), and functional use”. Although all these values are usually rated on the evaluators judgement, all of these factors could be measured more accurately using different methods, many of which are mentioned later in the literature review.

Research conducted by The National Turfgrass Evaluation Program (NTEP) in America showed that their past and present research into quality testing has used a scale from one to nine to rate the quality of the turf during growth and at cutting stages. A rating of nine is the highest reading, giving premium quality. This leaves rating one as the poorest rating denoting the turf as being in extremely poor health or dead. These ratings are based on the evaluator's judgement and therefore could be considered subjective and problems may arise due to differences in opinion between evaluators. The NTEP states that their quality evaluations are made up of factors such as colour, density, uniformity, texture, and disease or environmental stress (Morris, 2005). Each of these characteristics is rated separately before an overall rating can be specified.

Research being carried out by Tim Colmer of the University of Western Australia (UWA) measures turf quality using two factors, colour and strength (UWA, 2007). UWA did not use a ratings scale to quantify turf colour quality, however opted for the use of a chroma meter. A chroma meter is a device that measures colour due to the reflective qualities. This method could not be subjective and would be the most consistent way of measuring turf greenness. When it came to measuring turf roll strength UWA used a rating scale of one to three. This was carried out by cutting three rolls and recording how many of them remained in one piece (UWA, 2007). This method is extremely subjective and may not give an accurate outlook of what is happening over the entire trial site. It is for this reason that this method will not be used for this student project and the same rating scale of one to nine will be used as per the colour rating method. Every part of the trial plot will be evaluated and not just a chosen area. By using this method a greater accuracy in the results will be possible.

2.1.2 Growth

The growth rate of turf must be analysed to find which amounts of both water and fertilizer give premium growth. A variety of methods exist as to how to go about growth measurement. The first method is used by UWA and is a simple procedure of mowing at the same height throughout the trial and collecting the clippings from a specified area. Clippings are then placed in an oven to remove all excess water. The weight of the clippings is then recorded and is used to decipher which sections of turf are growing at the greatest rate compared to the amount of water being placed on the field (UWA, 2007). The Crop Society of America also takes clipping samples monthly. The samples are dried, ground and analysed for total Nitrogen (The Crop Society of America, 2007). By finding out how much Nitrogen each part of the trial site has received, they decipher which parts of the field have responded the greatest with respect to colour and growth. These methods, although fool proof could not be used during this trial as there was no access to a mower equipped with a catcher. The mower used at Cabarlah Park Turf is 6.08 metres wide and disperses all clippings behind it, therefore rendering it useless for this kind of testing.

Fourth year engineering student Andrew Piper in 2004, was required in his project to record the difference in percentage between grass cover and dead or bare coverage. To do this he made a transportable wheeled cart that contained a USB video camera that was underneath a shroud to block out all sunlight. Under this shroud were two light

bulbs that gave uniform light for the camera to operate. All camera video was recorded to a laptop where a computer program converted the data into a percentage of green to bare form. A mounted GPS system was used to tell exactly where the data was being collected from the field.

2.1.3 Production seasons

In Australia, turf is grown all year round with increased growth rate during spring to early autumn. This is due to the warmer temperatures and the increase in daylight hours. Areas that receive winter minimums less than zero degrees Celsius are still able to grow turf. However the turf leaves get burnt due to frost and consequently growth slows to an absolute minimum. Varieties that growth is effected the greatest in winter are couches, buffalo, zoysia (H Bar H Turf Farms, 2007). These varieties are classed as warm season grasses, while varieties such as ryegrass and fescue are seen as cooler season grasses (Duble, 2007). When burning of the turf leaves occurs the farmers are able to apply specially designed turf paint which is simply used to increase the look of the product.

2.1.4 Management issues

Controlling the management of the irrigation scheduling was going to be of vital importance with respect to management of the trial site. The main issues found were:

- Do not irrigate after a significant rainfall event
- Irrigate at a time where wind and evaporation are at a minimum.

- Adjust irrigation to suit weather conditions
- Base irrigation of plant water requirements.

(McCabe, 2003)

All these factors were not only taken into account, but fully investigated so that these conditions could be changed to suit local environment.

An important management issue discussed by G.J. Connellan (Connellan, 2003) was the choice of relevant crop factors. These crop factors would be multiplied by an ETo reading to give the amount of irrigation required. Connellan (Connellan, 2003) has provided an extensive outlook into crop factors as he uses the crop factor to control required growth for urban irrigation of field with full crop cover (Connellan, 2003). Table 2.1 shows the benchmark figures that Connellan used for crop factor coefficients.

Turf Condition	Turf – Warm Season	Turf – Cool Season
Moderate growth, just acceptable	0.25 – 0.40	0.65 – 0.70
Strong growth	0.45 – 0.55	0.70 – 0.75
Vigorous growth	0.55 – 0.70	0.80 – 0.85

Table 2.1 Crop Factors for turf under varying weather and growth conditions

(Handreck et al, 2001)

Another management issue is how often to apply fertilizer to the trial site and at what rates. The University of Western Australia have undertaken current testing on kikuyu into this exact problem. Their methods incorporated the use of conventional, controlled

release and natural fertilizers at differing rates and quantities. They also managed the quantity of water used to water the nutrient into the soil profile. Turf receiving inorganic fertilisers at 200-300 kg N/ha were most likely to remain intact when cutting. Increasing the fertiliser application rate always increased turf growth for each fertiliser type at the low irrigation rate (UWA, 2007).

Aeration is an important management issue on any turf farm regardless of soil type. "Aeration opens up compacted soils and allows for easier movement of roots, nutrients, water and air" (Duble, 2007). "Mechanical aeration provides an excellent, and probably the only, means of correcting or alleviating soil compaction which may be quite serious on many lawn areas. Compaction occurs primarily in the surface area of the lawn. A compacted layer as thin as 5 to 10 mm can greatly impede water infiltration, nutrient penetration, and gaseous exchange between the soil and the atmosphere. Compaction of this type in the surface layer of soil can be corrected or reduced by the use of suitable aerating equipment. A safe general rule for time of aeration is to aerate only when the desirable grasses are growing vigorously" (Harper, 2007).

2.1.5 Water requirements and Scheduling

Correct scheduling of irrigation events is vital for a successful trial to measure minimum water requirements. Colorado State University defines the practice of irrigation scheduling as being "The purpose of irrigation scheduling is to determine the exact amount of water to apply to the field and the exact timing for application. The amount of water applied is determined by using a criterion to determine irrigation need and a

strategy to prescribe how much water to apply in any situation" (Broner, 2005). Similarly, another view of irrigation scheduling, is the decision of when and how much water to apply to an irrigated crop to maximise net returns. The maximisation of net returns requires a high level of irrigation efficiency. This requires the accurate measurement of the volume of water applied or the depth of application (Harris, 2007).

The advantages of irrigation scheduling are

- The rotation of water amongst paddocks to minimise crop water stress and maximise yields.
- A reduction in energy, water and labour costs through fewer irrigations.
- A lowering of fertiliser costs through reduced surface runoff and deep drainage.
- Increased net returns through increased yields and improved crop quality.
- A minimisation of water-logging problems.
- Assisting control of root zone salinity problems through controlled leaching.

(Harris, 2007)

- It reduces the farmer's cost of water and labour through fewer irrigations, thereby making maximum use of soil moisture storage.
- It results in additional returns by using the "saved" water to irrigate non-cash Crops that otherwise would not be irrigated during water-short periods.

(Broner, 2005)

A number of different methods can be used to put together an irrigation strategy. The most common way of assessing soil moisture is by feeling the soil for moisture and investigating the soil and crop's general appearance. This method has been used for centuries however it is extremely subjective and does not provide an accurate means of scheduling irrigation events.

There is a variety of soil moisture monitoring equipment available and all of them have their advantages and disadvantages. A tensiometer is a commonly used tool for measuring soil moisture tension. The greater the soil moisture tension, the greater the stress on the crop being grown. Once the tension reaches a desired stress level for a crop, it is time for an irrigation event. Tensiometers are relatively accurate and are reasonably priced however can only be used in moist soil as they are only accurate to around 480 kPa.

Agricultural engineer, I Broner from Colorado State University sums up the purpose and variations of irrigation scheduling perfectly, "Soil moisture content to trigger irrigation depends on the irrigator's goal and strategy. In this case, the goal is to maximize yield. Therefore, the irrigator will try to keep the soil moisture content above a critical level. If soil moisture falls below this level, the yield may be lower than the maximum potential yield. Thus, irrigation is applied whenever the soil water content level reaches the critical level (Broner, 2005).

Enviroscans are a multi sensor capacitance probe that is used to monitor soil moisture. An enviroscan is design to take soil moisture readings at different depths, which when the data is downloaded, can give you a graphical output of the soil moisture trends over the different depths in the soil profile. This knowledge enables you to get an idea of what root activity is occurring at different depths and also how deep in the soil profile irrigation events are penetrating. Although extremely accurate, this is a particularly expensive manner to measure soil moisture, as setting up an enviroscan unit can cost up to six thousand dollars (Sentek, 2007).

While these two examples of soil moisture monitoring tools can help you schedule irrigation events, neither tensiometers nor enviroscans can tell you the application amount that you must apply. Excessive application amounts could cause losses through runoff and deep drainage. Acquiring the right application rate is just as important as scheduling the irrigation at the right time.

A common tool used for irrigation scheduling is the water balance equation. This method of scheduling chooses a starting point total soil water in the root zone. Then the water balance equation is solved on a daily basis, considering the amounts of water that move into and out of the root zone for that day (Harris, 2005). The equation is shown below.

$$\mathbf{TW_T = TW_{T-1} + Irr + Rain - ET_C - DEEP - Runoff + FLUX_{net}}$$

where:

TW_T = total water in the root zone on day T

TW_{T-1} = total water in the root zone on the previous day (T-1)

Irr = irrigation water applied

Rain = rainfall

ET_C = evapotranspiration (soil evaporation plus plant use)

DEEP = drainage or percolation below the root zone

Runoff = runoff

$FLUX_{net}$ = any change in total water in the root zone from underground water movement (e.g. high water table or water moving laterally in the ground). (Harris, 2007)

There are a few different trials that have been conducted to work out the water requirements for turf growth. The first to be investigated uses the equation,
Water Requirement = 0.70[ETo – (Rainfall - Runoff)], (Duble, 2007).
This equation uses a constant crop factor of 0.7 regardless of seasonal changes. From this point any rainfall is subtracted from the ETo and the resulting irrigation amount is able to be calculated. An interesting part of this equation is that it subtracts runoff from any rainfall that occurs. This means that only rainfall that infiltrated the soil profile was taken into account when calculating turf water requirements. This is an excellent inclusion into the equation as you cannot use any water that is lost to runoff. Richard Duble's paper doesn't state how they were able to measure runoff as a mathematical quantity and how they accounted for water lost to deep drainage.

Geoff Connellan of the University of Melbourne completed a benchmarking exercise on turf and landscaping irrigation systems. His findings were to use the following equation to find irrigation application amounts.

Water requirement = Crop Factor x Pan Evaporation (Epan)

(Connellan, 2003).

The Epan value was calculated using a class A evaporation pan reading, while choosing the required crop factor became more complicated. There are two options which Connellan uses to determine a crop factor, the first shown in Table 2.1 demonstrates the variability in crop factors with differing seasons, while the data in Table 2.2 show relatively the same structure however crop factors are more vague than that of Table 2.1.

Performance Level	**Turf - Warm Season**	**Turf – Cool Season**
Premium, Lush	0.70	0.90
Medium, Strong Growth	0.55	0.80
Low Maintenance, Just acceptable	0.40	0.70

Table 2.2 Crop factors for differing performance levels during differing weather conditions.

(Charlton, 2003)

Connellan only uses a single crop factor depending on which performance level he requires and which season he is growing in. It would be recommended that Connellan initiate a new trial that takes into account crop cover as well as performance level and season. By instigating these procedures it would be possible to change the crop factors to a lower figure, as the crop cover continues to increase.

The University of Western Australia is currently running irrigation trials on kikuyu that involve differing irrigation quantities. Quantities of 70 and 140% of pan evaporation are applied to two different plots to see which plot performs greater with respect to both growth and colour. Their testing showed that by decreasing the irrigation rate from 140% replacement of daily evaporation to 70% generally increased the turf growth (UWA, 2007). While these trials may have shown an increase in growth by changing to 70% pan evaporation, the question must be asked as to why they did not conduct trials at 60%, %50 and 40% pan evaporation as well. By initiating this kind of trial they would have been able to find out which percentage of pan evaporation figure causes the plant to stress. In doing so an optimum pan evaporation percentage could have been established that would provide the greatest turf growth.

2.2 Irrigation systems and performance

2.2.1 Irrigation Performance Factors

Prior to the initiation of the project it was known that uniformity problems would be a major issue and therefore a major part of this trial. With this in mind it was imperative to posses the knowledge of how previous trials have dealt with these kind of problems. The DPI in Victoria declares the main problems involved with uniformity issues:

- excessive sprinkler spacing, incorrect nozzle operating pressure, or incorrect nozzle size;

- nozzle height, angle and wear;
- variation in pump performance, such as through wear,
- uniformity under windy conditions
- run-off from high average application rates.

(DPI Victoria, 2007)

All these issues must be analysed to ensure an increase in uniformity in the trial area. Low pressure at sprinkler nozzle can cause extreme decreases in sprinkler performance, which can be caused by a variety of factors. These factors include incorrect pipe size, high minor losses throughout the system, air trapped in the system and the pump running at an insufficient speed and pressure. Pressure at the sprinkler should be at least 35 kPa greater than the desired output pressure.

It is important to remember that there is more than one factor to consider when choosing a sprinkler to receive optimum performance. Technical factors include uniformity at the planned spacing, radius of throw, and precipitation rate and height of throw. Commercial factors include price, serviceability, availability and reliability (Cape, 1998).

Filtration of the pumping system is a vital part of sprinkler performance. A lack of filtration along with pumping of low quality water can cause blockages which limit sprinkler output and reduce pressure at the nozzle. Particles such as sand get blocked in the sprinkler entrance and also the sprinkler nozzle. When this occurs, sprinkler performance is exceptionally restricted and in some extreme case can clog the sprinkler completely.

Each of the factors that have an impact on system performance is equally important. You may have a system that has been designed at perfect lateral and sprinkler spacings however if the system is running at a low pressure, it will never be able to perform to a high level, no matter how well designed it is.

2.2.2 Performance evaluation

After reading numerous articles, previous dissertations and talking to industry professionals it became clear that the most commonly used piece of equipment to test for irrigation performance with respect to uniformity issues is by using catch cans. “Catch can tests are the simplest, most accurate way of determining distribution uniformity”, (Wallace, 2007). This consisted of placing cans in a grid inside the trial area. The sprinkler system was then run and the quantities collected in each can recorded. This type of testing will be used throughout this project with results from these tests to show distribution and coefficient of uniformities as well as providing data as to how much water each section of the trial site is actually receiving per irrigation event. It would be recommended that a solid set system be operating at above 85% distribution uniformity to ensure sprinkler performance remains high.

Along with the use of catch cans, when initiating a system assessment it is recommended that you place pressure gauges at different parts of the system, especially at the pump and at the sprinkler head. By taking these steps you are able to see where the pressure

changes occur and therefore you can pin point where the main losses are in your system. Measurement of flow rate, pump speed, electricity/diesel consumption is vital, as these measurements can allow the assessor to interpret whether your pump is running efficiently. If efficiency is low, it will allow the assessor the ability to recommend changes to your current system or whether there is a need to invest in new equipment.

2.3 Irrigation in the turf industry

2.3.1 Irrigation application systems used in Australian turf industry

There are a various range of application systems used to irrigate turf with the most common form of turf irrigation being used are big gun irrigators. Dan Corfe, Industry Development Officer for the Queensland Turf Producers Association states, “Around 80% of infield application systems in Southern Queensland are big gun irrigators”. Other less common methods of turf irrigation are travelling booms and laterals. While centre pivots are used to irrigate turf they are not widely used. Some hand shift systems are still used, but because of the high labour cost involved many farmers have opted for less labour intensive irrigation equipment.

Solid set systems such as the one used at Cabarlah Park Turf are not popular because of the high upfront installation cost and the fact that they are not able to cut turf on and beside the laterals. Another problem with both in and above ground solid set irrigation is

that machinery can not be driven over it and therefore this restricts traffic paths and can cause increased compaction in high traffic areas.

2.3.2 Measured performance of application systems in turf industry

Measurements of irrigation system performance in the turf industry in Southern Queensland was basically non existent until 2006 when the government recognised that the turf industry was using large quantities of water and that research into water saving practices had to be undertaken. For this purpose a grant was given to the Queensland Turf Producers Association to employ Dan Corfe as an industry development officer. Most of the system assessments that Dan Corfe has carried out have been on big gun irrigators. From initial testing Corfe found that the average distribution uniformity for irrigation systems in the turf industry was a disappointing 62%. The greatest DU received was 78% while the lowest was 53% (Corfe, 2007). The turf and landscaping industry standard for distribution uniformity is 75% (Connellan, 2003). The data that Dan Corfe has collected so far is well below the industry standard therefore there is much room for improvement of water efficiency in the turf industry.

2.2.3 Opportunities for improvement

The main area for improvement in the turf industry is distribution uniformity of in field irrigation systems. An average of 62% in Southern Queensland must be improved if any significant decreases in water use are going to be evident. By raising the uniformity above 85% every area in the field will be receiving virtually the same quantity of water per irrigation, therefore the application amount will be able to be dropped, as there will no longer be a need to run the system for longer periods to make up for dry spots in the field.

After gathering knowledge through this literature review it is obvious there are a number of issues that need further research in order to provide more accurate benchmark figures for growers to operate from. The specific objectives of this research were to increase distribution uniformity of the underground solid set system at a cost that is credible to the grower. Further defining crop factors with respect to ever changing crop cover is a part of the project that could save large quantities of water over an entire growth period. The current standard crop factor of 0.6 in winter and 0.9 in summer is unacceptable and must be further researched to provide water savings. Research into whether weather station ETo figures can be used to quantify irrigation amounts instead of previously researched pan evaporation figures will be an interesting and highly useful part of this project. The overall objective of this student project will be to find the minimum amount of water required to grow premium quality turf.

3. Materials and Methods

3.1 Trial site

The trial sites used are situated at a business named Cabarlah Park Turf, 960 Kingsthorpe-Silverleigh Road, Boodua. This is between Kingsthorpe and Oakey (Figure 3.1). This farm was chosen as it had only recently been established and the owner (Mr Geoff Hindmarsh) was interested in evaluating the sprinkler system efficiency and developing an understanding of the water requirements of the turf under the local climatic and soil conditions. The owner was also interested in evaluating the potential to estimate crop evapotranspiration using on-site weather station.

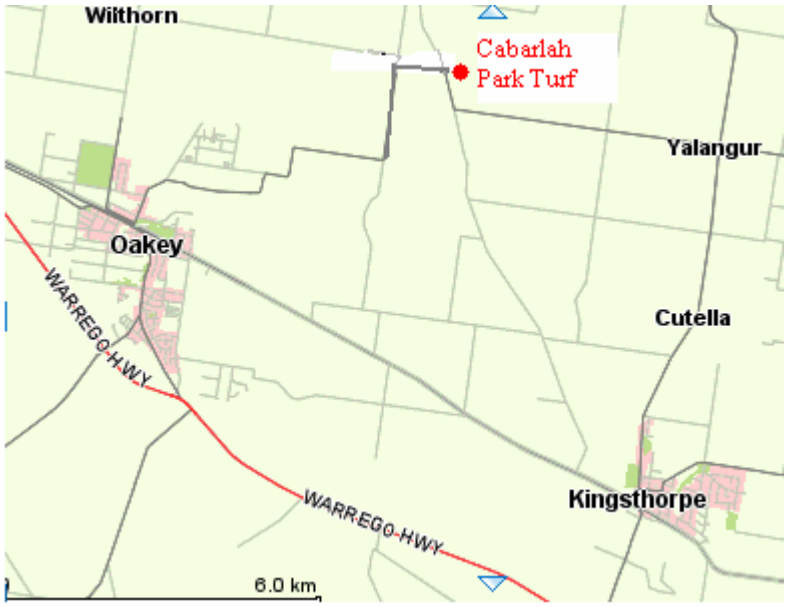

Figure 3.1 Locality map showing Cabarlah Park Turf and the surrounding area (Whereis ,2007)

The farm consists of six different blocks covering an area of 46 hectares. The turf varieties grown on farm are kikuyu, wintergreen couch, santa anna couch, tifdwarf couch with kikuyu and wintergreen couch dominating two thirds of the crop region as well as 80% of sales. There is a strong contrast of soil type within the property with block six consisting of black medium clay while block 2 has reddish sandy loam soil.

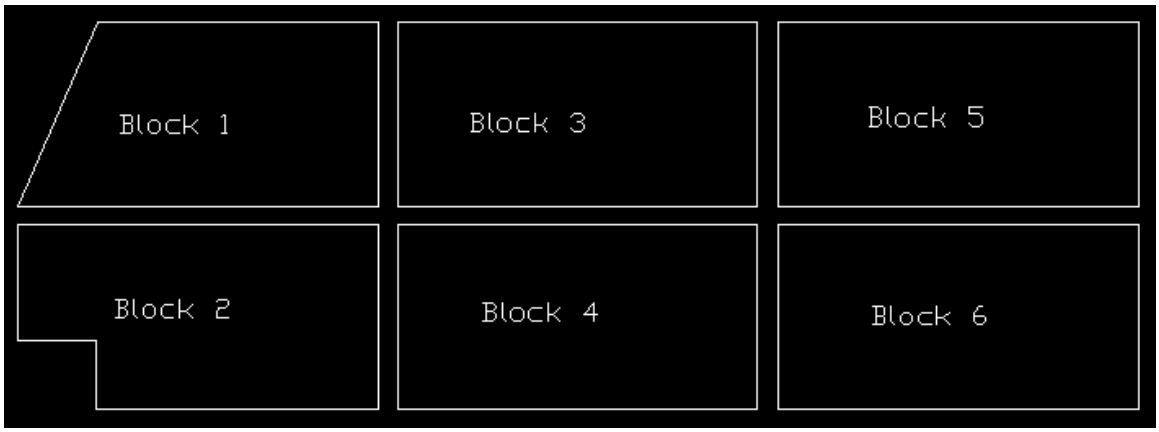

Figure 3.2 Cabarlah Park Turf farm layout

The farm receives an average annual rainfall of 627.4 mm (Bureau of Meteorology, 2007). However, in the last two years that figure has not been reached, hence the need for an efficient irrigation system. The mean temperature during summer is 30.4 °C and 19.2 °C during winter (Bureau of Meteorology, 2007). During the winter months, especially in July, the farm is affected badly by frost. This causes the leaf of the turf to be burnt and very little growth is produced during this period. The area has a mean wind speed of 17 km/h (Bureau of Meteorology, 2007) that generally blows from the north. This wind poses a problem with the solid set irrigation efficiency and is one of the major issues involved with this trial.

Statistics	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Years	
Temperature															
Mean maximum temperature (°C)	30.8	30.0	28.8	25.9	22.3	19.0	18.5	20.2	23.7	26.6	28.5	30.3	25.4	34	1973 2007
Mean minimum temperature (°C)	17.8	17.6	15.7	11.9	8.1	4.0	2.8	3.5	7.0	11.2	14.2	16.5	10.9	34	1973 2007
Rainfall															
Mean rainfall (mm)	78.8	83.2	44.6	33.7	41.2	29.9	30.2	25.6	31.3	58.0	77.8	95.4	628.1	37	1970 2007
Decile 5 (median) rainfall (mm)	74.8	73.6	34.8	20.8	28.0	17.8	23.8	24.3	23.6	46.6	72.2	94.6	622.2	36	1970 2007
Mean number of days of rain ≥ 1 mm	5.8	4.8	4.3	3.2	3.6	3.2	3.5	3.1	3.8	5.5	6.3	6.4	53.5	36	1970 2007
Other daily elements															
Mean daily sunshine (hours)															
Mean number of clear days	4.4	4.6	7.8	8.8	8.9	9.6	11.9	13.1	12.0	9.5	6.6	5.1	102.3	33	1973 2007
Mean number of cloudy days	5.5	6.8	5.8	5.2	6.5	5.6	5.6	3.9	3.7	6.3	6.1	5.1	66.1	33	1973 2007
9 am conditions															
Mean 9am temperature (°C)	24.2	23.5	22.3	19.5	15.3	11.0	10.3	12.5	16.8	20.1	22.1	23.8	18.4	34	1973 2007
Mean 9am relative humidity (%)	63	67	66	67	75	78	76	68	59	57	58	60	66	34	1973 2007
Mean 9am wind speed (km/h)	15.9	16.3	15.3	13.5	9.8	8.0	7.8	10.4	14.0	16.2	15.3	14.9	13.1	30	1973 2007
3 pm conditions															
Mean 3pm temperature (°C)	29.3	28.4	27.3	24.5	21.1	17.9	17.4	19.1	22.5	25.1	26.8	28.4	24.0	34	1973 2007
Mean 3pm relative humidity (%)	44	47	44	43	46	46	44	38	34	36	40	41	42	34	1973 2007
Mean 3pm wind speed (km/h)	18.0	17.1	16.6	15.9	16.0	16.8	16.7	17.5	17.7	17.4	17.3	17.1	17.0	25	1973 2007

Table 3.1 Weather Data from Oakey Aviation Base, 2km from the trial site.
(Bureau of Meteorology, 2007)

The property is irrigated using a Rain Bird computer controlled underground solid set irrigation system. The system runs 7005 SS series sprinkler heads using size 16 brown nozzles. Each sprinkler line has 10 sprinklers running off the one solenoid and the submersible pump can support two lines, hence twenty sprinklers at a time. There is only one bore on the property and this is the sole source for irrigation water. The main underground line is made from 203 mm PVC while the laterals are 101.6 mm poly.

The trial sites consist of a block of land which for the purpose of this trial will be referred to as a bay. The bays in block 5 have the measurements 17 m by 400 m which accounts for 6320 m^2 of producible turf. The bays in block 2 are 20 m by 400 m which caused differences in uniformity. Prior to this research, these bays had full crop cover and were harvested for turf sale. This process leaves the soil completely bare. It is then aerated to reduce compaction due to traffic on the bay during the growing and cutting periods. From this point all trials were instigated and all water placed on the bay from either irrigation or rainfall, was monitored. Two trials were conducted during 2007 to evaluate crop water use and the effect of irrigation non-uniformity on production over both summer and winter turf production periods.

3.2 Wintergreen Couch Field Trial

The wintergreen couch trial was located in Bay 6 of Section 5 of the property. This trial was initiated on the 19th January 2007 and was harvested on the 1st May 2007. During this time frame the turf was irrigated on Mondays, Wednesdays and Fridays, except if there was a rainfall event. The irrigation quantities were calculated using ETo figures from the on farm weather station. In the event of a rainfall event that quantity of rain (in mm) was taken off the ETo figures and the turf was not watered until the ETo was again positive. During this period three enviroscan soil moisture meters were placed on site. The first was placed in bare soil, the second in medium coverage and the third in fully established turf. The purpose of this placement was to see the difference in crop water use at different stages of crop cover and growth. They were also used to tell if the soil profile was being over irrigated. During this trial the sprinkler system was evaluated for distribution uniformity and it was decided that the sprinkler heads and nozzles be changed to try to improve uniformity results. Urea was added to the trial site at thirty day intervals to boost crop growth rate, increase colour and to lower turf water requirements. When the turf had grown to a-grade standard it was cut and evaluated in 2 m intervals within the trial site. The quality of the turf was then assessed with respect to differing water application amounts to determine a minimum water requirement for A-grade turf production.

3.2.1 Agronomic Management of trial

One of the main problems associated with reduction in turf quality and crop growth is the marks left in the top of the soil profile by various farm machinery, most notably tractor tyres. Most of the machinery has been fitted with specially designed turf tyres however track marks still get left in the top 50 mm of the soil which compacts the ground, reduces pore space and restricts root growth. The other issue is that the turf cutter is unable to cut properly on ground that is not flat. Ridges left by tyre marks makes it virtually impossible to get the turf to come up the conveyor belt in one piece which overall makes it unfit for sale and is therefore a loss. To try to remedy this problem a heavy roller is used to even out the soil profile. This process takes place prior to cutting and when the ground has been watered but not saturated. Although this process causes increased compaction to the soil, it is a necessary step in turf production and cannot be avoided.

Fertilisation of the bay was to be carried out using only urea as the turf's external nutrient source. Urea was placed on the bay on the day of aeration and was then renewed every 30 days for the first 90 days of growth. After the 90 day period expired an evaluation of the turf progress, growth and colour would take place to decide whether a fifth treatment of urea was needed, keeping in mind the financial cost of fertilising and the end cost to the consumer.

Fertiliser was to be placed on the trial site at the initiation of growth and then repeated every thirty days until cutting commenced. Urea was placed on the field on the 19th

January 2007 at a rate of 176 kg/ha. At both thirty and sixty days, fertiliser was again applied at a rate of 352 kg/Ha. It was decided that at the completion of the 90 day period that no fertiliser was needed as growth and colour were exceptional. Over the entire growth period there was 880 kg of urea placed on the trial site (6.8 ha), which equates to 130kg/ha. This is a large amount of fertiliser and further research would be required to discover that by decreasing the rate, at what point is more water is required for the same speed of growth.

In the case of growth of numerous weeds throughout the turf, it is necessary to spray various chemicals on the turf to ensure that the product being sold is weed free. The following chemicals are the most frequently used at Cabarlah Park Turf to control weed growth and insect disease.

SEMPRA	Nutgrass
KAMBA M	Broadleaf herbicide
DIMENSION	Pre-emergent
DACONATE	Some broadleaf weeds and kikuyu (only used in couches)
CHLORPYRIFOS	Insect and grub infection insecticide

Daconate is only used in extreme cases as it will not kill the couch grass. However, it will heavily reduce or stunt growth for a small period of time after application. To a lesser extent Kamba M will also have a bearing on crop growth post application. This is a production constraint that must be taken into account when assessing crop growth.

3.2.2 Irrigation Applications

Any irrigation that was applied to the turf is automatically recorded by the computer program that controls the pump and all solenoids. The system records the minutes that the irrigation is running and using the outflow figures from the pump, the mm/min of water that is actually applied to the turf can be established. That figure was 0.1755 mm/minute, which mean that the depth that had to be applied was divided by 0.1755 and the time that the pump had to be run was calculated.

The scheduling of the irrigation events was to occur three times a week, that being a Monday, Wednesday and Friday. This meant that the turf was receiving an irrigation event every two days and three days over the weekend period of the week. The volume of irrigation was varied according to the estimated crop water requirements and the fluctuation in daily ETo calculations. By not knowing the soil PAWC, TAW, RAW and field capacity made it hard to use the daily water balance equation. There was no underground water movement in the crop root zone therefore $Flux_{net}$ could be eliminated from the equation. Since total water in the root zone and total water in the root zone on the previous day could not be accurately found, the daily water balance equation was modified. The equation accounts for rainfall, deep drainage, Etc and runoff when calculating irrigation amounts. To calculate the irrigation application amount the following equation was used.

$$\text{Irrigation Amount(mm)}=\left(\text{chosen crop factor}\times\sum ETo\right)-\left(\text{Rainfall-}\left(\text{Deep Drainage+Runoff }\right)\right)$$

To convert the irrigation amount from mm to minutes the pump must be run for the following equation is used.

$$\text{Irrigation Time(min)} = \text{Irrigation Amount(mm)} \div 0.1755$$

The relevant crop factor involved with turf production is 0.6 in winter and 0.9 in summer (FAO 56, 1998). The crop factor was to be multiplied by evapotranspiration figures from the days that followed the previous irrigation event to produce the required amount of irrigation to be applied to the turf. The figure produced is the time that you must enter into the irrigation computer program for the sprinklers to operate for. This process is designed to ensure that the turf is receiving adequate irrigation for optimising growth. Obviously there will be parts of the field receiving greater amounts of water than others due to uniformity issues.

As the wintergreen couch trial site was investigated during the last half of summer and the beginning of autumn the crop factor was going to have to be continually reassessed using factors such as crop growth, ground cover and temperature as the basis of gauging whether a change in crop factor was warranted. The kikuyu trial site was to be investigated in the end of autumn into early winter, which meant there wasn't as much deviation in crop factors as there was in the wintergreen couch trial.

Since the purpose of the project was to find minimum water requirements, the irrigation pattern was started using a crop factor of 0.8. On the 26th of February a sufficient crop cover was reached, therefore it was possible to drop the crop factor to 0.7. Three weeks

later growth was still continuing at a satisfactory pace and a thick crop cover had now been produced over the majority of the trial site. From this point up until cutting the crop factor was dropped to 0.6.

3.2.3 Evaluation of Sprinkler Uniformity

This system is to be analysed and evaluated for distribution uniformity, coefficient of uniformity, pressure performance at pump and nozzle. Evaluation recommendations for improvements in the system must then be put forward. All performance advances must be evaluated in terms of actual improvement possibilities, to justify any excess costs involved.

There were four DU tests undertaken on the wintergreen couch trial site. Two of these tests were done using the 7005 rainbird sprinkler heads fitted with brown size nozzles. The other two tests were conducted with the 8005 rainbird sprinklers fitted with red sized nozzles. Plastic catch cans were used to test the performance of the Rain Bird computer controlled underground irrigation system. These can cans were 110 mm in diameter and were placed in a rectangular grid in between four sprinklers, seen in Figure 3.3.

To work out the depth of irrigation that various parts of the trial zone received, the data from the catch can results were used. Since we knew the depth irrigation each part of the field was receiving, this figure was multiplied by how many hours the pump was operational for. These figures were worked out firstly by using the readings taken from

the results from the 7005 sprinkler heads. The same was done with the 8005 heads and both figures were then totalled to give an overall figure of how much irrigation each interval of the field received over the entire growth period. All rainfall on the trial site was considered to be uniform. This enabled us to calculate how much water each field interval received from both irrigation and rainfall.

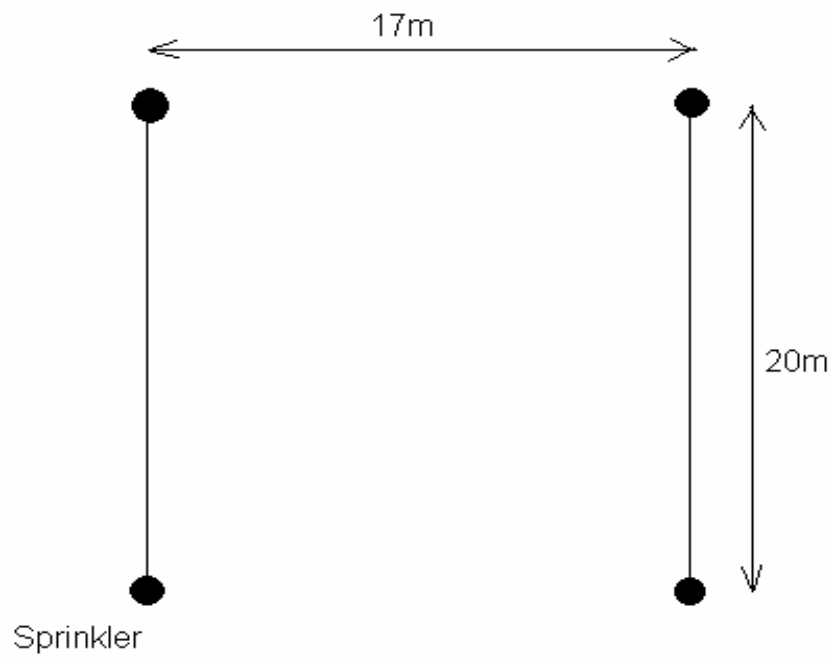

Figure 3.3 Sprinkler irrigation layout showing the distance between laterals and the sprinkler spacing.

The two lines of catch cans closest to the sprinkler lines were placed 1m away from the line. The rest of the catch cans were placed inside these two lines at 2m spacing. At this point wind speed and direction were noted as these factors can have a major bearing on the results. The sprinklers were then run for thirty minutes and data was then collected. Data was entered into a specially designed Microsoft Excel file where uniformity figures and graphs were produced. Unfortunately there are very few irrigation events at

Cabarlah Park that are at zero wind conditions. Therefore, any Du tests carried out, that were under these conditions, were not used in finding the overall amount of water differing sections of the bay received during growth period.

3.2.4 Soil Moisture Measurements

Three enviroscan soil moisture probes were placed in the ground at the initiation of the testing on the wintergreen couch trial site. One of the probes was positioned in the centre of the trial site which had zero turf cover. The second probe was placed along the sprinkler line and was surrounded by turf with full coverage. The third and final probe was positioned in the middle of the bay next to the trial site. This was done so that the probe could be surrounded by turf at approximately 50% coverage. The purpose of placing the probes in differing crop cover is to see the correlation between crop cover and water use. After conducting a distribution uniformity test on the trial site it was found that the probes in the bare and medium coverage areas where receiving the same application amount however the probe in the full crop cover was receiving 0.7 mm/hr more than the other two probes. This was taken into account when assessing soil moisture from the enviroscan output graphs.

The enviroscan logs soil moisture every thirty minutes and the data is able to be accessed on site or by phone. Graphs are produced using this data. They show how wet the soil profile is and at what depth. The depths were recorded at 10, 20, 30 and 50 cm in two of the probes while the other probe had an extra sensor at 40 cm deep.

3.2.5 Growth Rate and Final Yield Measurements

During the growth period photos over chosen fixed parts of the trial site were taken at differing growth stages. This gave an outlook of how crop cover was increasing over time. It also showed clearly which parts of the field were struggling due to low application amounts as a result of poor uniformity. When it is decided upon that the turf has reached a stage of growth equal to the requirements for a-grade turf production, cutting of the turf will commence. The turf is cut using a 17inch blade and is cut approximately 1.2metres in length. This size is the most common because most cutter machines are designed with this sized blade width and that three slabs of turf at this fits perfectly onto any common sized pallet.

The turf will be rated in 2 different areas, colour and sod strength. Sod strength refers to how well the slab of turf holds together after being cut without breaking into two or more pieces. Sod strength is therefore a direct result of how well the root system has grown and entwined together. Only turf that is cut and stays in one piece will be accepted as being a-grade turf. Any areas scoring zeros were unable to be cut. The sod strength in areas rated five and six were inferior and were just strong enough to hold together in one piece. The areas rated seven held together well however did not posses the stability to be granted a nine. The colour rating of the turf was calibrated using a one to nine scale, nine being a finest quality.

3.2.6 Rainfall

All rainfall received at the farm was recorded by an on-site weather station which sent the information to the computer program that ran the irrigation system. A standard rain gauge is also used for manual calculations as a check of the electronic weather station readings. If there is any difference in readings the manual calculations were used as they were guaranteed to be error free as there were no electronics involved.

The rainfall for the growth period was low with the total rainfall between the 19/01/07 and 1/5/07 being only 73mm. The graph of the rainfall events can be viewed in figure 3.4**.** It is important to note that this amount of rainfall is well below average for the area and that there was no rainfall at all after the 10/3/07. While this pitiful amount of rain did not help the farmer a great deal, it did allow the inefficiency of the irrigation system to be clearly evident.

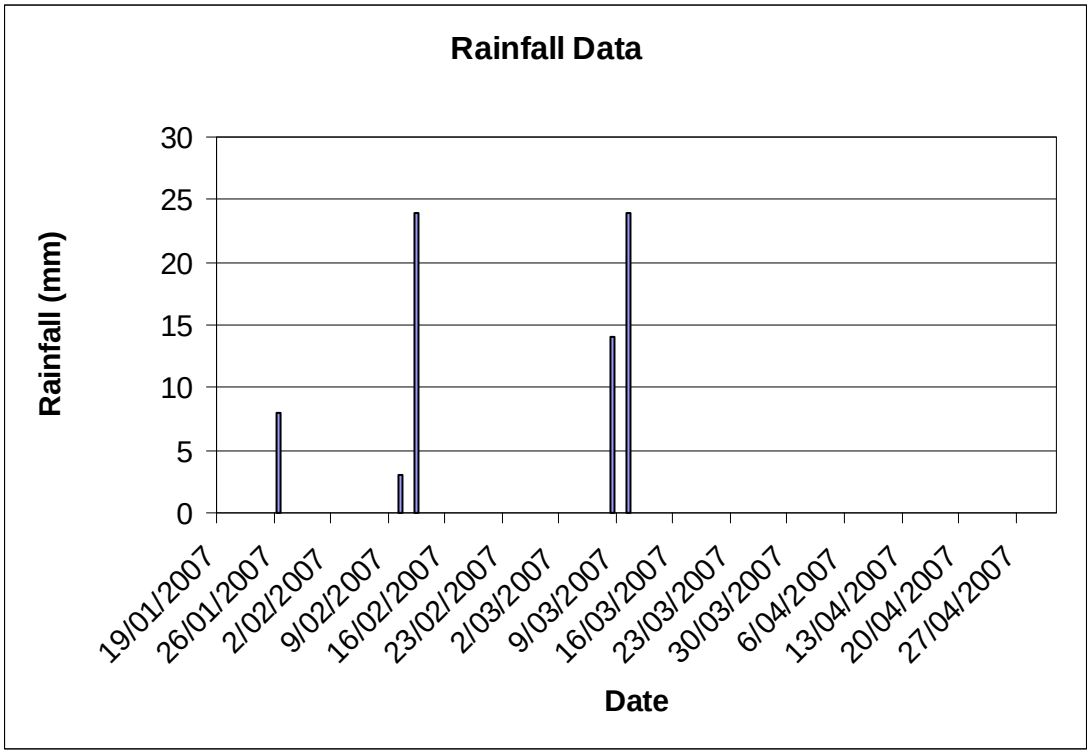

Figure 3.4 Rainfall at the farm during the trial growth period

3.2.7 Temperature

The daily temperature fluctuations must be monitored as they are a vital piece of data to calculate the daily ETo values. The temperature will also control how well the turf will grow as extremely high maximums during the day will not assist the turf to grow to its potential. The temperature was recorded using the on farm weather station and logged on the attached computer system.

As shown in figure 3.5 the maximum temperatures were the greatest during January and February and then started to drop off slowly during March. This drop in temperature and

therefore reduction in evaporation was another reason that the crop factor was able to be reduced. Figure 3.6 shows the minimum temperatures during the growth period. For the first two months of growth the minimums were reasonably stable however there was a considerable drop in minimum temperature after the ninth of March.

To check if the on farm weather station was accurately recording temperature reading a comparison of it and Oakey Aviation Base was required. The Aviation Base is three kilometres away from the trial site however it was a closest reliable weather station and it was deemed close enough to compare data. Figure 3.7 shows a clear comparison of both minimum and maximum temperature over the growth period between the two weather stations.

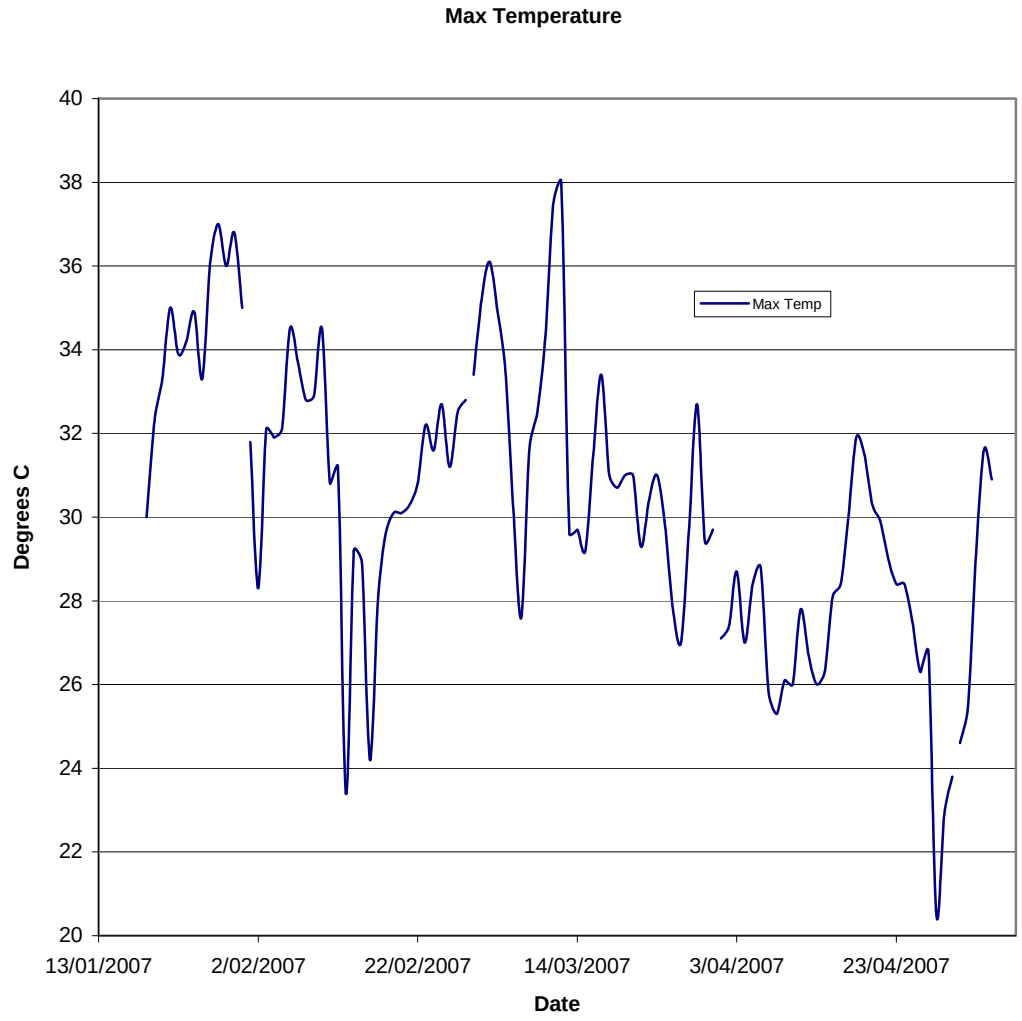

Figure 3.5 Maximum temperatures during growth period, the gaps in the data are the end of months

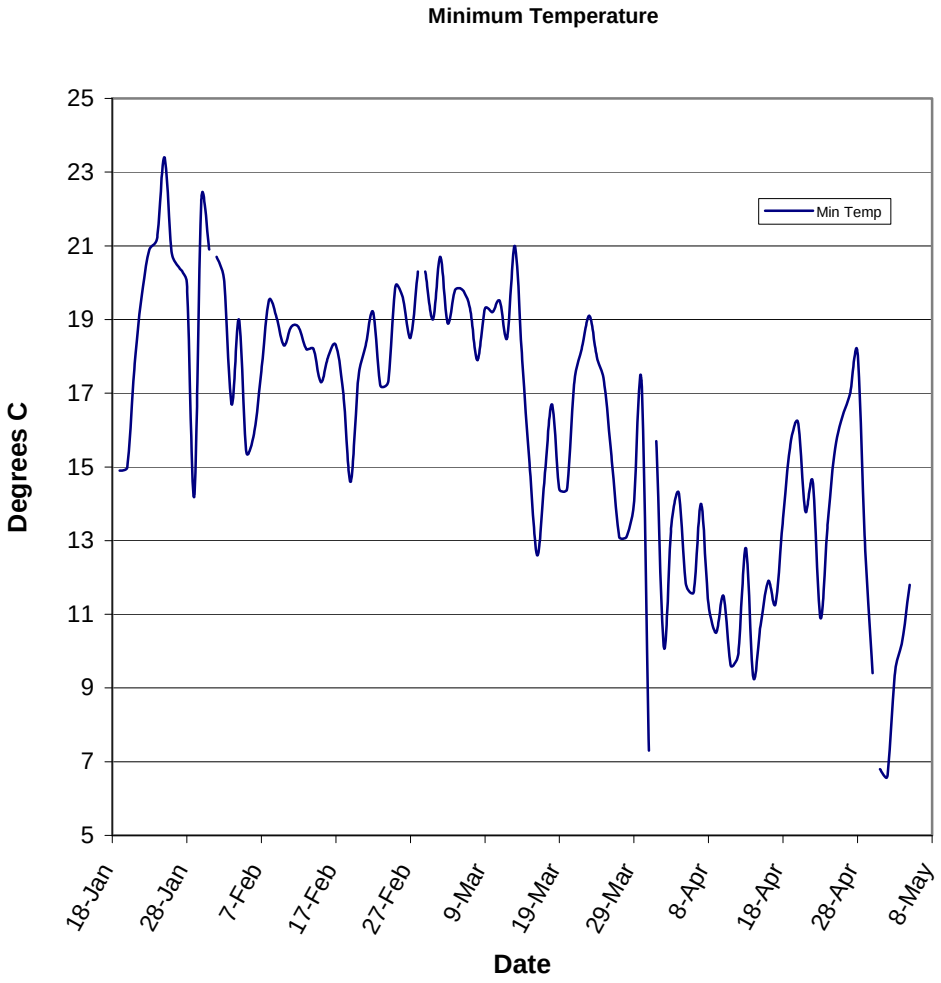

Figure 3.6 Minimum temperatures during growth period, the gaps in the data are the end of months

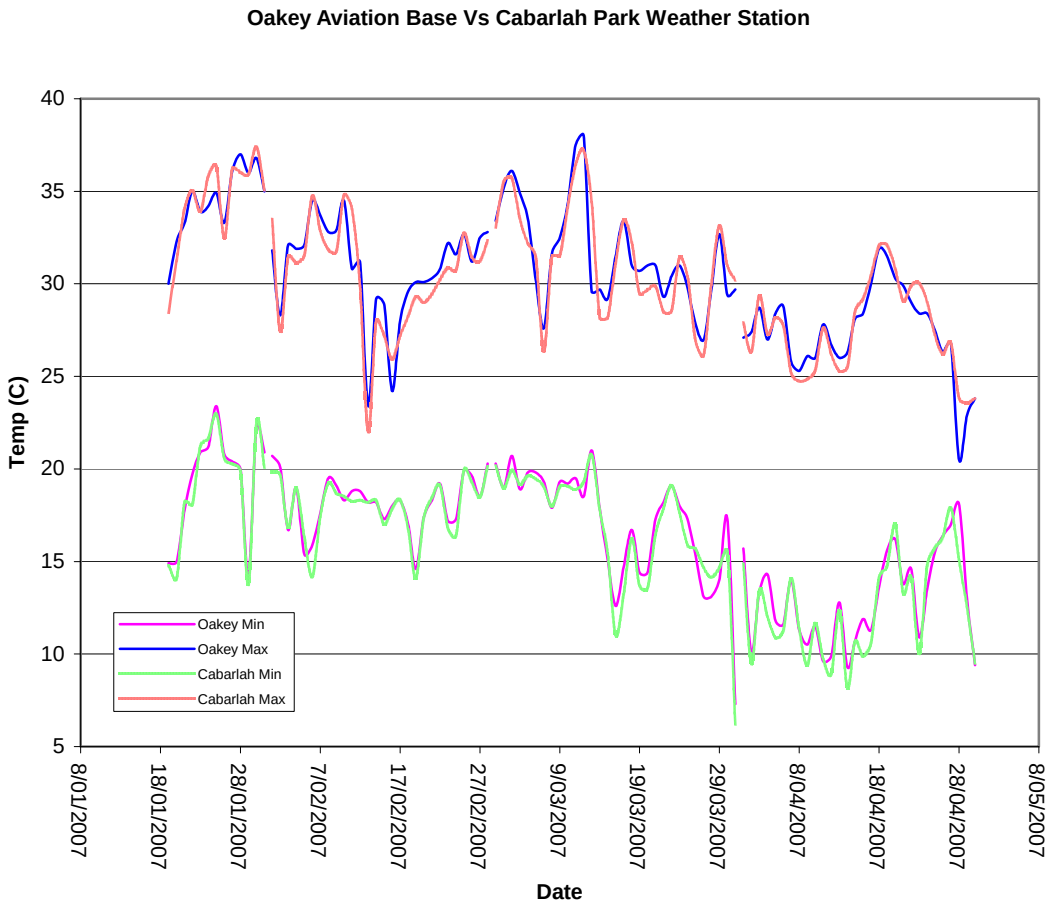

Figure 3.7 A comparison in temperature difference between Cabarlah Park temperature and Oakey Aviation Base

(Bureau of Meteorology, 2007)

3.3 Kikuyu Field Trial

The kikuyu trial was located in Bay 4 of Section 2 of the farm. This trial was initiated on the fifth of May 2007 and started as a success. However, problems that would eventually cause the project to be incomplete soon arose. The turbine pump at the farm failed and consequently no irrigation was placed on the field for a fortnight until the pump was fixed. Unfortunately when the pump was assessed it was found that not only the pump was no longer operational but the electric motor that drives the pump was also broken. This problem meant the turf was not irrigated for 4 weeks and was totally dependant on rainfall for a water source in this period of time. It was not until six weeks of no irrigation application that a replacement diesel engine was used for irrigation. This pump was only able to partially service the property and proper application amounts were still not being reached. When the new pump arrived the trial area again went without irrigation for a two week period when the new submersible pump and electrical work took place. During this period of no irrigation the turf growth was also affected by a large period of frost. This burnt the leaves of the turf and as there was not a great deal of readily available water in the top layer of soil, the kikuyu growth was stunted for a long period of time. The consequence of this long period without irrigation is that the turf will not be ready to be cut before the due date of the project. This means that there will some growth data and distribution uniformity data however there will not be a final outcome for the minimum water requirement of kikuyu on the Darling Downs.

3.3.1 Agronomic Management of trial

Fertilisation of the bay did not occur every thirty days as planned as urea has to be watered in and there was no access to irrigation at due dates of the fertiliser schedule. Fertilisation at a rate of 176kg/ha did occur at the initiation of the trial but did not take place afterwards.

All traffic and weed management practices were the same as described in section 3.2.1. Because of the sandy loam soil type the kikuyu trial did not get affected as badly with wheel marks as the wintergreen trial, which was in black medium clay soil.

3.3.2 Irrigation Applications

When the irrigation system was operational the kikuyu was watered using the same method as used in the wintergreen couch trial as described in section 3.2.2.

3.3.3 Evaluation of Sprinkler Uniformity

The kikuyu trial site was analysed and evaluated for distribution uniformity, coefficient of uniformity, pressure performance at pump and nozzle only once during the trial. This test was carried out on the trial site once the new submersible pump was operational. Evaluation recommendations for improvements in the system must be then put forward. The DU test undertaken on the kikuyu trial site were done using the 7005 rainbird

sprinkler heads fitted with brown size nozzles. No 8005 rainbird sprinklers were used or evaluated in the kikuyu trial.

3.3.4 Soil Moisture Measurements

The soil moisture measurements were taken as per section 3.2.4. In the kikuyu trial due to an equipment shortage, there was no access to a third probe therefore the test carried out in turf at 50% coverage was unable to be used for this trial. There was a difference of 1.5 mm/hr between the application rates of the two probes. The probe in the bare ground received the higher rate and this was taken into consideration when assessing enviroscan soil moisture graphs.

3.3.5 Growth Rate and Final Yield Measurements

The growth rate measurements were done in the same way as section 3.2.5. As well as using this method, an extra method was used to try to mathematically quantify turf growth. It was decided that since there was access to the same wheeled cart that past student, Andrew Piper had used, it would be used in this trial to measure growth rates. To test the growth of the kikuyu site a machine has been made that takes a video stream of the turf. From this video stream a computer program has been developed that can turn the video data into three different percentages. These percentages consist of green, being the prospering turf, bare being the soil and dormant being dead turf. The growth rate will therefore be how many percent the turf or green percentage can increase per week. There

is a GPS system attached to the video unit so you can pin point which areas of the trial site are growing at different rates. This system will be once every three week, dependent on growth and weather until full crop cover is reached. Ten data sections throughout the trial site will be used.

3.3.6 Rainfall

The same method that was used in 3.2.6 was used for the kikuyu trial. Because of the break down of the pumping system the kikuyu trial relied totally on rainfall for its source of water for most of the time frame shown below in figure 3.8. There is a period of six weeks that no rain fell between July and August, which happened to coincide with the coldest period of the year. During this stage the turf was unable to grow properly and was almost dormant.

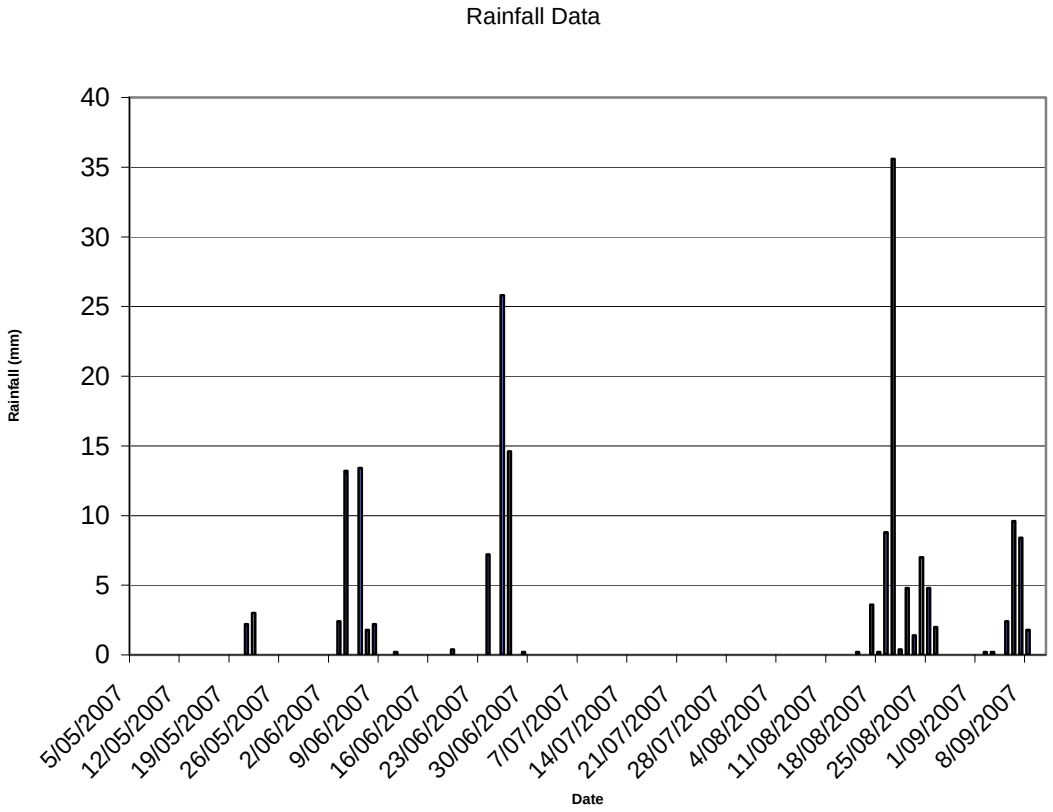

Figure 3.8 Rainfall at the farm during the trial growth period

3.3.7 Temperature

Temperature for the kikuyu trial was recorded as per section 3.2.7. As shown in figure 3.9 the average daily maximum temperature over the growth period was 20ºC. As kikuyu is classed as a warmer season grass (Duble, 2007), this kind of temperature does not provide premium growing conditions for kikuyu. The minimum temperatures over the same growth period can be viewed in Figure 3.10. The average minimum temperature was 6ºC which is extremely cold and although it is slightly well above the average of 4.5ºC (Bureau of Meteorology, 2007) it is still cold enough to burn the leaf of

the kikuyu and bring the crop to the brink of dormancy. It is also important to note that there were thirteen days where the minimum temperature was below zero.

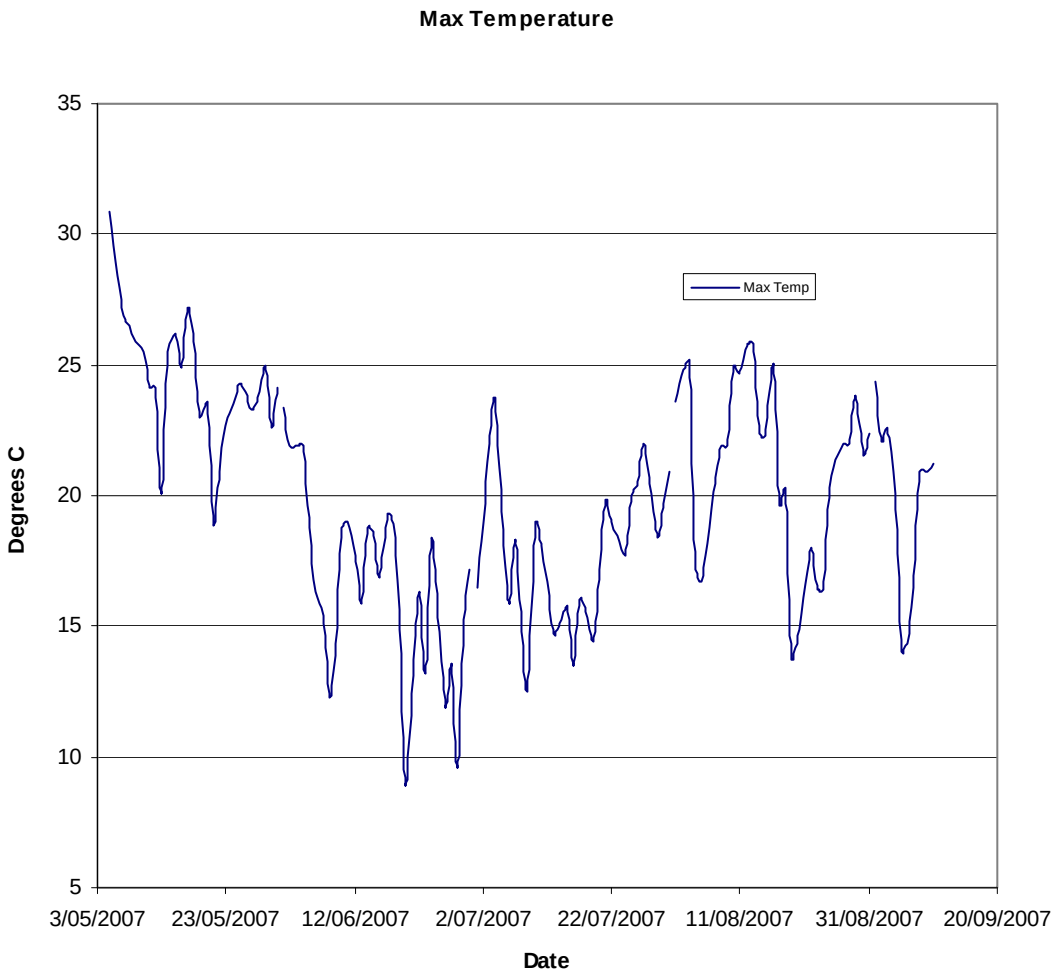

Figure 3.9 Maximum temperatures during growth period, the gaps in the data are the end of months

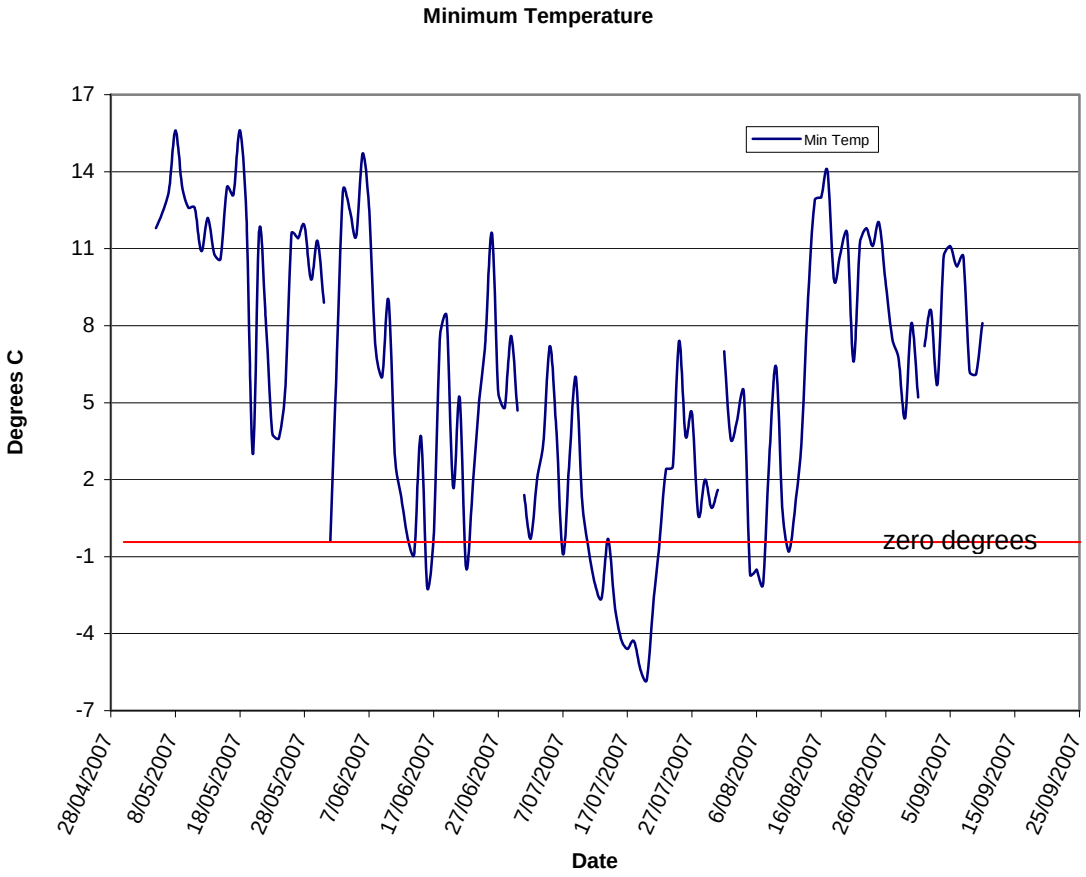

Figure 3.10 Minimum temperatures during growth period, the gaps in the data are the end of months

4. Results

4.1 Wintergreen Couch Field Trial

4.1.1 Irrigation applications

Shown below in Table 4.1, is the amount of irrigation that was applied to the trial site separated into weekly intervals. The rainfall events that occurred during the growth period are not shown in this table. The irrigation run time is also included in the table. This gives you an outlook of how many pumping hours were required to water the trial site over the 19th January to the 1st May.

Period	mm	Irrigation Run Time (min)
19/01/2007 - 26/01/2007	42	240
27/01/2007 - 2/02/2007	56	320
3/02/2007 - 9/02/2007	31	176
10/02/2007 - 16/02/2007	10	56
17/02/2007 - 23/02/2007	29	165
24/02/2007 - 2/03/2007	44	248
3/03/2007 - 9/03/2007	16	90
10/03/2007 - 16/03/2007	34	195
17/03/2007 - 23/03/2007	30	173
24/03/2007 - 30/03/2007	33	189
31/03/2007 - 6/04/2007	42	240
7/04/2007 - 13/04/2007	15	88
14/04/2007 - 20/04/2007	27	152
21/04/2007 - 27/04/2007	19	110
27/04/2007 - 28/04/2007	2	14
Total	431	2456

Table 4.1 The amount of irrigation applied in weekly periods.

4.1.2 Irrigation Uniformity

Figures 4.1 to 4.4 show which parts of the field are receiving different amounts of water in a period of one hour. The trial area is in between two laterals and four sprinklers, which are the stars in the figures.

After running the first catch can test it was found that the Du and Cu were 54.2 and 72.3 respectively. Although these figures did not come as a surprise, they were disappointing. The differences in uniformity, shown in Figure 4.1, were visible over the trial site with some fairly major variations in growth in differing areas. Another trial was done a week later and the results were Du of 54.5% and a Cu of 68.8%. The second trial, shown in Figure 4.2, was done under heavier than normal wind conditions and for that reason the data from the first trial was used. Results from both sets of data made it clear that changes had to be made to improve sprinkler performance uniformities.

Shown in Figure 4.3 and 4.4 are the Du results when using the 8005 sprinkler heads. The first test was done at zero wind conditions, while the other test was carried out in conditions that reflected a normal irrigation event. The Du at zero wind conditions was 62% while the windy conditions registered a Du of 58.9. The graphs were made using Microsoft excel.

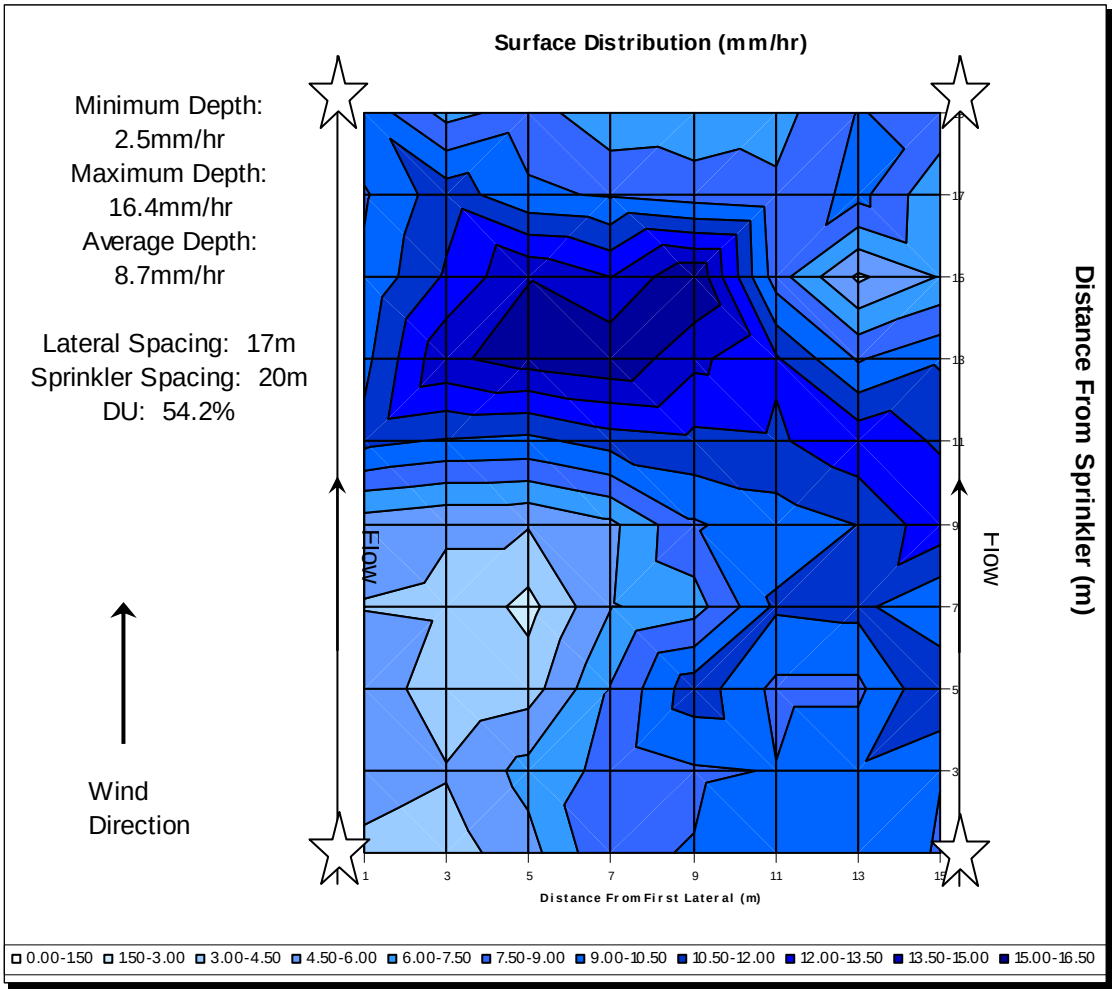

Figure 4.1 Du results of 54.2% using 7005 sprinklers

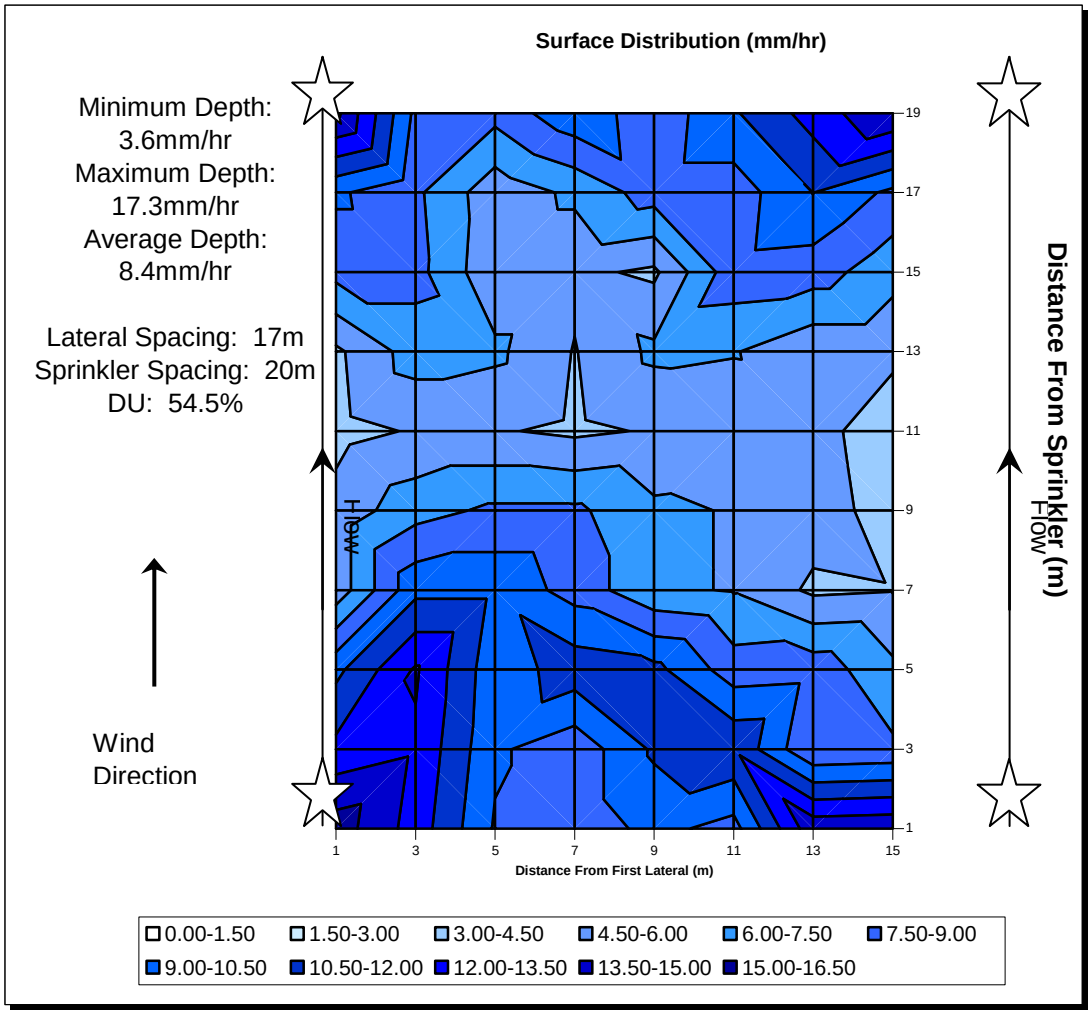

Figure 4.2 SecondDu results of 54.5% using 7005 sprinklers

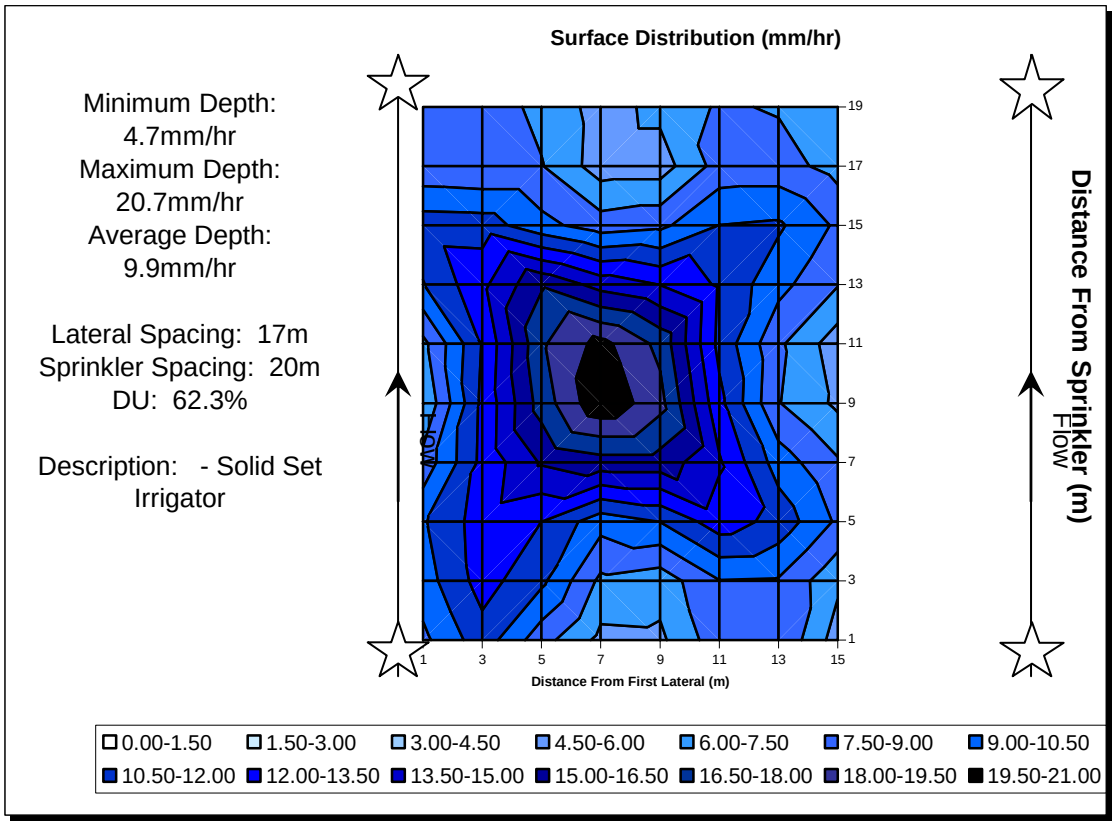

Figure 4.3 Du results of 62.3% using 8005 sprinkler heads in zero wind conditions

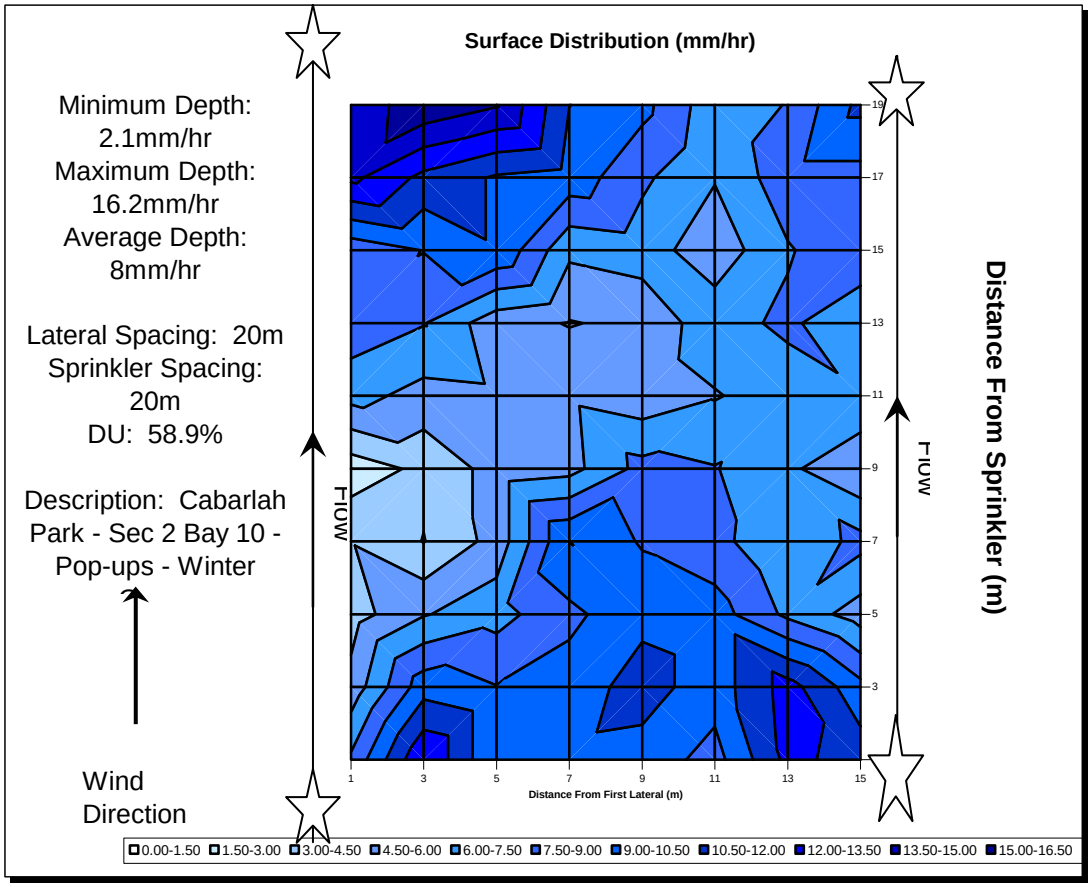

Figure 4.4 Du results of 58.9% using 8005 sprinklers in windy conditions

4.1.3 Growth rate and Yield Responses

The Figure 4.5 to 4.11 displays photos taken over the growth period. The photos clearly show the parts of the trial site that suffered badly from poor irrigation. These photos make it clear that growth rates over different parts of the field were entirely different.

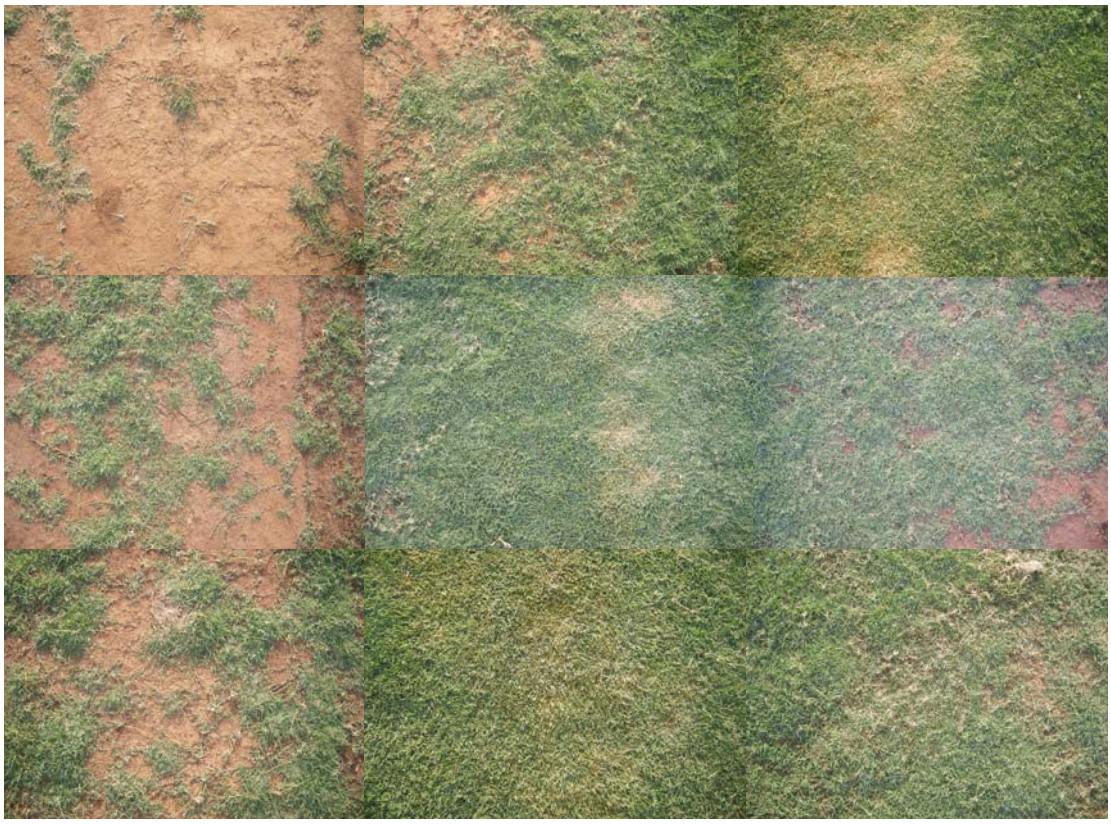

Figure 4.5 Growth at 16/02/07

Figure 4.6 Turf Growth at 23/02/07

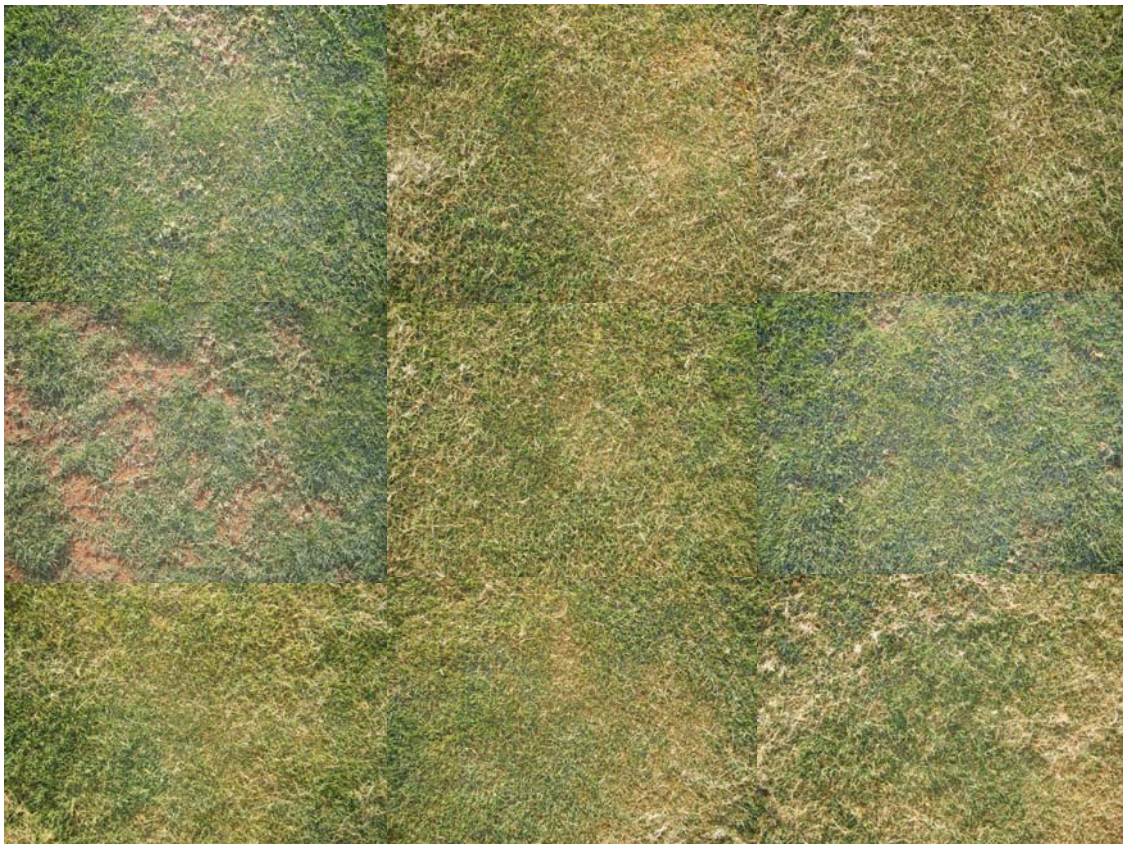

Figure 4.7 Turf growth at 5/03/07

Figure 4.8 Turf growth at 12/03/07

Figure 4.9 Turf growth at 19/03/07

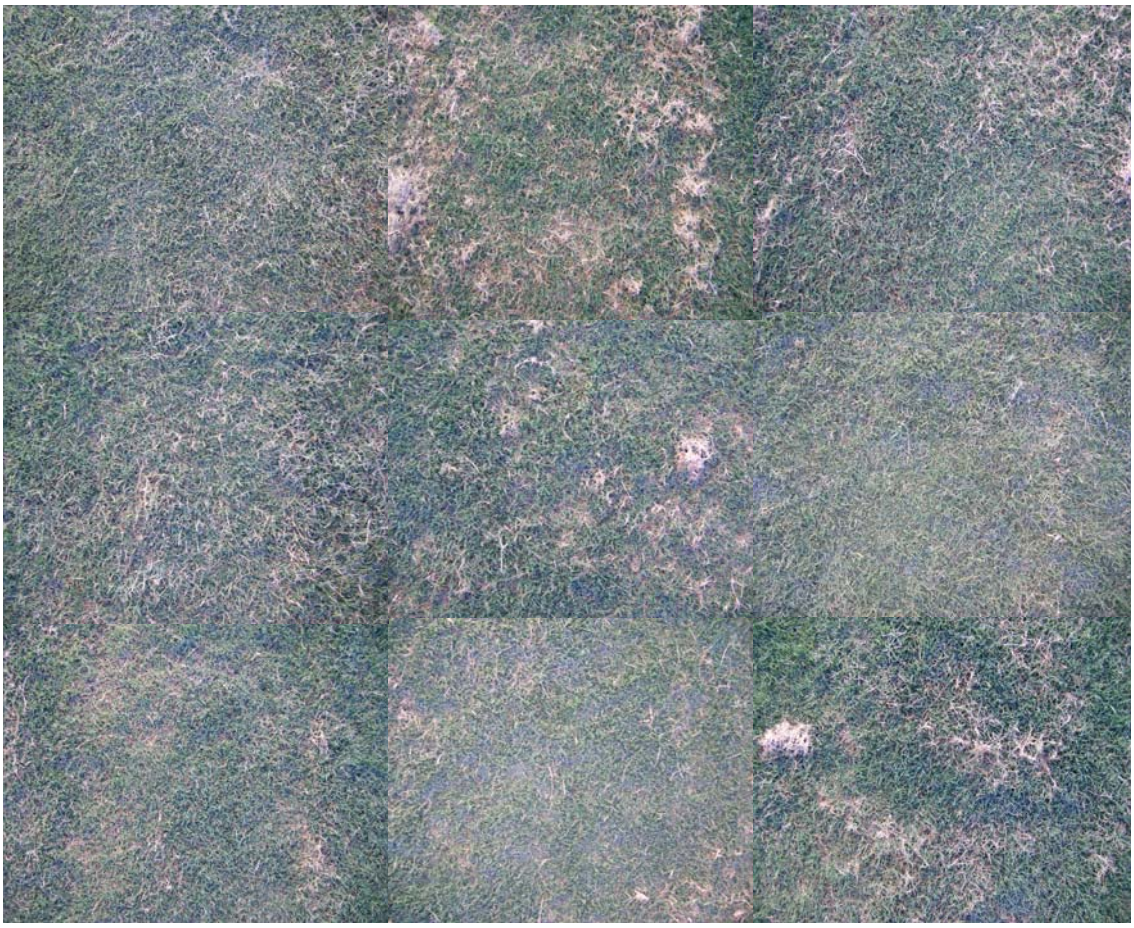

Figure 4.10 Turf growth at 23/04/07

Figure 4.11 Turf growth at 1/05/07

Colour Rating

From the trial site the majority of the 20m by 17m area expressed superb rich green cover and registered a nine in the colour rating scale which is depicted in Figure 4.12. There was one area, shown in Figure 4.12, which showed slightly less lustre and as a result was awarded a rating of only eight. It is illustrated that the area that received a rating of eight received a great deal less water than the other sections of the trial site.

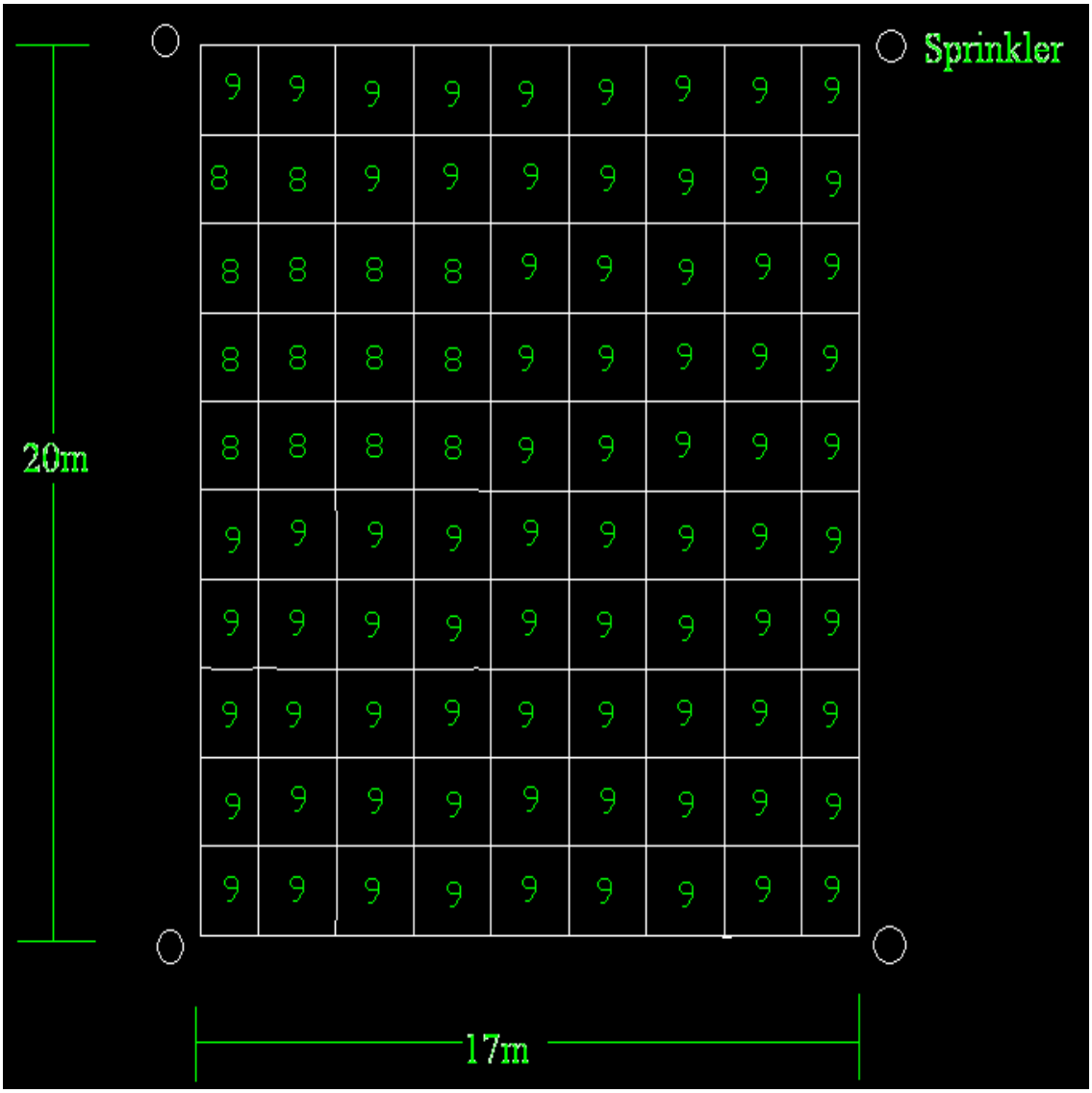

Figure 4.12 Turf Colour Chart

Strength Rating

Shown below in Figure 4.13 is how the various parts of the trial site were rated with respect to their strength attributes. Most of the field received a rating of nine however there was a section that was inferior. This coincided with the area that received the lowest amount of irrigation due to poor uniformity.

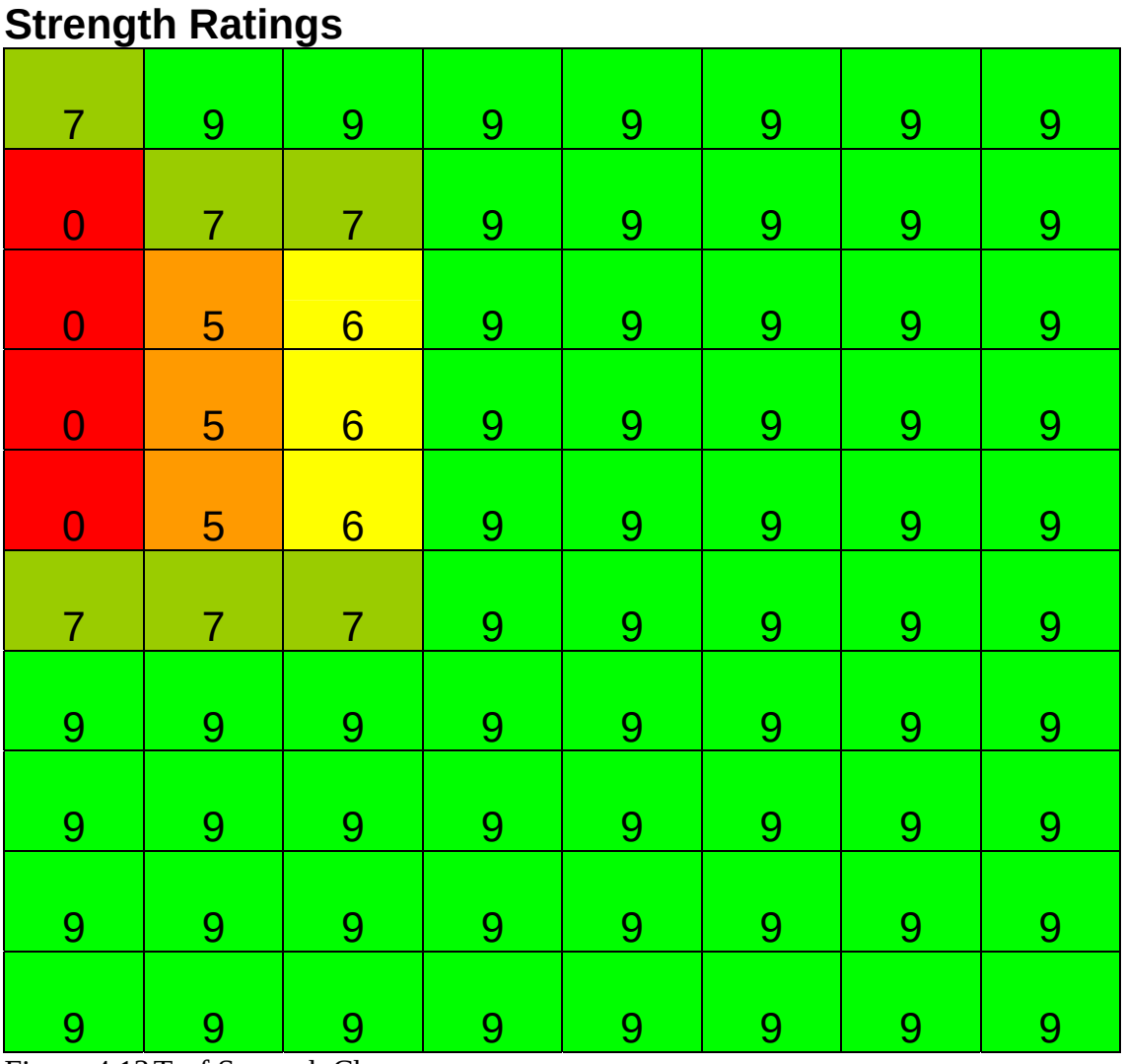

Figure 4.13 Turf Strength Chart

4.1.4 Soil Moisture Measurements

Shown below in Figures 4.14 to 4.16 are Enviroscan screen shots of the soil moisture at different levels in the soil profile. To find the depth of the sensor there is an index at the top of each graph that matches the depth with the colour of the line. Each graph corresponds with a different section of the trial site. These sections are no, medium and full crop cover at the time of installation. These graphs are referred to as stacked graphs due to the individual data being graphed on top of one another.

Figures 4.17 to 4.19 are Enviroscan screen shots of the combined soil moisture of the 10, 20 and 30 cm sensors. These graphs are referred to as summed graphs due to the output graph being made up of data summed from multiple sensors. The graphs are designed to give you an idea of soil moisture in your entire crop root zone, which in this case is 30 cm and not just at different depths.

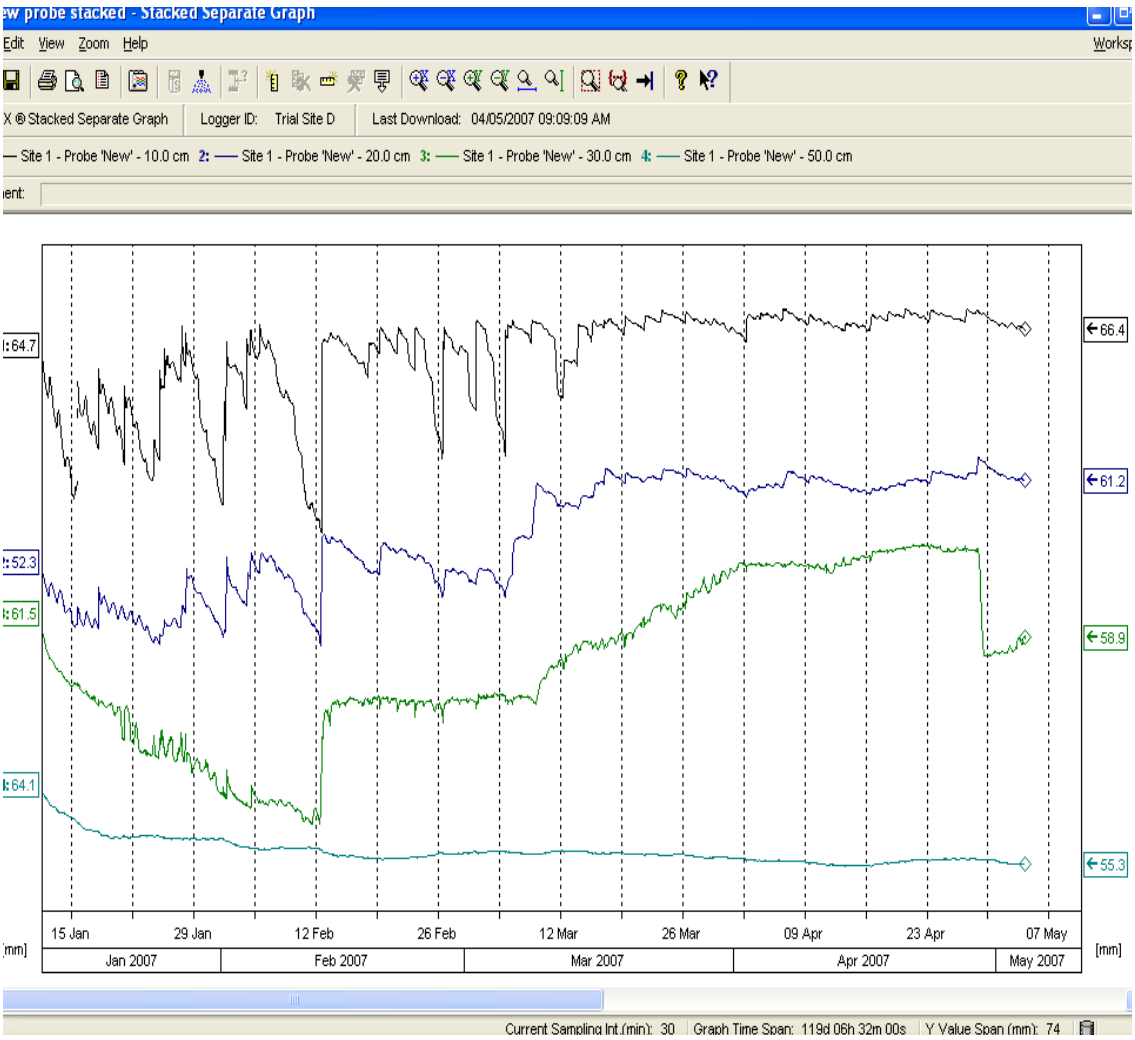

Figure 4.14 Stacked Enviroscan data from probe initially positioned in the bare ground

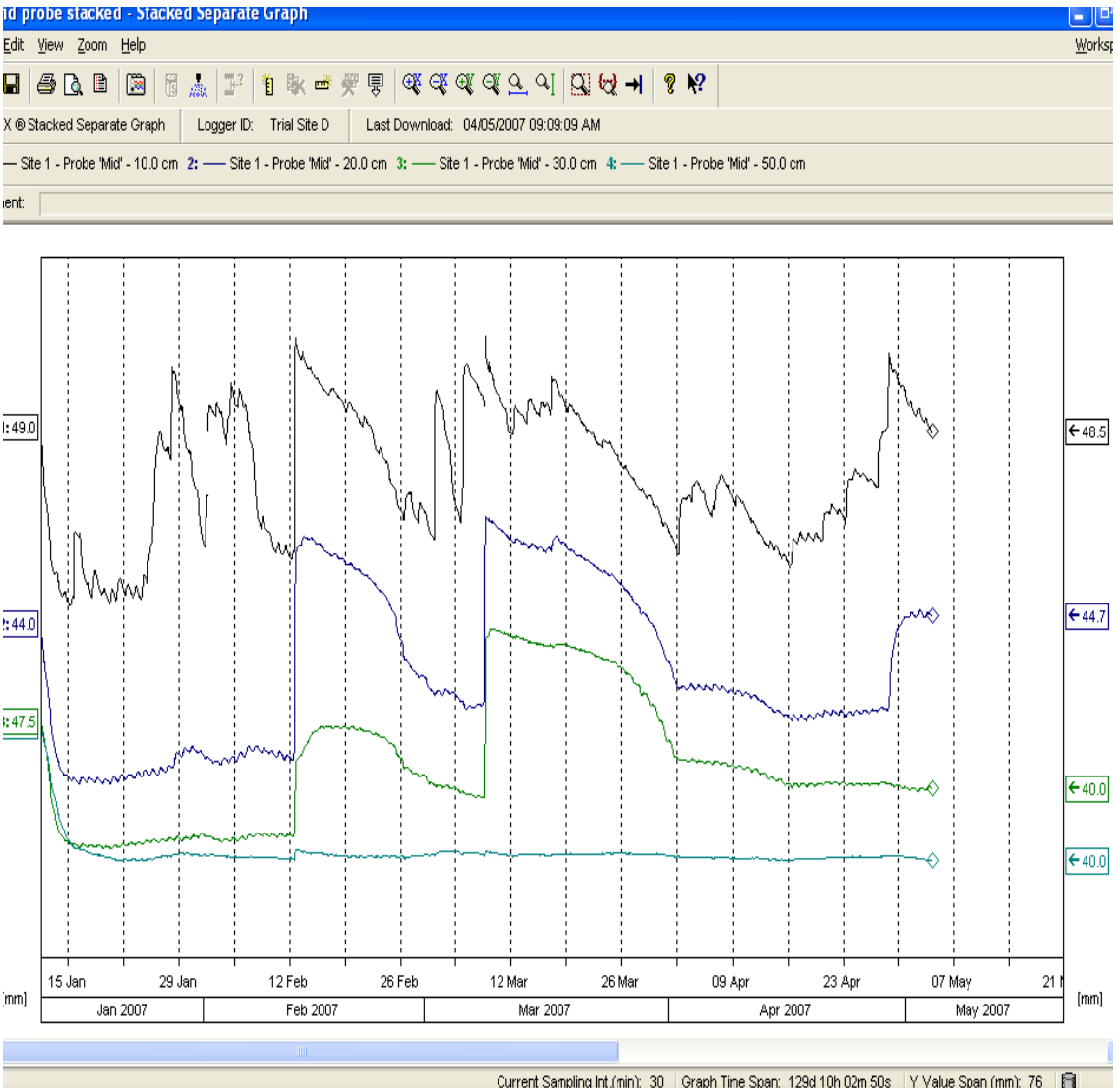

Figure 4.15 Stacked Enviroscan data from probe initially positioned in the ground with medium crop cover

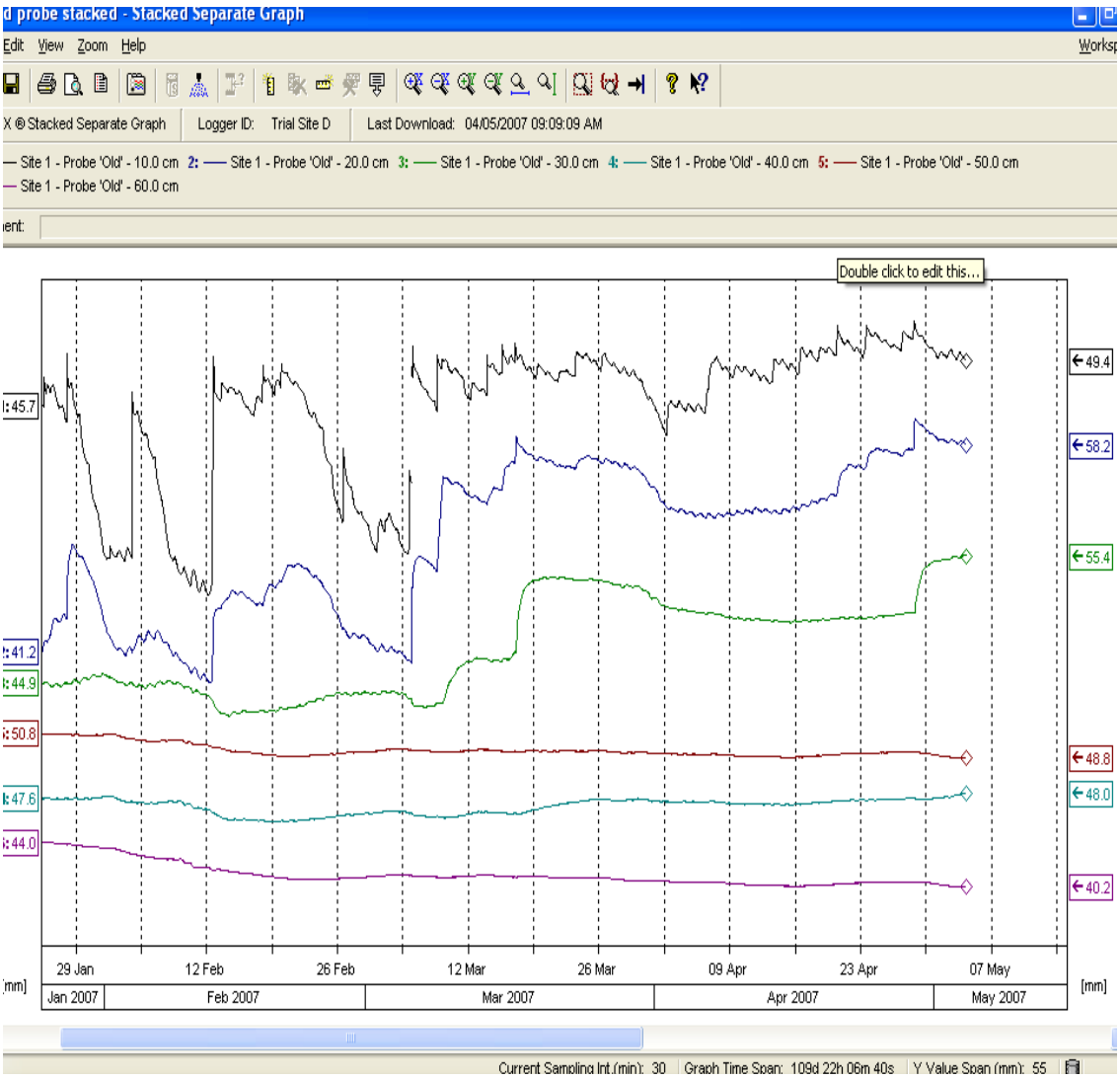

Figure 4.16 Stacked Enviroscan data from probe initially positioned in the ground with full crop cover.

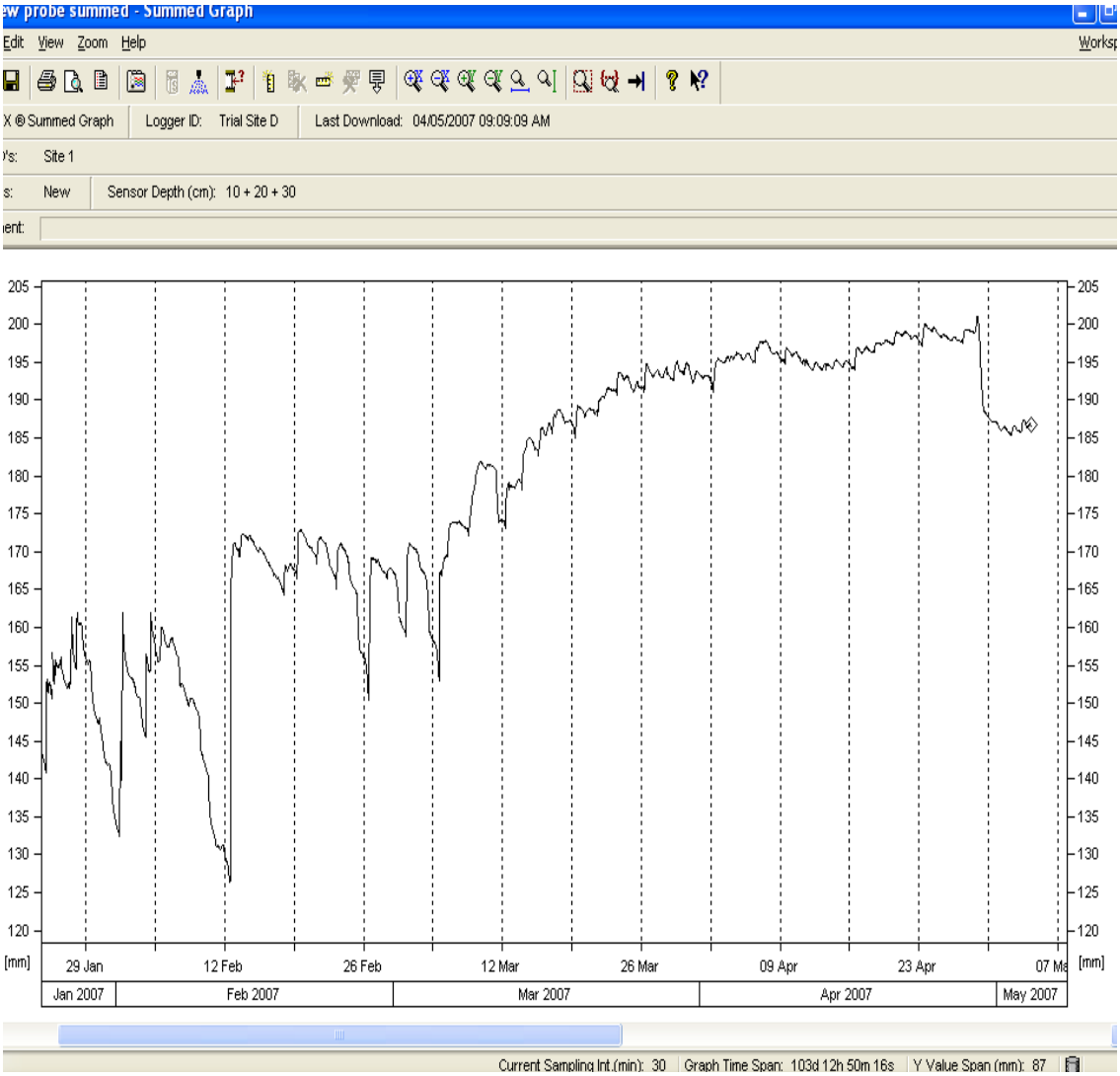

Figure 4.17 Summed Enviroscan data from probe initially positioned in the bare ground.

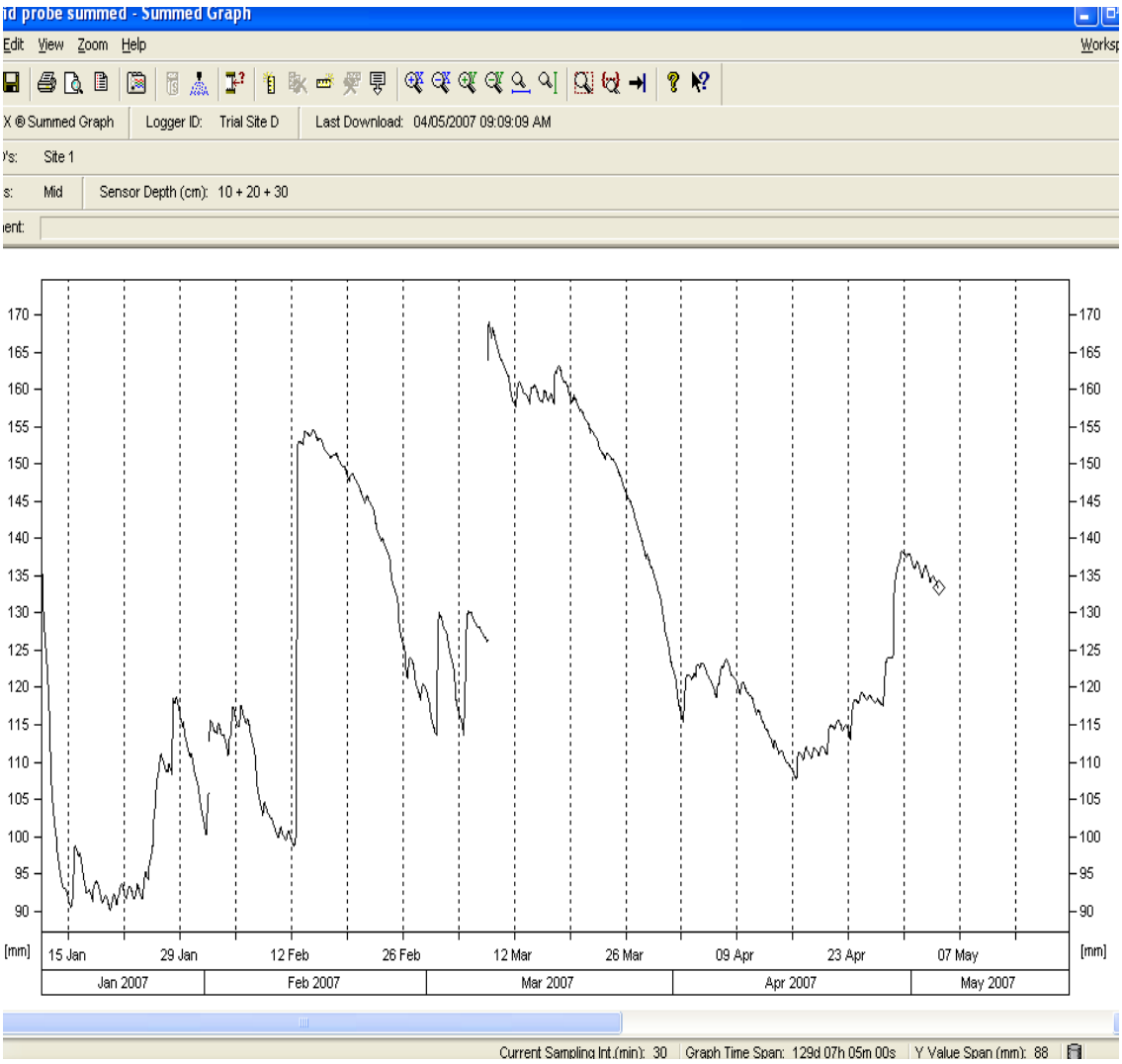

Figure 4.18 Summed Enviroscan data from probe initially positioned in the ground with medium crop cover.

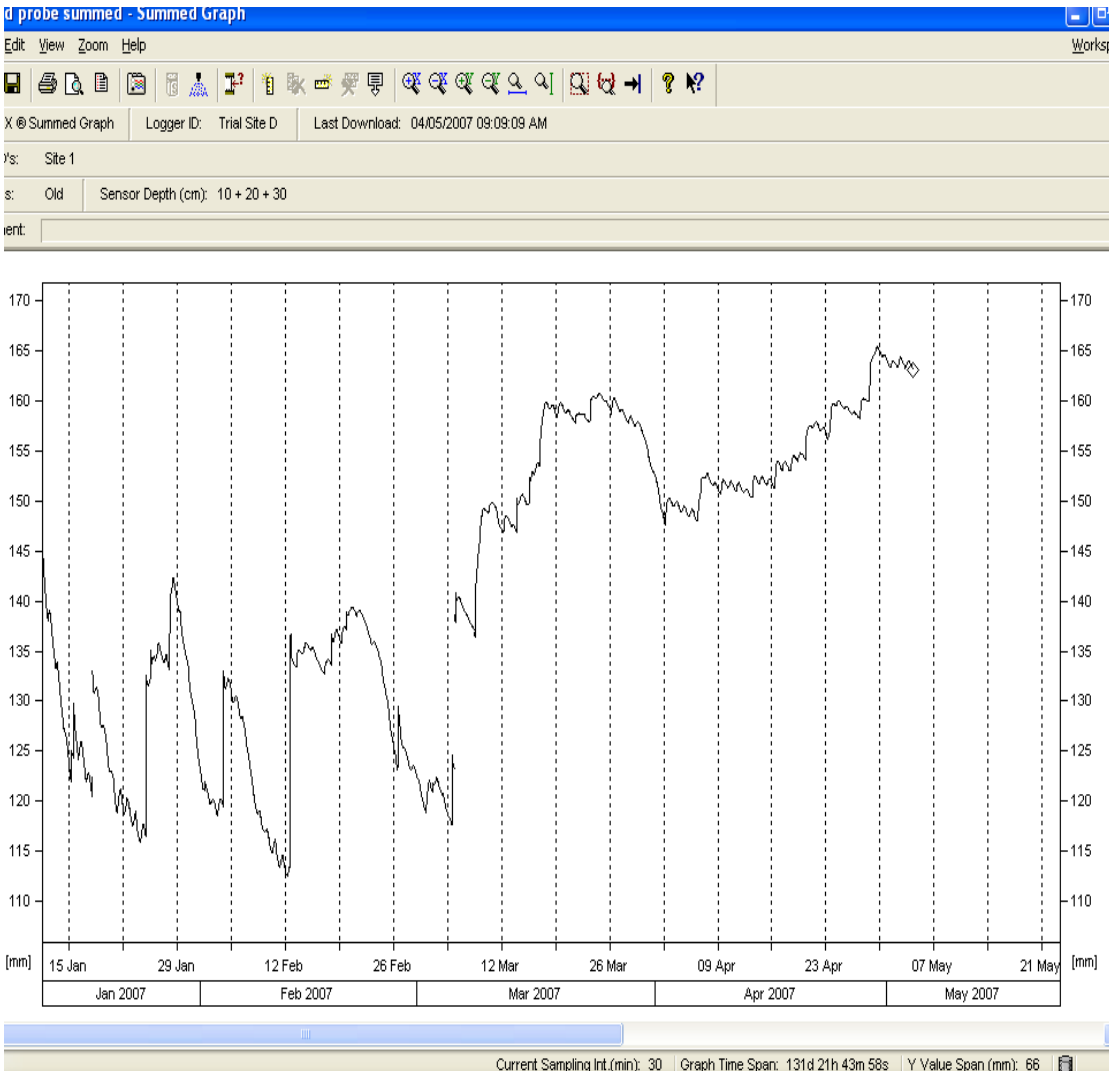

Figure 4.19 Summed Enviroscan data from probe initially positioned in the ground with full crop cover.

4.1.5 Relationships between irrigation uniformity and turf growth

The amount of irrigation versus the strength rating gives you an idea of what quantities of water achieved premium strength and also shows what parts of the trial site received lower quantities of water and did not provide adequate strength. Each dot on the graph represents a different part of the field. Individual data for all sections in the trial site can be viewed in Appendix C.

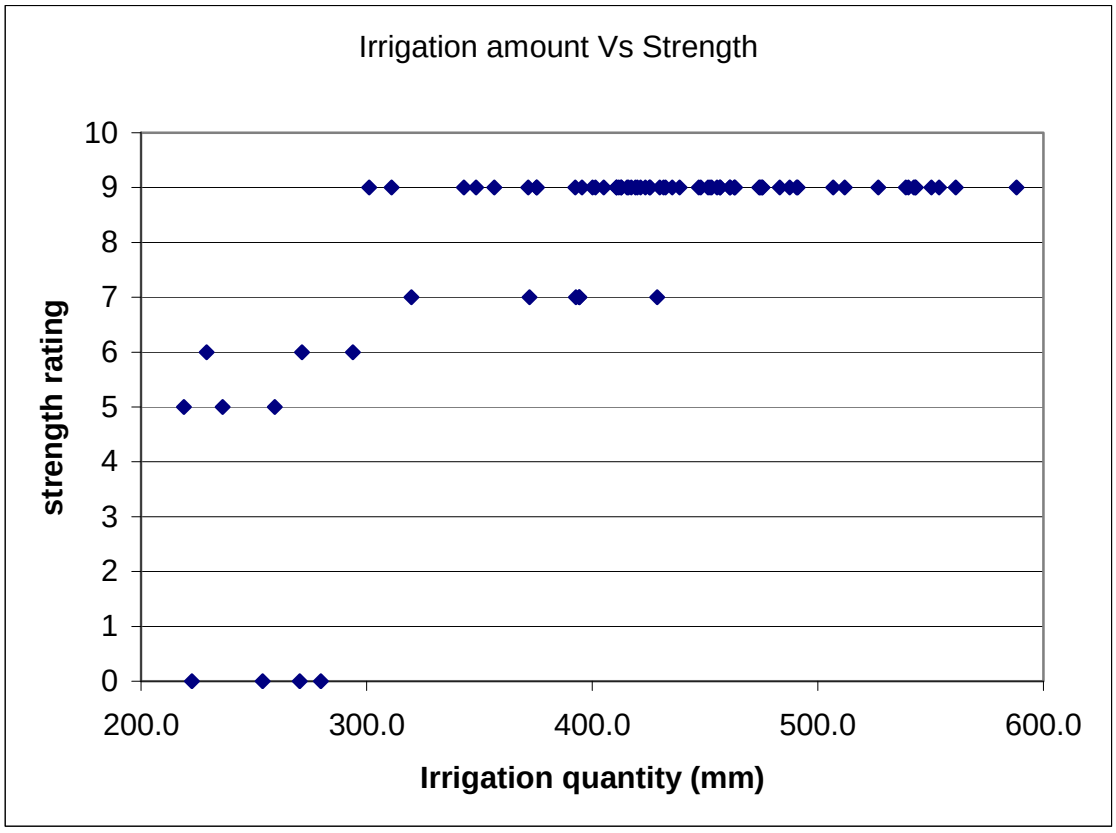

Figure 4.20 The relationship between irrigation quantities and strength rating.

4.2 Kikuyu Field Trial

4.2.1 Irrigation applications

Due to the site irrigation computer malfunctioning there was inaccurate data for the irrigation applications. While the computer was able to still save irrigation events, the irrigation quantities were wrong and the timing of these events was also inaccurate. For this reason there was no irrigation events data for the kikuyu trial.

4.2.2 Irrigation Uniformity

Figure 4.21 shows which parts of the field are receiving different amounts of water in a period of one hour. This test was carried out after a new pump had been fitted and was done so using 7005 sprinkler heads. The distribution uniformity was 57% which was a pleasing result seeing that the laterals were at twenty metre spacings, three metres greater than the wintergreen trial site.

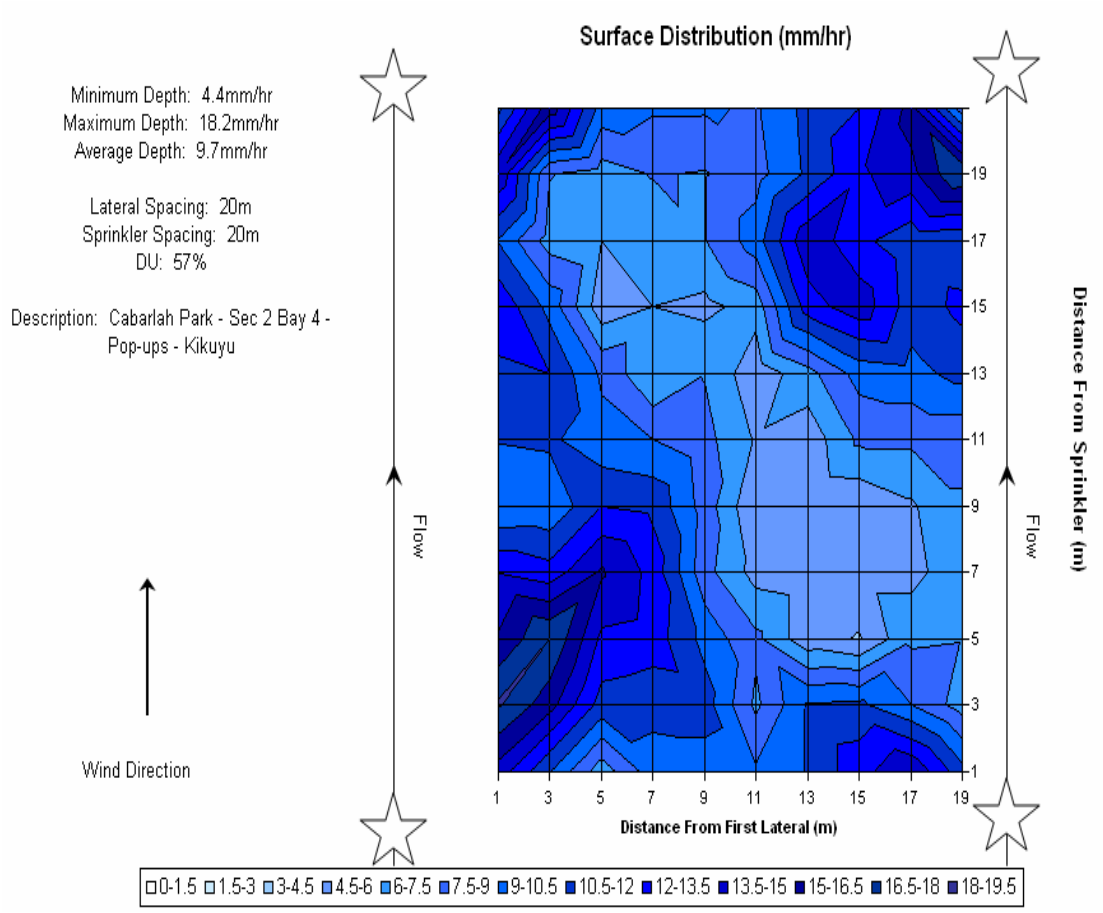

Figure 4.21 Du test using 7005 sprinklers

4.2.3 Growth rate and Yield Responses

Show in Figures 4.16 to 4.20 are growth rate photos over that were taken at various dates through the kikuyu growth period. Because of leaf burn due to frost there was a large period between the 11/6/07 and 17/7/07 that no photos were taken. This was because the turf was not growing and looked virtually dead. There was no photo when there was bare ground due to the trial site being chosen when there was already some regrowth.

There are no strength and colour results due to the turf not being ready to cut. As already stated, the pump broke down for a large period of time which inevitably caused the cessation of the trial due to the fact the turf would not be ready to cut before the end of November.

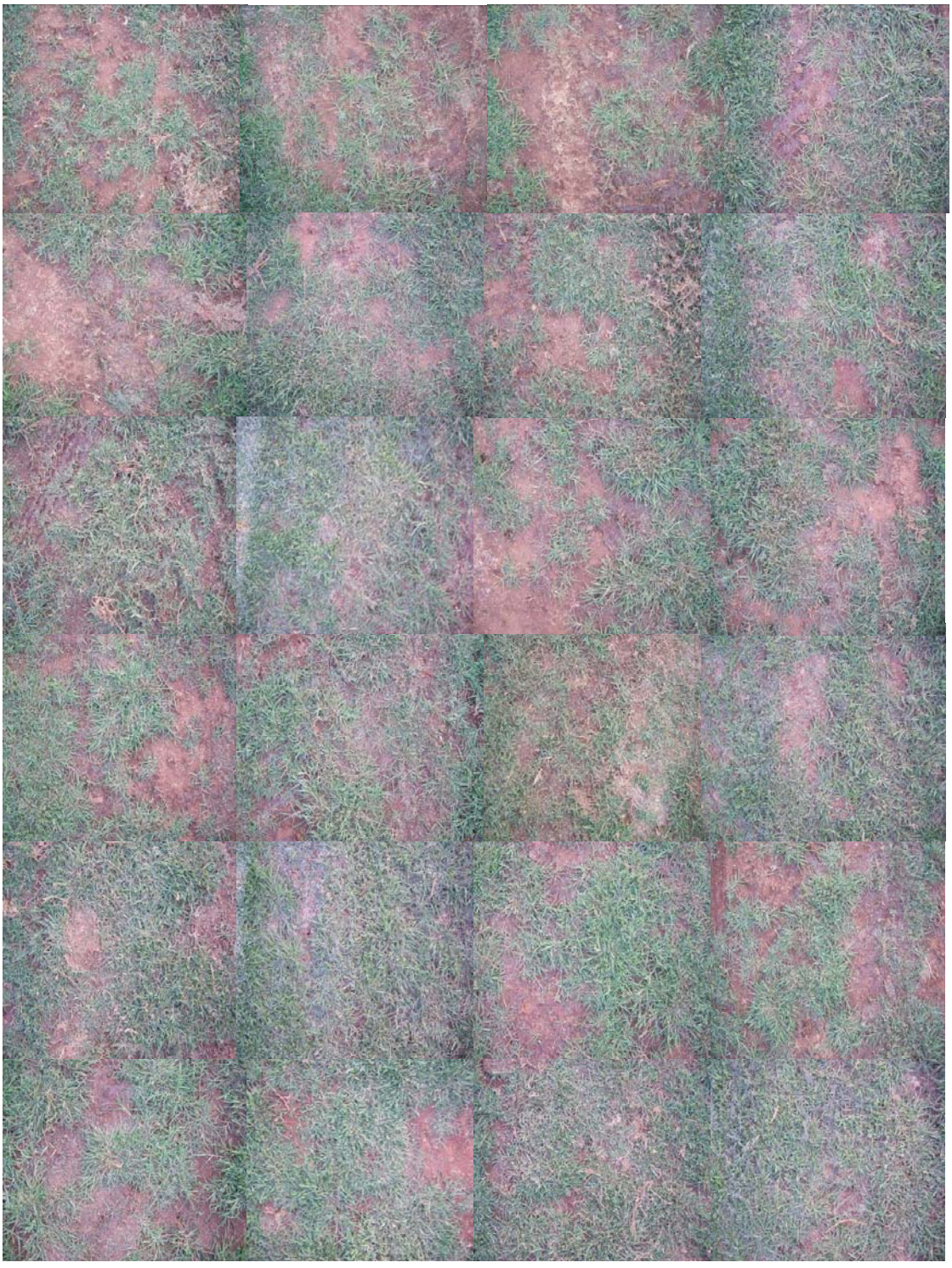

Figure 4.22 Turf growth at 28/05/07

Figure 4.23 Turf growth at 11/06/07

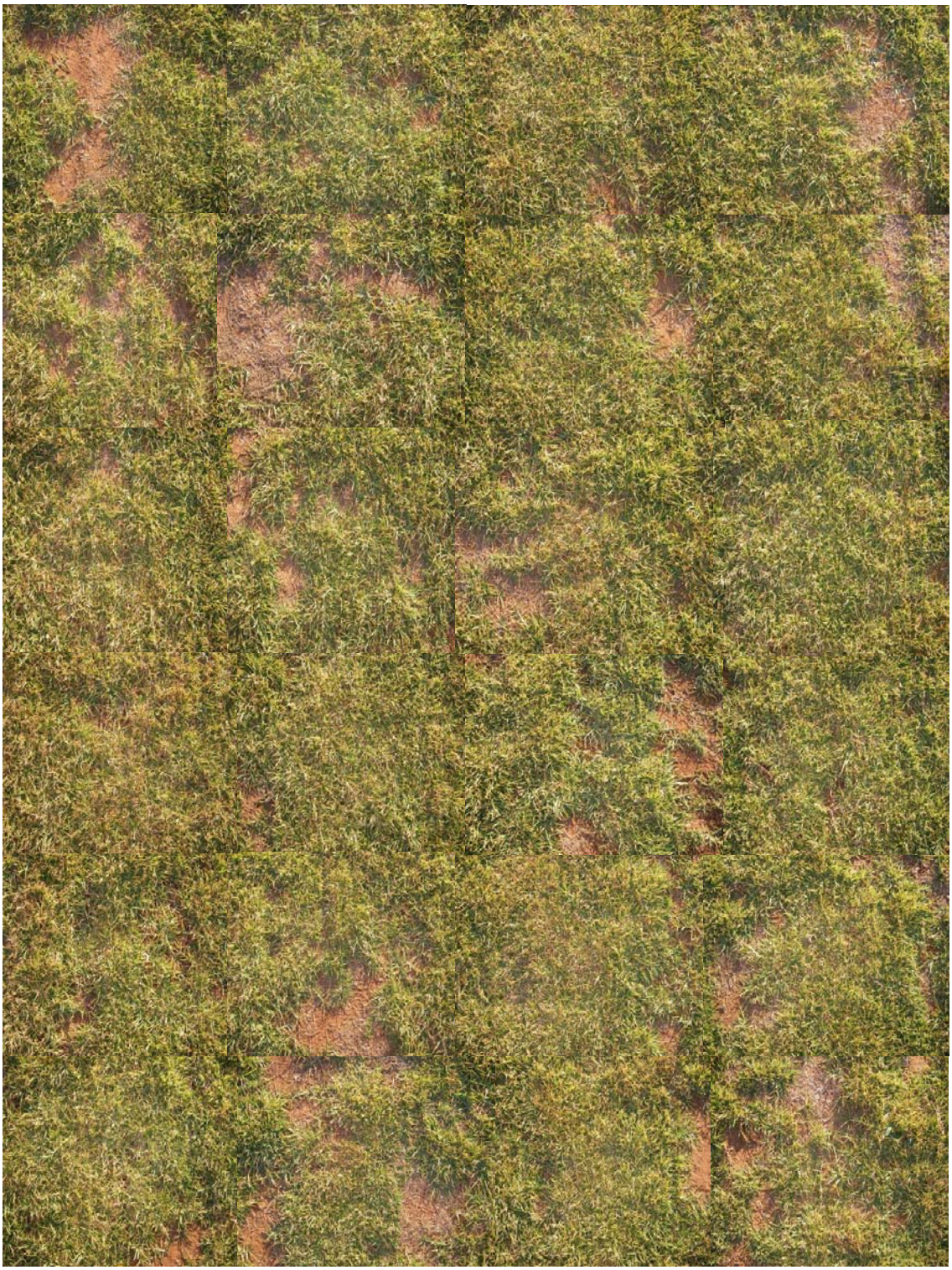

Figure 4.24 Turf growth at 17/07/07

Figure 4.25 Turf growth at 13/08/07

Figure 4.26 Turf growth at 27/08/07

4.2.4 Soil Moisture Measurements

The Figures 4.27 and 4.28 are Enviroscan screen shots of the soil moisture at different levels in the soil profile. To find the depth of the sensor there is an index at the top of each graph that matches the depth with the colour of the line. Each graph corresponds with a different section of the trial site. These sections are bare and full crop cover at the time of installation. There was no medium crop cover probe for the kikuyu trial due to lack of equipment. These graphs are referred to as stacked graphs due to the individual data being graphed on top of one another.

Figures 4.29 and 4.30 are Enviroscan screen shots of the combined soil moisture of the 10, 20 and 30 cm sensors. These graphs are referred to as summed graphs due to the output graph being made up of data summed from multiple sensors. The graphs are designed to give you an idea of soil moisture in your entire crop root zone, which in this case, is 30 cm, and not just at different depths.

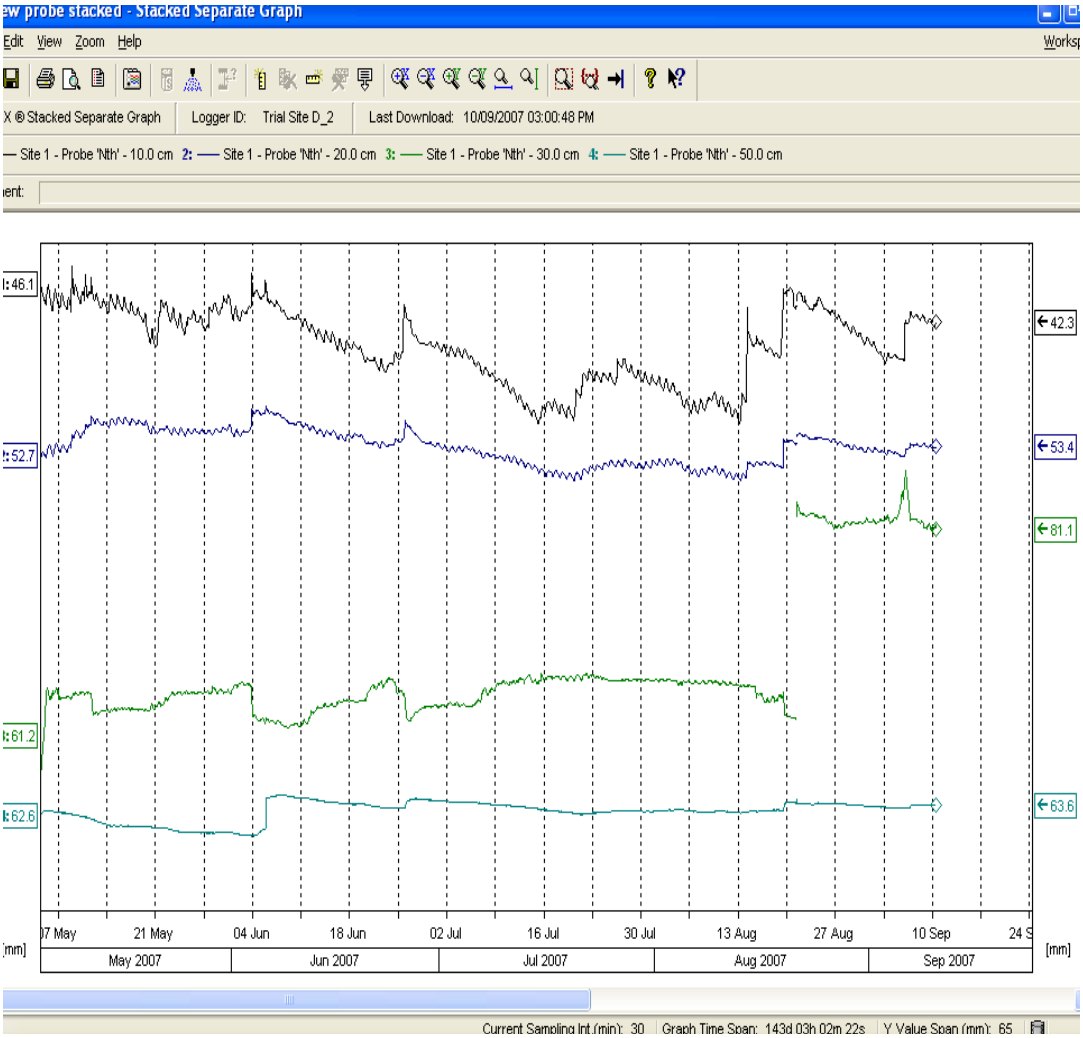

Figure 4.27 Stacked Enviroscan data from probe initially positioned in the ground with no crop cover.

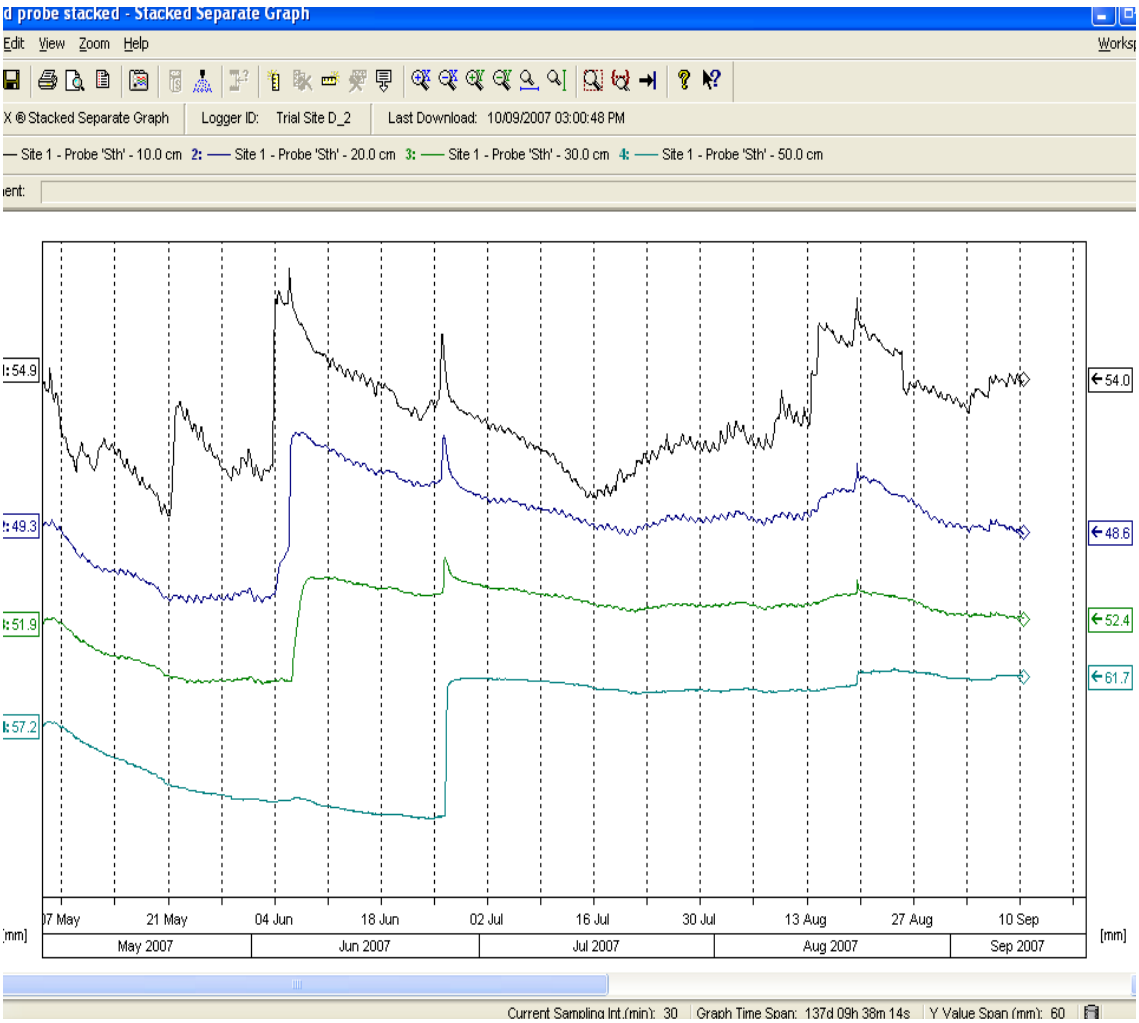

Figure 4.28 Stacked Enviroscan data from probe initially positioned in the ground with full crop cover.

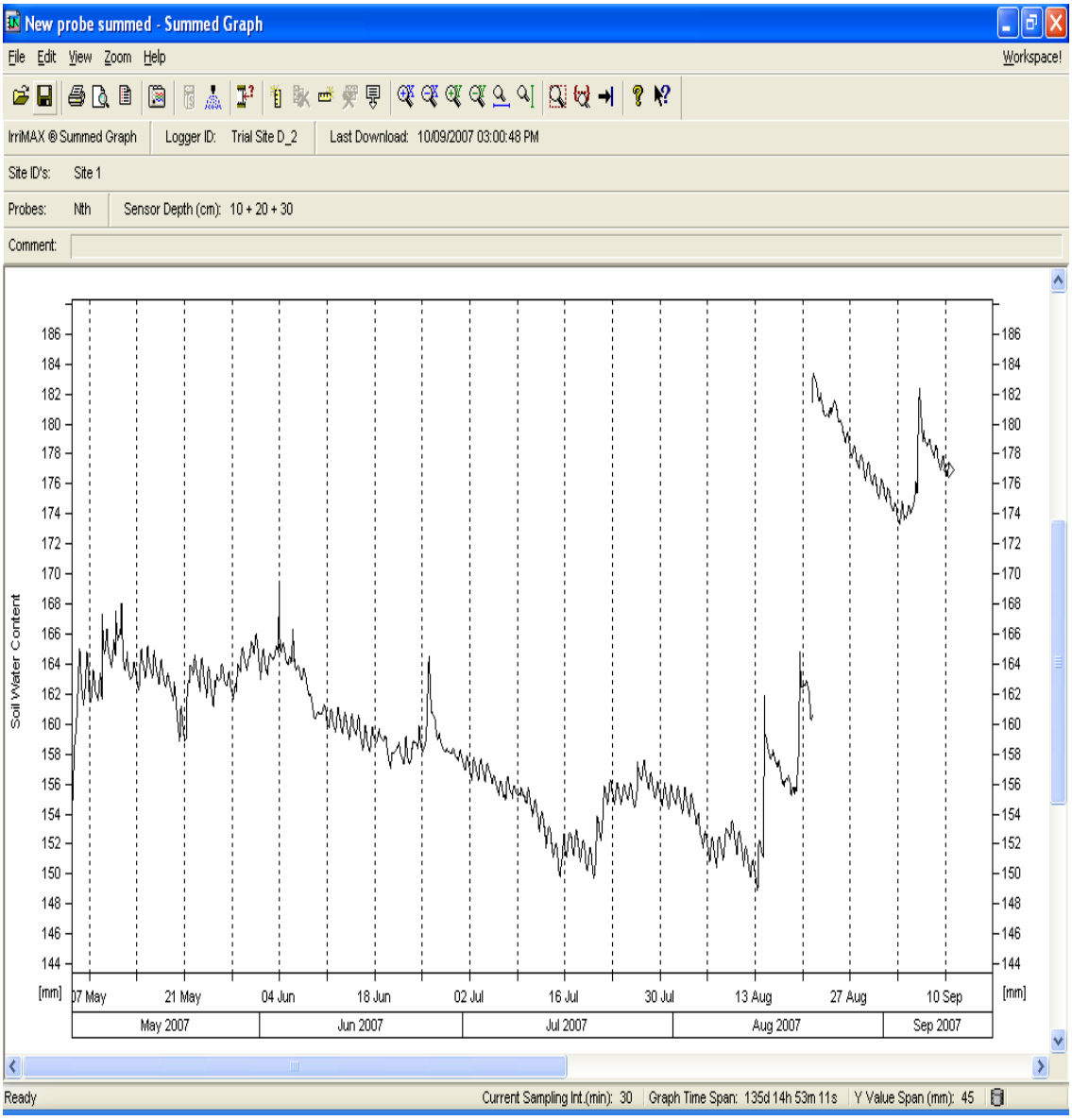

Figure 4.29 Summed Enviroscan data from probe initially positioned in the ground with no crop cover.

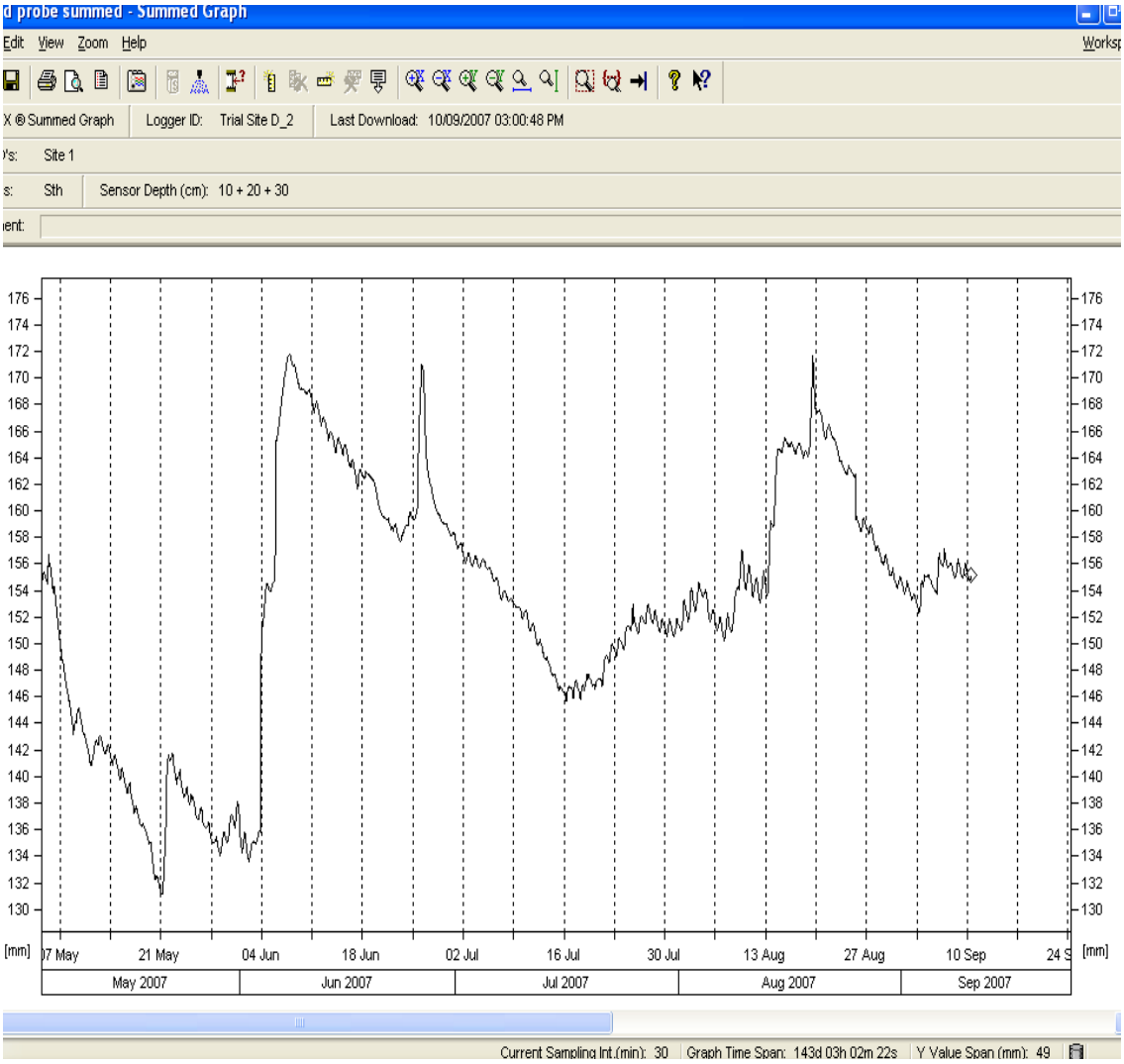

Figure 4.30 Summed Enviroscan data from probe initially positioned in the ground with full crop cover.

4.2.5 Turf Growth Using Video Stream

The data shown the Figures 4.31 to 4.33 are results from the video stream apparatus used to decipher what percentage of the trial site is covered by green turf, dormant turf or bare soil. The graphs display the changes in growth over different periods in time. It must be noted that in Figure 4.31, which displays the percentage of green foliage, there is a

reduction in percentage as the growth period increases. This is due to the fact that the turf leaf was burnt due to frost and would have looked like dormant foliage to the video sensor. In Figure 4.32 the percentage of dormant foliage on the 14th May was unusually high. The reasoning behind this is that after turf is cut there is some waste and small amounts of turf get left behind on the ground and then die. These clippings eventually get blow away in the wind or dispersed evenly through the field after mowing. Raw data from the video can be viewed in appendix B.

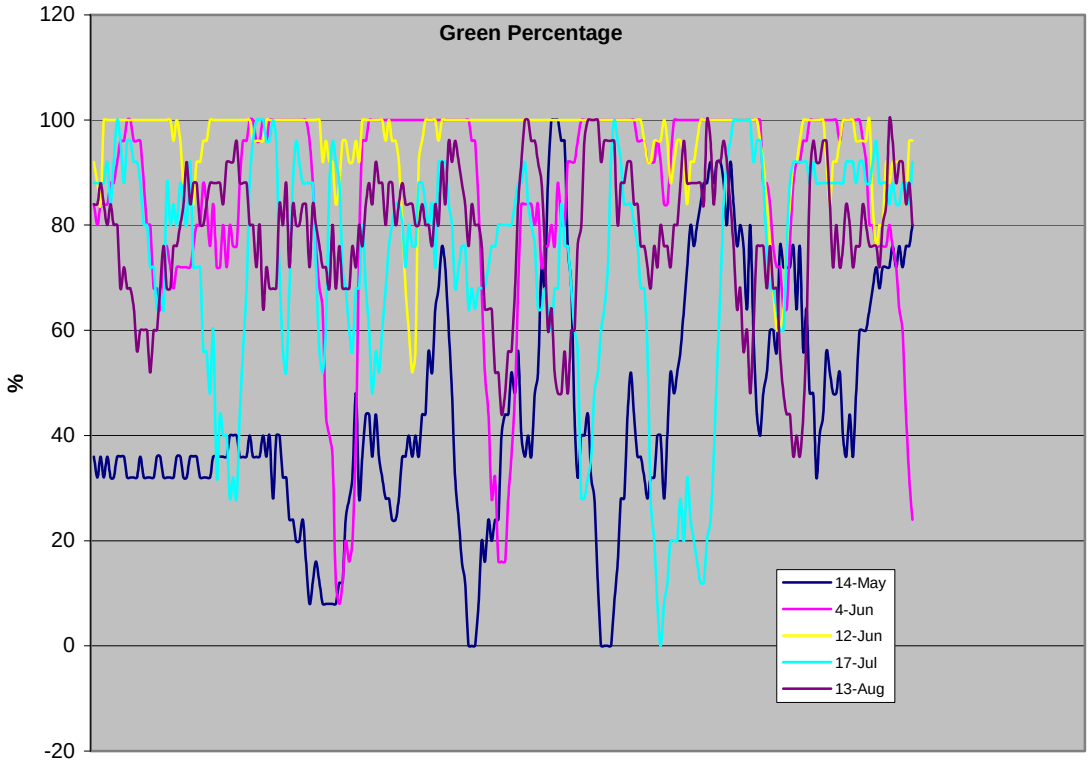

Figure 4.31 Percentage of trial site covered by green foliage.

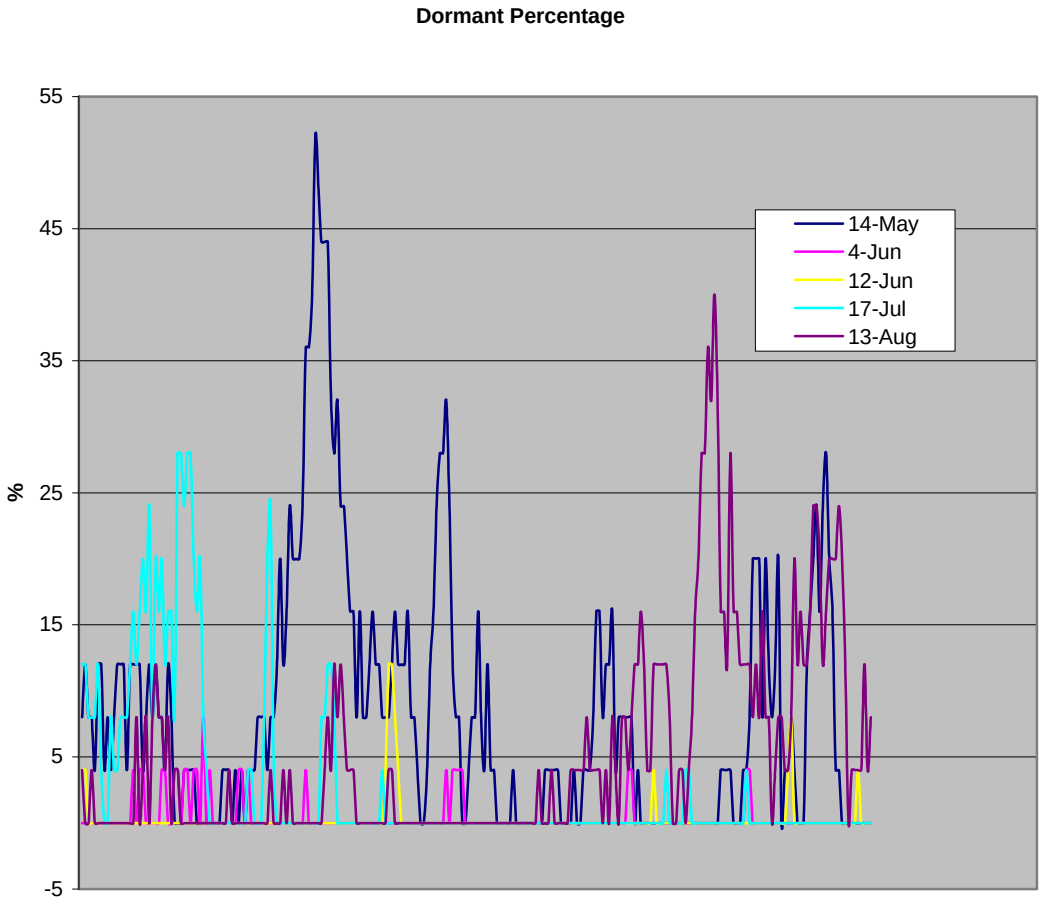

Figure 4.32 Percentage of trial site covered in dormant foliage

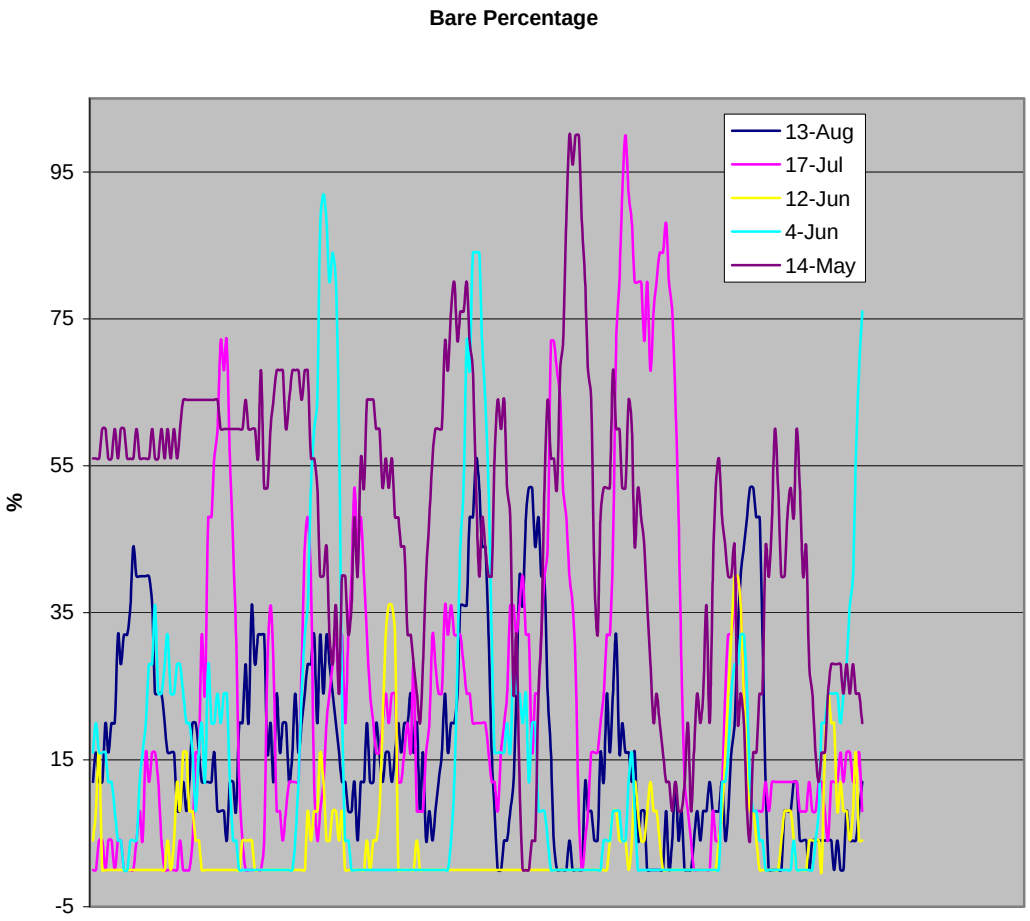

Figure 4.33 Percentage of trial site with no foliage cover

5. Discussion

5.1 Wintergreen Trial

5.1.1 Impact of irrigation performance on turf production

As stated in the results, the distribution uniformity for the solid set system was less than impressive. The 7005 sprinkler heads could only manage a Du of 54.2% which gave a minimum application rate of 2.5 mm/hr and a maximum of 16.4 mm/hr. This is a massive difference in application rate over an area of measurements twenty metres by seventeen metres. This low uniformity caused the creation of a dry spot, which in turn meant that different sections of the trial site were performing at different growth rates and therefore the crop cover differed greatly within the trial site. This made it difficult to choose a relative crop factor that would reflect the growth of the entire trial site, an issue that would not arise if uniformity was high.

By changing to the 8005 sprinkler heads the uniformity was only raised by 4.7% while the minimum and maximum application rates were barely changed. This was a disappointing result. However this initial result was proven to be wrong over the time of the trial. The change of sprinkler heads did improve turf production. By changing the sprinklers this reduced the area of the trial site that was receiving an hourly application rate of 2.5 mm. Although it did not fix the dry spot problem fully, as the strength and colour ratings have shown, it did reduce the problem and any increase in yield is

welcomed. The reason that the increase in yield was evident was not only due to the Du test on the 8005 sprinkler heads showing a reduction in area that received 2.5 mm, but the other end of the same bay, that the trial site was situated in, had been irrigated using the same amount of irrigation. However it had been left with 7005 sprinklers for the entire growth period. While it was slightly evident by eye that the 7005 sprinklers end had produced slightly lower rating turf than the 8005 end, the real test came when the turf was actually cut. In the area and the surrounds that the dry spot was located 40% more turf was deemed ineligible for sale in the section that the 7005 sprinkler heads were used for the entire growth period. Considering there is eighteen dry spots to each bay, which is an incredible increase in yield. At a yield increase of that proportion, the up front cost involved with buying and installing the new 8005 sprinklers could be paid off within two production seasons, which in this case would be one year.

Out of the intervals that received a strength rating of nine the minimum amount of water applied was 301.2 mm. The majority of the intervals that recorded a strength rating of nine received between 400-460 mm of water during the trial. As shown in the figure 4.20 all of the intervals that received ratings of seven received more water than five of the intervals that received a rating of nine. A reason that this could have occurred is that all the intervals that received a strength rating of seven were directly next to intervals that received a strength rating of six or lower. These dry areas may have been drawing water from neighbouring intervals which may have caused some stress to these areas and therefore have not performed as well as some other areas that received the same or slightly less quantities of water. Over the entire growth period the interval with the

lowest amount of water was 219mm while the greatest amount of water in an interval was 588.1mm.

Seventy-nine percent of the trial site received a rating of nine for sod strength. This was a particularly pleasing result, as binding of the turf roots was the most worrying factor for the success of the project. With an irrigation system only operating at 58% distribution efficiency there of course were areas throughout the trial site that did not receive an adequate amount of water for sufficient growth. Out of 340 m^2 only 30 m^2 were unable to be cut and therefore received a rating of zero. The area directly next to that section was rated at five to six. These pieces where not only lacking colour but also, did not hold together effectively. The turf that was rated in this region, although held in one piece cannot be considered A-grade quality and therefore the amount of water placed on these sections was insufficient. The outskirts of these areas were rated at seven, and while they were rich in colour, they lacked the sod strength that would be contributed to turf conveying the quality of a rating of nine. A sod strength rating of seven with a colour rating of nine can be considered of a quality of A^- and therefore have to partially considered and analysed when evaluating what is the minimum quantity of water required for turf production.

One impact of low distribution uniformity is that some areas of the trial site received greater than required application rates that meant that some parts of the field were always noticeably wetter than others. This presented a problem in regards to traffic use. The wetter the top of the soil profile the greater the area is to being effected by wheel marks. This was clearly evident in the wetter sections of the trial site as these wheel

marks caused some high quality turf to be ineligible for sale due to the turf cutter not being able to cut the slab in one piece due to the undulating soil profile that a wheel rut creates.

5.1.2 Strategies for improving irrigation performance

After assessing the current sprinkler system, ideas for improvements must be put on the table. These improvements must not only fix and improve the distribution figures, but also be affordable for the owner. Such improvements will consist of firstly changing nozzle types and then if necessary, change the type of in ground sprinkler heads. One other improvement that is to be suggested is that the current 76.2 mm solenoids be changed to 101.6 mm, the same size as the lateral pipeline. This would obviously be a more costly exercise but may prove to be worth the up front outlay of large improvements in uniformity are produced. The system was designed to run with 101.6 mm solenoids therefore to perform at a level that the system was designed it is strongly recommended that the solenoid be changed. The owner of the property was not interested in finding out recommendations of sprinkler and lateral spacings therefore, for this project, moving the layout of the sprinklers to improve the uniformity was not an avenue that was able to be explored. This avenue was going to be an extremely expensive one considering changes to the lateral spacings would involve earthmoving to remove old line and install the new pipelines. This would disrupt the turf growth and would cause the business to have to shut down, until the turf had grown back. For these reasons, no recommendations of sprinkler overlap models or alternate design patterns

have been given. If the owner was interested it would be recommended that the system is changed to the original Rainbird recommendations of no greater than an 18 m by 18 m square spacing. Considering the wind conditions at the site it would be recommended that the system be designed with a square spacing of 17 m.

To try to remedy the uniformity issues, the 7005 sprinklers were removed and replaced with 8005 models fitted with nozzles slightly larger than that used in the 7005's. The factory specifications stated that the 8005 heads were capable of a throw radius of twenty three metres, two metres longer than the 7005's. It was hoped with the longer throw radius and the use of the larger nozzle that the droplet size would be slightly larger and would be able to travel further distances under windy conditions. When removing the 7005 sprinkler heads it was found that many of them were installed at incorrect depths and angles. In some cases the sprinkler heads were installed at a distance from the surface so deep that the stream of water that the sprinkler produced was being restricted because it was spraying straight into the side of the surrounding turf. The angle that the many sprinklers were operating at also brought cause for concern. In some cases the sprinkler heads were approximately 20° off the proper working angle. This caused the sprinkler to spray at an angle too low for half of its designed target area and too high for the remaining half. Not operating at the designed angle causes the throw radius to be changed and when the sprinkler is spraying higher in the air than designed, the wind is going to have a greater effect on your overall uniformity. When the 8005 sprinkler heads were installed special consideration was taken to ensure that each sprinkler was flush with the top of the soil profile and that the sprinkler angle was exactly perpendicular with the surface. By installing the sprinklers in

this manner meant that the excuse of incorrect installation could no longer be a contributing factor for poor distribution uniformity. Two catch can tests were then carried out to see what improvements were made. The first test showed results that were disappointing with only a 4.7% increase in distribution uniformity and a no change in Cu. The second test was carried out when wind conditions were at zero. This improved the Du to 62.3% and raised the min depth applied from 2.1mm to 4.7mm.

It would be recommended that the entire property be changed from the 7005 sprinkler heads to the 8005 sprinkler heads. The 8005 showed an increase in Du of nearly 5%, which would be a welcome increase in performance across the entire property. Presently the 8005 is the sprinkler head with the largest throw radius that Rainbird produce. It would be recommended that when a new model is designed with a greater throw radius, that these be bought and trialled, in an endeavour to further improve Du.

In conjunction with changing to the 8005 sprinkler heads it is recommended that the currently used brown nozzle, be changed with the slightly large red sized nozzle. It was proven in the wintergreen trial that changing to the red nozzle increased droplet size and mark ably increased the sprinkler resistance to the affects of wind. By using a smaller size than the brown nozzle the throw radius was able to be improved slightly however the sprinklers were severely affect by wind resistance. When using a nozzle greater in size than the red nozzle, a higher than desired application rate was being produced, which was exceeding infiltration rate and therefore increasing the chance of losses through runoff and evaporation. It was proven that by using an 8005 sprinkler head

along with a red sized nozzle that this was the greatest uniformity results achieved using the system at Cabarlah Park.

A simple way to increase uniformity is to set your irrigation event to start at a time that average wind speed is at a minimum. This normally coincides with night time which will lower evaporation losses. Management constraints will have a bearing on being able to schedule the entire property during optimum conditions as to apply 5mm to the whole farm would take in excess of twenty five hours. By increasing application amounts and altering scheduling techniques it would be possible to maximise the amount of time a section could be watered during optimum weather conditions. Changing the application rate may cause trouble with infiltration rates. An alternative that would be recommended is that you choose the section of the property that is next in line to cut which would take preference over the rest of the farm. This section would get irrigated when condition are optimum. The on-site weather station showed that the average minimum wind speed occurred during 4 am and 6am. It would be recommended that where possible, the majority of irrigation event be run around that time period.

Initial pressure testing proved that the recommended operating pressure was not being met at the back of the property, which is where the wintergreen trial is situated. In a normal situation the first thing you would recommend would be to increase your pump speed and hence increase pressure. It was at this point that a new problem had arisen. While the pressure was insufficient at the sprinkler nozzle the pressure at the pump itself was nearing capacity of the system specifications. Already there has been one underground main burst because of pressure rising above design point. This meant that

nothing could be done to improve the pressure in the system without a major overhaul. Fortunately this overhaul did occur when the original pump ceased to operate and was replaced with a new submersible pump that was attached to a computer that automatically changes operating pressure depending on the system requirements at any one time. If the pump had not broken down, it would have been recommended that the pump be replaced as it was a turbine pump and had not been intended for use with regular stop-starting of the system. This may have well been the reason the pump broke down it the first place.

The entire system has been badly affected by sand in the pipelines due to the fact that the filter system has not been operating properly and the sand filter needs replacing. The system is fitted with flush valves at the end of the each lateral. It is recommended that a new filter be bought and that a full system flush be initiated. During this time all sprinklers on the property must be removed and cleared of any impurities stuck in the inlet or in the nozzle.

5.1.3 Soil Moisture Measurements and Crop Factors

Having access to the Enviroscan soil moisture meters was an invaluable resource that proved to give an accurate outlook in soil moisture at different depths in the soil profile over the growth period of the wintergreen turf. The probe originally positioned in the bare soil showed intense changes in soil water loss/use over the first six weeks until an adequate crop cover was reached and evaporation loss was reduced. Once the crop cover

was near 100% fluctuations in soil moisture between irrigation events dropped considerably. The enviroscan graphs clearly showed the relationship between crop cover and soil moisture fluctuation. The enviroscan graphs were able to clearly show that with an increase in crop cover, came a clear decrease in soil moisture fluctuations. The probe in medium crop cover had some sort of electrical issue on the 9th March and therefore some of the data on that graph is inaccurate. The summed graphs form the full crop cover and the bare ground showed fairly steady increases in soil moisture from the 12th March onwards.

During the same period the soil moisture at 30 cm rose substantially which is a situation that was wished to be avoided in a minimum water requirements project. The summed graph show in Figure 4.17 shows this rise in soil moisture perfectly. This data indicates that during this period the moisture at these depths was growing which means that the crop was not using all the readily available water that was being applied. This means two things, the first, is that some water could have been lost to deep drainage and the second being that the chosen crop factor, was not low enough. This data proves that constant updating of the crop factor must be initialised as there was definite room for improvement in water use in the last seven weeks of the growth period. The deep drainage mentioned earlier would not have been a significant amount as the 50 cm sensor was decreasing in moisture for the entire growth period. If the irrigation or rainfall events were reaching this depth there would have be spikes in the data however as shown in Figure 4.14 the 50 cm sensor line was virtually straight.

The probe originally placed in turf at medium crop cover showed a fairly constant water use for the duration of its growth period. The two major rainfall events showed up clearly in this data, even reaching the 50 cm, shown in Figure 4.15, on the 12th February.

The probe placed in the section with full crop cover showed major fluctuations in water use for the first four weeks, which came as a bit of a surprise as initial thoughts would be that this data would be the most constant out of the three probes. This probe also showed the two major rainfall events clearly however the most pleasing data brought from this enviroscan probe is that irrigation events only reached the sensors at depths 10-30 cm and no moisture was lost to the lower regions at 40-60 cm and therefore deep drainage was eliminated.

It must be acknowledged that there was a distinct increase in soil moisture on the 30th April. This irrigation event was not needed in terms of ETo calculations however was applied because the turf was going to be cut the following day and the turf cutter will not operate in dry soil conditions. The extra moisture it the turf helps it survive better between the time it's been cut and the time it's laid. This extra irrigation event was included in the irrigation applications table and was added to the overall water use for the growth period. Wetting the top of the soil profile to cut turf is vital at Cabarlah Park Turf however this management technique may not have to be implemented on other turf farms depending on soil type.

The enviroscan graphs showed that the crop factors used throughout the wintergreen trial were slightly high and needed to be dropped to avoid deep drainage and to further

minimise water use. The enviroscan soil moisture meters helped greatly with the recommendations of the crop factors. The soil moisture meters showed that in the last month of growth, moisture levels were higher than average and therefore it could have been possible to reduce the crop factor.

Recommendations of the ever changing crop factors required much investigation and thought when relating them back to percentage of crop cover present. The recommendations are shown below,

Initiation/Bare Ground – 0.8

50% Cover – 0.75

75% Cover – 0.6

Just reached 100% Cover – 0.55

Two weeks after reaching 100% Cover – 0.5

Two weeks after previous milestone, until cutting – 0.45

The milestone of “Just reached 100% cover”, means that the turf is covering the bare soil completely however is a long way off being ready to cut. The penultimate milestone of a crop factor of 0.5 is when the turf has progressed into a more lush texture and has a slightly firm feeling under foot. It was chosen to put the last two milestones in terms of a time frame instead of a percentage. The time period was chosen from what progress the turf had made during the wintergreen trial at that point in time. The final milestone of a crop factor of 0.45 is recommended when the turf has a rich green finish and has a fairly firm feel under foot. It is up to the manager’s discretion as to when the turf is ready to cut after this point. Often a test cut takes place to see if the turf strength is sufficient.

Continuation of use of the enviroscan is recommended. Professional advice to set up a summed graph showing field capacity and refill point would be strongly advised. By initiating these strategies it would become possible to schedule your irrigation events using the enviroscan data. It would also be recommended that tensiometers be installed. The tensiometers could be firstly used in conjunction with the enviroscan data. It would be beneficial to record the soil tension when the enviroscan shows that an irrigation event is needed. By recording this soil tension you will be able to get an accurate outlook of what stress your crop is under at a certain tension. Once specific tensions for desired crop stress points have been finalised it would be possible to use the tensiometers for irrigation scheduling instead of the enviroscan. Since the enviroscan is on loan, the tensiometers would be a much cheaper alternative to purchase, if it proved to be an accurate measurement tool in turf and suited your management practices, with respect to the tensiometers labour requirements.

5.1.4 Yeild Issues

The only turf that was deemed ineligible for sale that was rated at nine was due to traffic issues. Wheel marks or furthermore, ridges left in the ground from machinery tyres leaves the soil uneven. The turf cutter is only able produce the slabs of turf in one pieces when the soil is level. Five square metres were lost during testing due to wheel marks which equates to 1.5% of wastage due to traffic issues. This figure would have been much larger if the trial site had not been previously compacted with a heavy roller.

Whilst the heavy rolling helps iron out wheel mark it does compact the soil and aeration is then necessary to once again decrease compaction and increase soil pore space.

The rich green colour of the turf can be attributed to the large amount of urea that was placed on the field during growth. Visible increases in turf colour were able to be seen ten days after each fertilization process took place. Initially urea was to be placed on the field in thirty day intervals however when due at ninety days it was deemed urea was not necessary, as the turf was growing at a sufficient rate and there had been no decline in the intensity of the turf colour. While placing extra urea on the field no doubt would have increased growth rate and probably would have boosted colour intensity slightly, the decision to not put urea on the field was more a financial decision rather than being firmly based on growth. This decision did prove to be justified as the turf did not loose colour and did not seem to grow at a slower rate even when the irrigation crop factor was reduced from 0.7 to 0.6.

It was evident after cutting just how important aeration at the start of the growth period is. Intensive root growth was unmistakable in each of the gaps in the soil profile that had been left from aeration. Apart from giving the roots of the turf an easy passage to start growing but it also loosens the soil which decreases compaction and increases soil water holding capacity. If the top soil is not compact then root growth will not be restricted and should flourish. Aeration also helps to rectify the unwanted effects from wheel marks and compaction due to other traffic and heavy rolling.

5.1.5 Water Requirements

The minimum water requirement was only based on intervals that received a rating of nine for both strength and colour. Regions that received a rating of nine ranged in water quantity from 301-588 mm. The majority of data points that matched that criterion received between 392-438 mm of water. There was however areas that received lower amounts of water and still gained a rating of nine. Another problem was that there were areas that received quantities of water greater than 392 mm and were only rated at seven. This fact must be acknowledged and therefore must be analysed. One of the reasons the areas that received a water amount greater than 392 mm and only received a seven strength rating could be the fact that the areas directly next to them were only receiving water amounts of around 270 mm. This is a major difference in uniformity and the areas of lower water quantity may have been drawing water from its neighbouring areas through couch's structured root formation. It is clearly visible in Figure 4.14 that regions in the trial site that received less than 293 mm were not able to be reach a strength rating greater than six, with some areas not even warranting being cut.

This could also be the reasoning behind the areas that received less than 392mm and still gained a rating of nine. Out of the areas in question all but one were surrounded by areas that received larger than average quantities of water, therefore the lower water quantity areas could have also been drawing water from neighbouring areas. For this reason any of the data points below 392mm were considered as data that could be seen as subjective and not relevant data when deciding upon minimum water requirement for turf. After expelling all the subjective data the minimum water requirement for wintergreen couch

turf production in one entire growth cycle was 392mm. This amount was a pleasing result as a figure lower than 400mm was not expected at the initiation of the project.

5.2 Kikuyu Trial

There will be no discussion on yield and minimum water requirements of kikuyu as the trial was cancelled before the turf growth period was finished and therefore rating of the cut turf did not occur.

5.2.1 Impact of irrigation performance on turf production

The impact the low uniformity had on the kikuyu trial was not evident due to the pump being broken down for such a long period of time. During this period rainfall was the only water source and any major differences in growth were unable to been seen. Due to the turf not being ready to cut there is no data to show what impact the irrigation system had on the final product.

5.2.2 Strategies for improving irrigation performance

There were no changes made to the irrigation system in the kikuyu trial apart from the obvious pump change when the original pump broke down. It would be to great benefit to the grower if everything that was implemented and spoke about in section 5.1.2 were also implemented in the kikuyu trial.

5.2.3 Soil Moisture Measurements and Crop Factors

Not as much useful data came out of the kikuyu enviroscan probes due to the fact there was no irrigation for much of the growth period. What the data was able to show due to there being no irrigation over much of the winter period is the minute amount of water that the turf uses during this period. This is mostly because of the turf being virtually dormant due to frost. The graphs displayed in Figures 4.27 and 4.28, show that the probe positioned in the full crop cover used more water than the probe positioned in the emerging growth. This could be because the maximum temperatures during winter are just as high as the summer minimums and evaporation effects were not as high as the summer period and therefore moisture losses in the bare ground were less during this period. The other more obvious reasoning behind the difference in water use is that the established turf has a greater root structure and therefore would be more likely to use a greater quantity of water during this period.

There was some spiking in the data that was not the result of a rainfall or irrigation event. This is due to faulty sensors, which is a problem that occurs occasionally with enviroscan products. An example of this can be viewed in Figure 4.27, where the 30 cm sensor (green line) has risen dramatically at the 20th August. This is a definite error in the data and should not be used in soil moisture evaluation.

5.2.4 Video Stream Data

Using the video stream data to monitor turf growth percentages proved to be a challenging exercise. Figures 4.31 to 4.33 show graphical data of the three different percentages being green, dormant and bare. Although the data was useful in did show inaccuracies in many different areas. For the machine to give accurate output data it must be moved on the exactly same path each time to ensure the data points match up over differing growth stages. The video takes a video picture of approximately 20 cm by 20 cm therefore if the machine is not transported over the exact same path data can easily be inaccurate. Although due care was taken to try to ensure that the paths were identical for each trial the results showed that this was not the case as there was many inaccuracies. The initial thoughts regarding the video stream data was that it would provide a fairly accurate mathematical means of measuring turf growth. After using the machine it has been proven that unless the paths are exactly the same then the data is not accurate. Another reason the data could be inaccurate is the GPS system used on the machine to record each position in the trial site is not of the quality to record data down to accuracies such as 10 cm.

Overall the data produced was able to give an outlook of the growth stages but with some inaccuracy. The method was a good idea however needs some tweaking if it is going to be used in any further research. In hindsight the video stream data was probably a little too technical for a trial of this type as the data showed. Visual analysis of turf growth was in the form of photos proved a better way of seeing growth changes however it is not mathematically measurable and there is therefore there is room for error in this method as well.

5.3 Recommendations for further research

Due to running out of time to complete this part of the project the section of obtaining crop evapotranspiration data using either soil-water and/or weather station measurements to provide recommendations in relation to crop factors for turf production and the potential for deficit irrigation of turf, was not able to be fully researched. This is an area that could benefit greatly through further research. Research into a method to choose a benchmark crop factor depending on crop cover percentage would revolutionise the way turf was irrigation in the future. At present there are only single benchmark figures for summer and winter periods. The opportunity to save water by having multiple benchmark crop factors that take into account seasonal climate as well as crop cover percentage would be significant.

At present there are many different methods, such as the two in the literature review, for determining how much water to apply per irrigation. Some use pan evaporation and crop

factors while other research has used crop coefficients and Etc figures to determine application amounts. Research into one equation that can be used universally would provide growers with an industry benchmark for determining irrigation application.

Further research could be undertaken into enviroscan soil moisture measurements being used to increase the productivity of irrigation scheduling. Investigation into benchmarking refill points in soil profiles could reduce water lost to deep drainage and also give further insight into what application rate suits the soils infiltration rate. Enviroscan's could also be research as monitoring tools to allow for growers to see how deep a rainfall event penetrated the surface as well as let them know how long the rainfall event has an effect on the soil profile moisture point.

The most obvious field for further research would be to initiate and trial for minimum water requirements of kikuyu due to the fact that the results from this project were incomplete. The kikuyu trial would be a more accurate exercise as the mistakes made in the wintergreen trial can be rectified to allow for a precise figure for the minimum water requirements of kikuyu.

6. Conclusions

The wintergreen couch trial was successful with the main objective of finding the minimum water requirements for turf production being able to be met. The results showed that the minimum water requirement for a full growth period for wintergreen couch was 392mm. This quantity was well below the initial estimates on how much water the turf would need for entire growth period. Another pleasing outcome from the project was that soil moisture meters used in the trial proved there was even more room for improvement if further research were to be carried out on the subject.

Not being able to complete the kikuyu trial was extremely disappointing as the minimum water use of kikuyu was the species of turf that the grower, Geoff Hindmarsh was most interested in and what the project was originally set up for. Although colour and strength parameters were unable to be collected not all was lost as there was some valuable data to come out of the kikuyu trial in the form of a distribution uniformity test using the new pumping system as well as enviroscan soil moisture data, which gave an outlook of turf water use through the winter period.

The low distribution uniformity of the irrigation system so able to show which quantities of water would grow premium turf whilst also proved what quantity of water failed to produce a sufficient yield. Improvements made in distribution uniformity after recommendations were given after initial testing proved to only increase performance by a small amount. Greater increases in distribution uniformity could be reached by

changing both the lateral and sprinkler spacing however this would be an extremely costly exercise and was unable to be explored during this project. Had the system been an above ground solid set system the distribution uniformity could have been increased greatly.

The Irrigation scheduling technique used for the duration of the project proved to be a successful practice however enviroscan soil moisture monitors did suggest an increase in available water after an 80% crop cover was reached. Although crop factors for differing crop cover percentages were found, further research must take place to improve crop factors with respect to ever changing crop cover percentage. By carrying out this research this would minimise error in irrigation application amounts, which ensures the turf is not being over irrigated and water is not being wasted.

While the project did not meet all goals that were originally set out, it did answer many questions that were previously unknown on the Darling Downs. The project has opened the door for any student willing to take part in further research on the subject as there is an opportunity for study on topics such as crop factor analysis, nutrient response and leeching rates and irrigation scheduling using a collaboration of both ETo calculation and enviroscan soil moisture data.

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8. Appendix A

University of Southern Queensland

FACULTY OF ENGINEERING AND SURVEYING

ENG4111/4112 Research Project
PROJECT SPECIFICATION

FOR: **BEN MULLER**

TOPIC: Irrigation performance and water use efficiency of turf production

SUPERVISOR: Steven Raine

TECHNICAL ADVISOR: Dan Corfe, QTPA

SPONSORHSIP: NCEA, Cabarlah park Turf

PROJECT AIM: To investigate performance of a commercial sprinkler irrigation application system on a turf farm and identify opportunities to improve the performance and management. Also evaluate turf growth under various irrigation management regimes to identify the minimum water requirements of both Noonan kikuyu and wintergreen couch and the effect on turf quality.

PROGRAMME: (**Issue A, 21 March 2007**)

1. Investigate unground sprinkler system uniformity using catch cans and analyse how the system can be improved.

2. Identify and manage irrigation scheduling on selected variety plots over the crop period

3. Use the range of water volumes applied associated with the non-uniformity of the application to evaluate the effect of applied water volumes on crop growth.

4. At harvest, evaluate quality of the turf for commercial sale and relate to the irrigation schedule and total volume of water applied.

5. Provide recommendations regarding strategies to improve the irrigation design and management to optimise the crop growth, quality and commercial returns.

Time and resource permitting:

6. Obtain crop evapotranspiration data using either soil-water and/or weather station measurements to provide recommendations in relation to crop factors for turf production and the potential for deficit irrigation of turf.

AGREED _____ (student) _____ (supervisor)

Date: / / 2007 Date: / / 2007

Co-examiner: _____

9. Appendix B

14-May			4-Jun			12-Jun			17-Jul			13-Aug		
G	D	B	G	D	B	G	D	B	G	D	B	G	D	B
36	8	56	84	0	16	92	4	4	88	12	0	84	4	12
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32	8	60	84	0	16	100	0	0	88	8	4	84	4	12
36	4	60	84	0	16	100	0	0	92	8	0	80	0	20
32	12	56	88	0	12	100	0	0	84	12	4	84	0	16
32	12	56	88	0	12	100	0	0	92	4	4	80	0	20
36	4	60	92	0	8	100	0	0	100	0	0	80	0	20
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36	4	60	96	0	4	100	0	0	88	8	4	72	0	28
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44	24	32		96	0	4		100	0	0		68	0	32		84	8	8
44	20	36		100	0	0		100	0	0		60	0	40		88	4	8
36	16	48		100	0	0		100	0	0		48	0	52		84	4	12
44	16	40		100	0	0		100	0	0		56	0	44		92	4	4
36	8	56		100	0	0		100	0	0		52	0	48		88	0	12
32	16	52		100	0	0		100	0	0		60	0	40		88	0	12
28	8	64		100	0	0		96	0	4		68	0	32		80	0	20
28	8	64		100	0	0		100	0	0		76	0	24		88	0	12
24	12	64		100	0	0		96	0	4		80	0	20		88	0	12
24	16	60		100	0	0		96	0	4		84	0	16		80	0	20
28	12	60		100	0	0		92	0	8		84	0	16		84	0	16
36	12	52		100	0	0		80	0	20		80	0	20		88	0	12
36	8	56		100	0	0		68	0	32		72	4	24		84	0	16
40	8	52		100	0	0		60	4	36		80	0	20		84	0	16
36	8	56		100	0	0		52	12	36		76	0	24		84	4	12
40	12	48		100	0	0		56	12	32		76	0	24		80	4	16
36	16	48		100	0	0		92	8	0		88	0	12		80	0	20
44	12	44		100	0	0		96	4	0		88	0	12		84	0	16
44	12	44		100	0	0		100	0	0		84	0	16		80	0	20
56	12	32		100	0	0		100	0	0		80	0	20		80	0	20
52	16	32		100	0	0		100	0	0		84	0	16		76	0	24
64	8	28		100	0	0		100	0	0		72	0	28		84	0	16
68	8	24		100	0	0		96	0	4		92	0	8		80	0	20
76	4	20		100	0	0		100	0	0		92	0	8		92	0	8
72	0	28		100	0	0		100	0	0		92	0	8		84	0	16
60	0	40		100	0	0		100	0	0		84	0	16		96	0	4
48	4	48		100	0	0		100	0	0		80	0	20		92	0	8
32	12	56		100	0	0		100	0	0		68	0	32		96	0	4
24	16	60		100	0	0		100	0	0		72	0	28		92	0	8
16	24	60		100	0	0		100	0	0		76	0	24		88	0	12
12	28	60		100	0	0		100	0	0		76	0	24		84	0	16
0	28	72		100	0	0		100	0	0		64	0	36		76	0	24
0	32	68		96	4	0		100	0	0		68	0	32		84	0	16
0	24	76		96	0	4		100	0	0		64	0	36		80	0	20
8	12	80		84	4	12		100	0	0		68	0	32		80	0	20

20	8	72		68	4	28		100	0	0		68	0	32		76	0	24
16	8	76		52	4	44		100	0	0		68	0	32		64	0	36
24	0	76		44	4	52		100	0	0		72	0	28		64	0	36
20	0	80		28	0	72		100	0	0		76	0	24		64	0	36
24	4	72		32	0	68		100	0	0		76	0	24		52	0	48
24	8	68		16	0	84		100	0	0		80	0	20		52	0	48
40	8	52		16	0	84		100	0	0		80	0	20		44	0	56
44	16	40		16	0	84		100	0	0		80	0	20		48	0	52
44	8	48		28	0	72		100	0	0		80	0	20		56	0	44
52	4	44		36	0	64		100	0	0		80	0	20		56	0	44
48	12	40		48	0	52		100	0	0		84	0	16		68	0	32
56	4	40		68	0	32		100	0	0		88	0	12		84	0	16
40	4	56		84	0	16		100	0	0		88	0	12		92	0	8
36	0	64		84	0	16		100	0	0		92	0	8		100	0	0
40	0	60		84	0	16		100	0	0		84	0	16		100	0	0
36	0	64		84	0	16		100	0	0		80	0	20		96	0	4
48	0	52		80	0	20		100	0	0		76	0	24		96	0	4
52	0	48		84	0	16		100	0	0		64	0	36		92	0	8
72	4	24		72	0	28		100	0	0		64	0	36		88	0	12
68	0	32		76	0	24		100	0	0		68	0	32		76	0	24
88	0	12		76	0	24		100	0	0		64	0	36		60	0	40
100	0	0		80	0	20		100	0	0		60	0	40		64	0	36
100	0	0		76	0	24		100	0	0		68	0	32		52	0	48
100	0	0		88	0	12		100	0	0		68	0	32		48	0	52
96	0	4		80	0	20		100	0	0		84	0	16		48	0	52
96	0	4		80	0	20		100	0	0		76	0	24		56	0	44
76	0	24		92	0	8		100	0	0		76	0	24		48	4	48
68	0	32		92	0	8		100	0	0		68	0	32		60	0	40
44	4	52		92	0	8		100	0	0		60	0	40		60	0	40
32	4	64		96	0	4		100	0	0		56	0	44		76	0	24
40	4	56		100	0	0		100	0	0		28	0	72		80	4	16
40	4	56		100	0	0		100	0	0		28	0	72		96	0	4
44	4	52		100	0	0		100	0	0		32	0	68		100	0	0
32	0	68		100	0	0		100	0	0		36	0	64		100	0	0
28	0	72		100	0	0		100	0	0		48	0	52		100	0	0
12	0	88		100	0	0		100	0	0		52	0	48		100	0	0
0	0	100		100	0	0		100	0	0		60	0	40		92	4	4
0	4	96		100	0	0		100	0	0		64	0	36		96	4	0
0	0	100		100	0	0		100	0	0		72	0	28		96	4	0
0	0	100		100	0	0		100	0	0		92	0	8		96	4	0
8	4	88		100	0	0		100	0	0		100	0	0		96	4	0
16	4	80		100	0	0		100	0	0		96	0	4		80	8	12
28	4	68		100	0	0		100	0	0		92	0	8		88	4	8
28	8	64		100	0	0		100	0	0		84	0	16		88	4	8
44	16	40		100	0	0		100	0	0		84	0	16		92	4	4
52	16	32		100	0	0		100	0	0		84	0	16		92	4	4
44	8	48		100	0	0		100	0	0		80	0	20		84	0	16
36	12	52		96	0	4		100	0	0		76	0	24		84	4	12
36	12	52		96	0	4		100	0	0		68	0	32		76	0	24
32	16	52		96	0	4		96	0	4		68	0	32		76	8	16
28	4	68		92	0	8		92	0	8		56	0	44		72	4	24
32	8	60		92	0	8		92	0	8		28	0	72		68	0	32
32	8	60		92	0	8		96	0	4		20	0	80		76	8	16
40	8	52		96	0	4		96	0	4		8	0	92		72	8	20
40	8	52		92	4	4		96	0	4		0	0	100		80	4	16
28	8	64		84	4	12		100	0	0		8	0	92		76	8	16
40	0	60		84	0	16		96	0	4		12	0	88		76	12	12
52	4	44		92	0	8		88	0	12		20	0	80		72	12	16
48	0	52		100	0	0		92	0	8		20	0	80		80	16	4
52	0	48		100	0	0		96	0	4		20	0	80		80	12	8
56	0	44		100	0	0		96	0	4		28	0	72		88	4	8
64	0	36		100	0	0		92	0	8		20	0	80		96	4	0
72	0	28		100	0	0		84	4	12		32	0	68		88	12	0
80	0	20		100	0	0		92	0	8		24	0	76		88	12	0
76	0	24		100	0	0		92	0	8		20	0	80		88	12	0

80	0	20		100	0	0		96	0	4		16	0	84		88	12	0
84	0	16		100	0	0		100	0	0		12	4	84		88	12	0
88	0	12		100	0	0		100	0	0		12	0	88		84	8	8
88	0	12		100	0	0		100	0	0		20	0	80		100	0	0
92	0	8		100	0	0		100	0	0		24	0	76		96	0	4
88	0	12		100	0	0		100	0	0		36	0	64		84	4	12
92	0	8		100	0	0		100	0	0		52	0	48		92	4	4
92	0	8		100	0	0		100	0	0		68	4	28		92	0	8
88	0	12		100	0	0		100	0	0		84	4	12		96	4	0
80	0	20		100	0	0		100	0	0		92	0	8		92	8	0
92	0	8		100	0	0		100	0	0		96	0	4		84	16	0
84	0	16		100	0	0		100	0	0		100	0	0		76	20	4
76	0	24		100	0	0		100	0	0		100	0	0		64	28	8
80	0	20		100	0	0		100	0	0		100	0	0		68	28	4
76	0	24		100	0	0		100	0	0		100	0	0		56	36	8
64	0	36		100	0	0		100	0	0		100	0	0		60	32	8
80	0	20		100	0	0		100	0	0		100	0	0		48	40	12
60	0	40		100	0	0		100	0	0		92	0	8		60	32	8
44	4	52		100	0	0		100	0	0		96	0	4		76	16	8
40	4	56		100	0	0		96	0	4		96	0	4		76	16	8
48	4	48		88	0	12		92	0	8		88	0	12		76	12	12
52	4	44		88	0	12		84	0	16		76	0	24		68	28	4
60	0	40		84	0	16		76	0	24		68	0	32		76	16	8
60	0	40		76	0	24		68	0	32		68	0	32		68	16	16
56	0	44		72	0	28		60	0	40		64	0	36		68	12	20
76	4	20		72	0	28		60	0	40		60	0	40		56	12	32
72	4	24		64	4	32		64	0	36		60	4	36		48	12	40
72	8	20		64	4	32		76	0	24		76	0	24		44	12	44
72	20	8		76	0	24		84	0	16		88	0	12		44	8	48
76	20	4		88	0	12		92	0	8		92	0	8		36	12	52
64	20	16		92	0	8		92	0	8		92	0	8		40	8	52
76	8	16		92	0	8		96	0	4		92	0	8		36	16	48
56	20	24		96	0	4		100	0	0		92	0	8		44	8	48
64	12	24		96	0	4		100	0	0		92	0	8		60	8	32
48	8	44		100	0	0		100	0	0		88	0	12		88	0	12
48	12	40		100	0	0		100	0	0		92	0	8		96	4	0
32	20	48		100	0	0		100	0	0		88	0	12		92	8	0
40	0	60		100	0	0		100	0	0		88	0	12		92	8	0
44	4	52		100	0	0		100	0	0		88	0	12		96	4	0
56	4	40		100	0	0		92	4	4		88	0	12		96	4	0
52	8	40		100	0	0		84	8	8		88	0	12		84	8	8
48	4	48		100	0	0		92	0	8		88	0	12		72	20	8
48	0	52		100	0	0		92	0	8		88	0	12		80	12	8
52	0	48		96	0	4		96	0	4		88	0	12		72	16	12
40	0	60		100	0	0		100	0	0		88	0	12		76	12	12
36	12	52		100	0	0		100	0	0		92	0	8		84	12	4
44	16	40		100	0	0		100	0	0		92	0	8		80	16	4
36	20	44		100	0	0		100	0	0		92	0	8		72	24	4
48	24	28		100	0	0		96	0	4		88	0	12		76	24	0
60	16	24		100	0	0		96	0	4		92	0	8		76	20	4
60	24	16		96	0	4		96	0	4		92	0	8		84	12	4
60	28	12		92	0	8		96	0	4		88	0	12		80	16	4
64	20	16		80	0	20		100	0	0		88	0	12		76	20	4
68	16	16		80	0	20		84	0	16		92	0	8		76	20	4
72	4	24		76	0	24		76	0	24		96	0	4		76	20	4
68	4	28		76	0	24		80	0	20		88	0	12		72	24	4
72	0	28		76	0	24		80	0	20		88	0	12		80	20	0
72	0	28		76	0	24		92	0	8		88	0	12		84	12	4
72	0	28		80	0	20		88	0	12		84	0	16		100	0	0
76	0	24		76	0	24		92	0	8		88	0	12		96	4	0
72	0	28		72	0	28		92	0	8		84	0	16		88	4	8
76	0	24		64	0	36		92	4	4		84	0	16		92	4	4
72	0	28		60	0	40		92	0	8		88	0	12		92	4	4
76	0	24		44	0	56		84	0	16		88	0	12		84	12	4
76	0	24		32	0	68		96	0	4		84	0	16		88	4	8

80	0	20		24	0	76		96	0	4		92	0	8		80	8	12

Figure B.1 Video Steam Data – 1st Run

14-May				4-Jun				12-Jun				17-Jul				13-Aug		
G	D	B		G	D	B		G	D	B		G	D	B		G	D	B
56	36	8		84	4	12		100	0	0		84	8	8		68	16	16
56	36	8		84	0	16		100	0	0		76	12	12		72	12	16
52	36	12		84	0	16		100	0	0		80	4	16		64	12	24
60	28	12		96	4	0		100	0	0		80	8	12		68	12	20
48	40	12		88	4	8		100	0	0		72	4	24		76	0	24
60	32	8		92	0	8		100	0	0		72	4	24		76	0	24
64	36	0		96	0	4		100	0	0		72	12	16		84	8	8
64	32	4		92	0	8		100	0	0		64	8	28		88	4	8
60	32	8		92	0	8		100	0	0		72	12	16		92	8	0
60	28	12		96	0	4		100	0	0		68	12	20		92	4	4
56	32	12		96	0	4		100	0	0		60	12	28		92	0	8
68	24	8		100	0	0		100	0	0		84	0	16		96	0	4
72	20	8		100	0	0		100	0	0		76	0	24		92	0	8
68	24	8		100	0	0		100	0	0		84	0	16		88	4	8
68	28	4		96	0	4		100	0	0		84	0	16		88	4	8
68	24	8		100	0	0		100	0	0		88	0	12		80	12	8
76	20	4		96	4	0		100	0	0		72	0	28		80	12	8
80	12	8		96	0	4		100	0	0		80	0	20		84	4	12
80	16	4		100	0	0		100	0	0		72	0	28		76	12	12
72	20	8		100	0	0		100	0	0		80	0	20		92	4	4
72	20	8		100	0	0		100	0	0		80	0	20		88	8	4
76	16	8		100	0	0		100	0	0		76	0	24		96	0	4
68	20	12		96	0	4		100	0	0		72	0	28		92	8	0
80	8	12		100	0	0		100	0	0		68	0	32		100	0	0
76	12	12		100	0	0		100	0	0		68	0	32		96	4	0
80	4	16		100	0	0		100	0	0		68	0	32		100	0	0
76	8	16		100	0	0		100	0	0		68	0	32		88	12	0
72	4	24		100	0	0		100	0	0		60	0	40		92	8	0
68	4	28		96	0	4		100	0	0		64	0	36		92	4	4
60	12	28		100	0	0		100	0	0		68	0	32		84	12	4
60	16	24		100	0	0		100	0	0		84	0	16		76	20	4
60	16	24		100	0	0		100	0	0		92	0	8		76	16	8
52	12	36		92	0	8		100	0	0		92	0	8		64	24	12
40	24	36		80	0	20		100	0	0		88	4	8		56	24	20
32	24	44		92	0	8		100	0	0		92	0	8		56	20	24
36	32	32		84	0	16		100	0	0		96	0	4		52	24	24
20	36	44		76	0	24		100	0	0		96	0	4		52	32	16
20	28	52		80	0	20		100	0	0		88	4	8		52	28	20
20	40	40		72	0	28		100	0	0		88	4	8		52	32	16

32	36	32		60	0	40		100	0	0		80	4	16		64	16	20
36	36	28		64	0	36		100	0	0		80	4	16		64	16	20
36	40	24		52	4	44		100	0	0		72	8	20		88	8	4
48	40	12		40	4	56		100	0	0		76	8	16		96	4	0
52	24	24		52	0	48		100	0	0		68	4	28		96	4	0
52	24	24		36	4	60		100	0	0		84	8	8		100	0	0
48	32	20		40	0	60		100	0	0		80	8	12		96	4	0
56	28	16		40	0	60		100	0	0		84	4	12		96	4	0
52	24	24		48	0	52		100	0	0		84	4	12		100	0	0
56	24	20		48	0	52		100	0	0		84	8	8		88	8	4
64	12	24		68	0	32		100	0	0		88	4	8		92	8	0
60	20	20		64	0	36		100	0	0		80	4	16		84	16	0
80	8	12		80	0	20		100	0	0		72	4	24		72	20	8
72	20	8		80	0	20		100	0	0		84	0	16		68	24	8
92	8	0		88	0	12		100	0	0		72	4	24		64	24	12
96	4	0		96	0	4		100	0	0		68	4	28		68	24	8
92	8	0		100	0	0		100	0	0		64	8	28		68	20	12
80	8	12		100	0	0		100	0	0		80	4	16		80	8	12
80	8	12		100	0	0		100	0	0		80	0	20		76	12	12
72	8	20		100	0	0		100	0	0		96	0	4		80	8	12
76	4	20		100	0	0		100	0	0		88	4	8		88	4	8
64	12	24		100	0	0		100	0	0		84	8	8		92	4	4
52	12	36		100	0	0		100	0	0		96	0	4		96	4	0
56	16	28		100	0	0		100	0	0		92	0	8		88	12	0
44	24	32		100	0	0		100	0	0		80	0	20		84	16	0
48	28	24		100	0	0		100	0	0		80	8	12		84	16	0
52	32	16		100	0	0		100	0	0		84	8	8		72	28	0
56	32	12		100	0	0		100	0	0		96	0	4		76	24	0
60	20	20		100	0	0		100	0	0		92	4	4		72	24	4
64	24	12		100	0	0		100	0	0		88	8	4		72	20	8
72	20	8		92	4	4		100	0	0		92	4	4		84	12	4
68	20	12		96	4	0		100	0	0		84	4	12		72	16	12
72	20	8		96	0	4		100	0	0		88	0	12		52	24	24
60	20	20		96	4	0		100	0	0		88	0	12		56	28	16
68	12	20		96	0	4		100	0	0		92	0	8		64	28	8
48	20	32		100	0	0		100	0	0		88	0	12		52	36	12
44	12	44		96	0	4		100	0	0		92	0	8		80	16	4
36	24	40		100	0	0		100	0	0		88	0	12		88	12	0
28	24	48		96	0	4		100	0	0		84	4	12		84	16	0
24	20	56		100	0	0		100	0	0		72	4	24		84	16	0
16	28	56		100	0	0		76	0	24		80	4	16		84	16	0
16	28	56		100	0	0		84	4	12		68	8	24		96	0	4
16	28	56		100	0	0		72	4	24		68	4	28		84	0	16
24	44	32		100	0	0		84	0	16		68	4	28		64	4	32
28	32	40		100	0	0		100	0	0		72	0	28		44	0	56
32	24	44		100	0	0		100	0	0		84	0	16		44	0	56
44	24	32		100	0	0		100	0	0		80	0	20		48	0	52
52	20	28		96	0	4		100	0	0		92	0	8		68	4	28
68	16	16		100	0	0		100	0	0		76	0	24		80	12	8
68	8	24		100	0	0		100	0	0		60	0	40		84	12	4
64	8	28		100	0	0		100	0	0		60	0	40		92	8	0
80	0	20		100	0	0		100	0	0		60	0	40		96	4	0
76	0	24		100	0	0		100	0	0		60	0	40		96	4	0
80	0	20		100	0	0		100	0	0		60	0	40		96	0	4
64	0	36		100	0	0		100	0	0		64	0	36		96	4	0

52	0	48		100	0	0		100	0	0		64	0	36		92	8	0
64	0	36		100	0	0		100	0	0		72	0	28		96	4	0
64	0	36		96	0	4		100	0	0		72	0	28		92	8	0
76	0	24		92	0	8		100	0	0		80	0	20		100	0	0
76	0	24		84	0	16		100	0	0		76	0	24		76	0	24
80	0	20		68	0	32		96	0	4		76	0	24		52	4	44
60	0	40		68	0	32		96	0	4		60	0	40		40	4	56
60	8	32		48	0	52		96	0	4		52	0	48		40	4	56
68	12	20		32	0	68		100	0	0		60	0	40		60	0	40
56	16	28		16	0	84		100	0	0		68	0	32		68	0	32
68	12	20		16	0	84		100	0	0		80	0	20		64	4	32
48	16	36		16	0	84		100	0	0		76	0	24		68	0	32
56	12	32		8	0	92		100	0	0		84	0	16		76	0	24
64	12	24		8	0	92		100	0	0		88	0	12		84	4	12
64	12	24		20	0	80		100	0	0		88	0	12		76	16	8
80	4	16		20	0	80		100	0	0		88	4	8		76	16	8
72	0	28		32	0	68		100	0	0		88	0	12		80	16	4
68	0	32		40	0	60		100	0	0		88	0	12		80	8	12
72	0	28		40	0	60		100	0	0		84	0	16		76	8	16
76	0	24		72	0	28		100	0	0		88	0	12		84	0	16
88	0	12		88	0	12		100	0	0		92	0	8		84	0	16
88	0	12		88	0	12		100	0	0		84	0	16		84	4	12
80	0	20		92	0	8		100	0	0		80	0	20		84	4	12
76	0	24		72	0	28		100	0	0		84	0	16		88	4	8
80	0	20		52	0	48		100	0	0		76	0	24		88	8	4
76	4	20		48	0	52		100	0	0		80	0	20		96	4	0
64	12	24		44	0	56		100	0	0		88	0	12		92	8	0
76	8	16		36	0	64		100	0	0		88	0	12		92	4	4
80	8	12		36	0	64		100	0	0		84	0	16		92	8	0
76	12	12		24	0	76		100	0	0		88	0	12		92	4	4
80	4	16		20	0	80		100	0	0		84	0	16		100	0	0
76	0	24		24	0	76		100	0	0		80	0	20		96	0	4
76	0	24		28	0	72		100	0	0		72	0	28		96	4	0
76	0	24		28	0	72		100	0	0		68	0	32		96	0	4
76	0	24		32	0	68		100	0	0		72	0	28		96	0	4
68	0	32		36	0	64		100	0	0		76	0	24		84	8	8
60	0	40		36	0	64		100	0	0		64	0	36		80	12	8
52	0	48		48	0	52		100	0	0		68	0	32		76	12	12
48	0	52		64	0	36		100	0	0		64	0	36		80	8	12
48	0	52		76	0	24		100	0	0		60	0	40		76	12	12
64	0	36		76	0	24		100	0	0		72	0	28		68	20	12
56	0	44		76	0	24		100	0	0		64	0	36		72	16	12
64	4	32		88	0	12		100	0	0		72	4	24		68	20	12
64	4	32		88	0	12		100	0	0		76	4	20		68	24	8
44	16	40		88	0	12		100	0	0		80	0	20		72	24	4
44	28	28		84	0	16		100	0	0		80	0	20		72	20	8
40	36	24		72	0	28		100	0	0		80	0	20		72	24	4
32	36	32		72	0	28		100	0	0		68	4	28		68	20	12
24	36	40		64	0	36		100	0	0		72	0	28		60	24	16
28	32	40		72	0	28		96	0	4		76	0	24		72	12	16
36	24	40		76	0	24		96	0	4		68	0	32		68	8	24
40	16	44		80	0	20		100	0	0		72	0	28		76	4	20
44	12	44		92	0	8		100	0	0		64	0	36		84	0	16
48	4	48		100	0	0		100	0	0		64	0	36		84	0	16
44	4	52		100	0	0		100	0	0		68	0	32		88	0	12

60	0	40		100	0	0		100	0	0		64	0	36		76	0	24
44	0	56		100	0	0		100	0	0		72	4	24		88	0	12
24	4	72		100	0	0		100	0	0		84	4	12		88	0	12
24	12	64		100	0	0		100	0	0		80	8	12		80	8	12
4	16	80		100	0	0		100	0	0		72	8	20		88	4	8
0	16	84		100	0	0		100	0	0		84	4	12		80	8	12
0	20	80		96	0	4		100	0	0		84	0	16		72	16	12
0	16	84		92	0	8		96	0	4		84	0	16		80	8	12
0	24	76		96	0	4		92	4	4		84	0	16		68	20	12
0	24	76		88	0	12		80	4	16		80	0	20		92	8	0
0	16	84		88	0	12		76	0	24		80	0	20		76	20	4
8	24	68		88	0	12		80	0	20		72	4	24		80	12	8
24	12	64		88	0	12		76	0	24		80	0	20		80	12	8
16	20	64		92	0	8		88	0	12		72	0	28		76	16	8
32	16	52		100	0	0		88	0	12		80	0	20		96	0	4
56	8	36		96	0	4		100	0	0		76	0	24		80	12	8
52	8	40		92	0	8		100	0	0		72	8	20		76	16	8
72	4	24		96	0	4		96	0	4		76	4	20		76	16	8
72	4	24		96	0	4		100	0	0		76	0	24		84	8	8
84	0	16		100	0	0		96	0	4		72	4	24		88	4	8
96	0	4		100	0	0		100	0	0		72	0	28		84	8	8
100	0	0		100	0	0		96	0	4		76	0	24		92	0	8
96	0	4		96	0	4		96	0	4		80	0	20		84	12	4
88	0	12		96	0	4		100	0	0		84	0	16		88	12	0
88	0	12		100	0	0		96	0	4		80	0	20		88	12	0
84	0	16		100	0	0		96	0	4		88	0	12		84	16	0
80	0	20		100	0	0		100	0	0		88	0	12		84	12	4
84	0	16		100	0	0		100	0	0		84	0	16		84	16	0
84	0	16		100	0	0		96	0	4		84	0	16		88	8	4
92	0	8		100	0	0		96	0	4		80	0	20		88	8	4
92	0	8		100	0	0		100	0	0		80	0	20		100	0	0
96	0	4		100	0	0		100	0	0		88	0	12		100	0	0
100	0	0		100	0	0		100	0	0		88	0	12		92	4	4
96	0	4		100	0	0		100	0	0		72	0	28		84	4	12
100	0	0		100	0	0		100	0	0		72	0	28		76	4	20
96	0	4		100	0	0		96	0	4		72	0	28		56	4	40
96	0	4		100	0	0		100	0	0		80	0	20		44	0	56
92	0	8		100	0	0		100	0	0		68	0	32		28	0	72
84	0	16		100	0	0		100	0	0		80	0	20		28	0	72
76	4	20		100	0	0		100	0	0		80	0	20		12	0	88
80	0	20		100	0	0		96	0	4		84	0	16		4	0	96
84	0	16		100	0	0		100	0	0		80	0	20		8	0	92
88	0	12		100	0	0		100	0	0		68	0	32		24	0	76
72	4	24		100	0	0		100	0	0		60	0	40		20	4	76
84	0	16		100	0	0		100	0	0		52	0	48		32	0	68
76	0	24		100	0	0		100	0	0		44	0	56		44	4	52
80	4	16		100	0	0		100	0	0		32	0	68		48	4	48
80	4	16		100	0	0		100	0	0		36	0	64		60	8	32
84	0	16		100	0	0		100	0	0		32	0	68		68	8	24
84	0	16		100	0	0		100	0	0		40	0	60		80	12	8
84	4	12		100	0	0		100	0	0		60	0	40		76	12	12
88	0	12		100	0	0		100	0	0		72	0	28		96	4	0
92	0	8		100	0	0		100	0	0		84	0	16		84	16	0
96	0	4		96	0	4		100	0	0		96	0	4		88	8	4
96	0	4		100	0	0		100	0	0		100	0	0		92	4	4

80	0	20		100	0	0		100	0	0		100	0	0		84	4	12
76	0	24		92	4	4		100	0	0		100	0	0		92	0	8
60	0	40		88	0	12		100	0	0		100	0	0		96	0	4
64	0	36		68	0	32		100	0	0		96	0	4		88	4	8
52	4	44		48	0	52		100	0	0		92	0	8		96	0	4
48	8	44		48	0	52		100	0	0		84	0	16		96	4	0
52	8	40		32	0	68		100	0	0		76	0	24		92	4	4
64	8	28		20	0	80		100	0	0		64	0	36		88	4	8
68	8	24		36	0	64		100	0	0		68	0	32		92	4	4
68	8	24		36	0	64		100	0	0		60	0	40		96	0	4
64	8	28		60	0	40		100	0	0		48	0	52		96	0	4
76	4	20		76	0	24		100	0	0		52	0	48		92	4	4
72	0	28		80	0	20		100	0	0		56	0	44		88	4	8
64	0	36		92	4	4		100	0	0		68	0	32		80	16	4
56	0	44		96	0	4		100	0	0		72	0	28		72	16	12
56	0	44		96	0	4		100	0	0		76	0	24		68	20	12
48	4	48		96	0	4		100	0	0		80	0	20		68	20	12
52	0	48		92	0	8		100	0	0		88	0	12		72	20	8
44	0	56		92	0	8		100	0	0		96	0	4		64	24	12
44	0	56		88	0	12		100	0	0		88	4	8		56	36	8
48	0	52		80	0	20		100	0	0		92	4	4		64	20	16
44	8	48		72	0	28		100	0	0		92	0	8		72	20	8
44	8	48		72	0	28		100	0	0		84	4	12		72	28	0
48	4	48		68	0	32		100	0	0		80	0	20		76	24	0
56	8	36		64	0	36		96	0	4		72	8	20		84	12	4
64	4	32		60	0	40		100	0	0		76	8	16		84	12	4
72	8	20		76	0	24		96	0	4		72	0	28		92	8	0
76	0	24		72	0	28		100	0	0		84	0	16		96	4	0
92	0	8		92	0	8		96	0	4		80	0	20		96	0	4
100	0	0		96	0	4		96	0	4		88	0	12		92	0	8
92	0	8		100	0	0		96	0	4		92	0	8		80	0	20
80	0	20		100	0	0		100	0	0		88	4	8		72	0	28
72	0	28		88	0	12		100	0	0		96	0	4		64	0	36
76	0	24		84	0	16		100	0	0		92	4	4		56	0	44
64	0	36		76	0	24		100	0	0		92	4	4		44	0	56
56	0	44		64	0	36		100	0	0		92	8	0		40	0	60
72	0	28		52	0	48		96	0	4		92	8	0		32	0	68
80	0	20		40	0	60		96	0	4		92	4	4		24	0	76
84	0	16		28	0	72		96	0	4		96	4	0		36	4	60
80	0	20		20	0	80		88	0	12		96	4	0		32	4	64
80	0	20		8	0	92		92	0	8		88	8	4		36	4	60
80	0	20		8	0	92		84	4	12		88	12	0		48	8	44
76	4	20		8	0	92		88	0	12		88	8	4		52	4	44
84	4	12		20	0	80		88	0	12		88	8	4		60	16	24
84	0	16		36	0	64		88	0	12		88	12	0		60	12	28
76	0	24		36	0	64		92	0	8		92	4	4		76	12	12
68	4	28		56	0	44		88	0	12		96	4	0		80	8	12
60	4	36		72	4	24		92	0	8		88	12	0		84	12	4
52	8	40		80	0	20		100	0	0		76	20	4		88	8	4
48	8	44		88	0	12		100	0	0		88	12	0		84	12	4
56	8	36		92	0	8		96	0	4		80	16	4		80	20	0
60	4	36		100	0	0		100	0	0		80	16	4		80	20	0
60	8	32		100	0	0		100	0	0		80	16	4		76	24	0
68	4	28		96	0	4		100	0	0		84	12	4		80	20	0
68	4	28		100	0	0		100	0	0		88	8	4		84	16	0

80	0	20		96	0	4		100	0	0		88	8	4		80	12	8
80	0	20		92	0	8		96	4	0		92	4	4		72	20	8
92	0	8		96	0	4		96	4	0		92	8	0		64	24	12
96	0	4		92	0	8		96	4	0		84	8	8		56	20	24
100	0	0		96	0	4		96	4	0		88	12	0		68	16	16
100	0	0		80	8	12		96	4	0		80	12	8		60	16	24
100	0	0		88	8	4		96	4	0		88	12	0		68	12	20
100	0	0		96	4	0		96	4	0		84	12	4		64	16	20
100	0	0		92	8	0		96	4	0		76	16	8		68	12	20
92	0	8		96	4	0		96	4	0		76	20	4		76	16	8
76	0	24		100	0	0		96	4	0		72	24	4		72	20	8
80	0	20		92	4	4		96	4	0		72	24	4		76	16	8
80	0	20		88	12	0		96	4	0		76	16	8		84	12	4
84	0	16		96	4	0		96	4	0		84	12	4		84	12	4
76	0	24		88	8	4		96	4	0		80	16	4		88	12	0
76	0	24		96	4	0		96	4	0		64	28	8		88	12	0
68	0	32		96	4	0		96	4	0		56	36	8		96	4	0
64	0	36		92	4	4		96	4	0		64	28	8		92	8	0
56	8	36		96	0	4		96	4	0		64	32	4		88	12	0
56	8	36		100	0	0		96	4	0		72	24	4		92	8	0
48	4	48		100	0	0		96	4	0		84	16	0		84	16	0
48	8	44		100	0	0		96	4	0		84	16	0		84	12	4
52	4	44		100	0	0		96	4	0		80	20	0		92	8	0
44	4	52		100	0	0		96	4	0		88	12	0		84	16	0
56	4	40		100	0	0		96	4	0		96	4	0		84	16	0
52	0	48		100	0	0		96	4	0		84	8	8		80	20	0
40	0	60		100	0	0		96	4	0		80	8	12		80	20	0
36	0	64		100	0	0		96	4	0		76	8	16		80	20	0
28	0	72		100	0	0		96	4	0		72	0	28		76	24	0
24	0	76		100	0	0		96	4	0		72	0	28		80	20	0
4	0	96		100	0	0		96	4	0		60	0	40		80	20	0

Figure B.2 Video Stream data – 2nd Run

14-May				4-Jun				12-Jun				17-Jul				13-Aug		
G	D	B		G	D	B		G	D	B		G	D	B		G	D	B
88	4	8		96	0	4		100	0	0		92	0	8		60	4	36
84	4	12		96	0	4		100	0	0		92	0	8		52	16	32
88	4	8		96	0	4		100	0	0		84	0	16		52	16	32
84	4	12		96	0	4		100	0	0		76	4	20		52	24	24
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100	0	0		52	0	48		100	0	0		88	4	8		84	16	0
100	0	0		68	0	32		100	0	0		88	4	8		84	12	4
100	0	0		68	0	32		100	0	0		84	0	16		92	4	4
100	0	0		76	4	20		100	0	0		84	0	16		80	8	12

100	0	0		84	0	16		100	0	0		84	0	16		84	8	8
100	0	0		76	4	20		100	0	0		84	0	16		76	12	12
100	0	0		64	0	36		100	0	0		80	0	20		68	12	20
96	0	4		48	0	52		100	0	0		80	0	20		68	16	16
84	0	16		28	0	72		100	0	0		76	4	20		72	8	20
68	0	32		16	0	84		100	0	0		84	0	16		60	20	20
56	0	44		0	0	100		100	0	0		84	0	16		56	20	24
40	0	60		0	0	100		100	0	0		84	0	16		56	24	20
24	0	76		12	0	88		100	0	0		84	0	16		64	24	12
24	0	76		16	0	84		100	0	0		92	0	8		64	16	20
28	0	72		28	0	72		100	0	0		92	0	8		72	16	12
44	0	56		40	0	60		100	0	0		88	0	12		80	12	8
52	4	44		64	0	36		96	0	4		84	0	16		80	12	8
68	8	24		80	0	20		100	0	0		88	0	12		80	12	8
76	4	20		96	0	4		100	0	0		84	0	16		80	8	12
76	8	16		96	0	4		96	0	4		88	0	12		76	4	20
76	0	24		92	0	8		92	0	8		88	0	12		80	8	12
64	4	32		92	8	0		92	0	8		88	0	12		72	8	20
60	4	36		88	8	4		84	0	16		92	0	8		76	16	8
48	4	48		84	8	8		80	0	20		84	0	16		64	16	20
40	12	48		80	4	16		80	0	20		92	0	8		60	24	16
48	12	40		68	12	20		76	4	20		88	0	12		60	20	20
48	12	40		56	4	40		88	0	12		84	0	16		64	20	16
44	8	48		52	8	40		72	0	28		72	0	28		64	20	16
48	8	44		56	0	44		72	0	28		76	0	24		60	20	20
44	12	44		32	4	64		64	0	36		72	0	28		80	8	12
40	12	48		32	0	68		52	0	48		64	0	36		84	8	8
44	4	52		28	0	72		52	4	44		60	8	32		92	4	4
48	4	48		20	4	76		44	16	40		56	8	36		92	0	8
28	8	64		28	4	68		36	0	64		64	4	32		100	0	0
20	12	68		40	0	60		36	0	64		68	8	24		96	0	4
20	16	64		44	0	56		28	0	72		64	8	28		96	0	4
16	32	52		44	0	56		36	12	52		76	0	24		88	0	12
12	20	68		52	0	48		24	28	48		68	8	24		88	0	12
16	20	64		72	4	24		20	52	28		64	4	32		80	4	16
16	24	60		72	8	20		20	56	24		64	4	32		88	0	12
16	24	60		76	4	20		24	56	20		64	4	32		80	8	12
16	20	64		76	4	20		24	48	28		76	0	24		76	12	12
16	20	64		72	4	24		28	36	36		80	0	20		76	16	8
16	16	68		60	0	40		28	36	36		68	8	24		80	8	12
16	24	60		40	0	60		28	24	48		68	12	20		68	16	16
20	24	56		40	0	60		28	16	56		68	8	24		88	8	4
24	16	60		32	0	68		36	8	56		72	4	24		88	12	0
40	24	36		24	0	76		36	8	56		80	0	20		84	12	4
44	20	36		28	0	72		40	4	56		76	4	20		88	8	4
44	12	44		36	0	64		44	16	40		80	4	16		80	4	16
60	8	32		44	0	56		40	28	32		72	4	24		88	8	4
60	4	36		48	0	52		48	24	28		76	8	16		76	8	16
72	0	28		52	0	48		48	20	32		72	12	16		72	8	20
76	0	24		60	0	40		48	12	40		72	12	16		64	12	24
84	0	16		72	0	28		44	8	48		76	8	16		72	0	28
92	0	8		80	0	20		44	8	48		72	8	20		68	8	24
92	0	8		88	0	12		48	4	48		68	12	20		76	4	20

Figure B.3 Video Stream data – 3rd Run

14-May				4-Jun				12-Jun				17-Jul				13-Aug		
G	D	B		G	D	B		G	D	B		G	D	B		G	D	B
72	8	20		100	0	0		100	0	0		80	0	20		60	20	20
68	12	20		100	0	0		100	0	0		80	0	20		60	16	24
64	12	24		100	0	0		100	0	0		88	0	12		68	16	16
60	8	32		100	0	0		100	0	0		84	0	16		72	16	12
56	8	36		100	0	0		100	0	0		68	4	28		76	12	12
56	8	36		100	0	0		100	0	0		72	4	24		84	12	4
56	4	40		100	0	0		100	0	0		72	4	24		84	16	0
60	0	40		100	0	0		100	0	0		76	4	20		88	12	0
52	0	48		100	0	0		100	0	0		80	0	20		88	12	0
56	0	44		100	0	0		100	0	0		88	0	12		88	12	0
68	0	32		100	0	0		100	0	0		84	0	16		96	4	0
52	4	44		100	0	0		100	0	0		88	0	12		96	4	0
60	4	36		100	0	0		100	0	0		92	0	8		96	0	4
64	0	36		100	0	0		100	0	0		100	0	0		92	4	4
64	0	36		100	0	0		100	0	0		100	0	0		84	12	4
64	0	36		100	0	0		100	0	0		92	4	4		80	12	8
64	0	36		100	0	0		100	0	0		100	0	0		76	16	8
72	0	28		100	0	0		100	0	0		84	8	8		80	12	8
64	0	36		100	0	0		100	0	0		96	0	4		80	16	4
56	0	44		100	0	0		100	0	0		88	0	12		72	20	8
60	0	40		100	0	0		100	0	0		80	4	16		84	12	4
56	0	44		100	0	0		100	0	0		84	4	12		72	16	12
52	4	44		100	0	0		100	0	0		84	12	4		84	12	4
48	0	52		92	0	8		100	0	0		88	8	4		84	12	4
56	4	40		92	0	8		100	0	0		88	4	8		88	8	4
52	0	48		92	4	4		100	0	0		92	4	4		80	16	4
60	4	36		88	0	12		100	0	0		84	8	8		84	16	0
60	4	36		88	0	12		96	4	0		88	4	8		76	16	8
64	12	24		92	0	8		96	4	0		84	8	8		80	20	0
60	16	24		92	4	4		92	4	4		84	8	8		80	16	4
60	24	16		92	0	8		84	8	8		84	4	12		76	20	4
48	24	28		84	4	12		88	4	8		88	4	8		72	24	4
48	24	28		92	0	8		84	12	4		92	0	8		72	24	4
48	24	28		88	4	8		84	4	12		96	0	4		76	24	0
40	24	36		88	4	8		76	8	16		96	0	4		72	28	0
52	16	32		88	4	8		72	4	24		88	0	12		72	28	0
40	16	44		88	4	8		80	4	16		76	0	24		76	20	4
44	12	44		92	0	8		80	4	16		68	0	32		76	24	0
28	8	64		88	4	8		88	0	12		56	0	44		76	24	0
28	0	72		96	0	4		88	0	12		52	0	48		76	20	4
24	8	68		100	0	0		96	0	4		52	0	48		80	16	4
20	0	80		100	0	0		100	0	0		52	0	48		68	24	8
16	0	84		100	0	0		100	0	0		56	0	44		84	16	0
16	4	80		100	0	0		96	0	4		64	0	36		76	24	0
12	4	84		100	0	0		100	0	0		64	0	36		72	28	0
12	8	80		100	0	0		100	0	0		80	0	20		72	28	0
12	8	80		100	0	0		96	0	4		92	0	8		68	32	0
4	12	84		100	0	0		100	0	0		100	0	0		76	24	0

0	12	88		100	0	0		100	0	0		96	0	4		76	24	0
0	12	88		100	0	0		92	0	8		92	0	8		80	20	0
0	8	92		100	0	0		96	0	4		88	4	8		80	20	0
4	12	84		100	0	0		88	0	12		84	4	12		72	28	0
8	12	80		100	0	0		92	0	8		80	8	12		80	20	0
16	12	72		96	0	4		92	0	8		76	8	16		80	20	0
16	4	80		100	0	0		92	0	8		76	4	20		92	8	0
28	0	72		96	0	4		96	0	4		88	0	12		84	16	0
24	0	76		100	0	0		88	0	12		96	0	4		92	0	8
24	0	76		100	0	0		92	0	8		96	0	4		84	8	8
28	0	72		100	0	0		84	0	16		92	0	8		88	8	4
28	0	72		100	0	0		92	0	8		92	0	8		76	8	16
20	0	80		96	0	4		84	0	16		84	0	16		84	8	8
24	0	76		96	0	4		84	0	16		88	0	12		92	4	4
20	0	80		100	0	0		96	0	4		72	4	24		88	4	8
20	0	80		96	0	4		96	0	4		60	0	40		88	0	12
16	4	80		96	0	4		96	0	4		68	0	32		88	0	12
8	0	92		100	0	0		92	0	8		72	0	28		84	0	16
28	0	72		100	0	0		84	0	16		60	0	40		84	4	12
40	0	60		96	0	4		84	0	16		68	0	32		88	0	12
52	0	48		96	4	0		88	0	12		88	0	12		88	0	12
56	0	44		92	4	4		92	0	8		88	0	12		88	0	12
64	0	36		96	4	0		84	0	16		100	0	0		76	8	16
64	0	36		96	0	4		88	0	12		100	0	0		80	4	16
56	0	44		100	0	0		88	0	12		100	0	0		72	12	16
36	0	64		100	0	0		80	0	20		100	0	0		76	12	12
48	0	52		100	0	0		84	0	16		100	0	0		68	12	20
32	0	68		96	0	4		80	0	20		100	0	0		72	8	20
40	0	60		100	0	0		92	0	8		100	0	0		72	16	12
44	0	56		100	0	0		80	0	20		92	0	8		72	16	12
52	0	48		100	0	0		80	0	20		76	0	24		68	20	12
68	0	32		100	0	0		76	0	24		84	0	16		84	12	4
76	0	24		100	0	0		80	0	20		72	4	24		76	12	12
68	0	32		100	0	0		88	0	12		76	4	20		84	8	8
76	0	24		100	0	0		88	0	12		68	4	28		84	12	4
64	8	28		100	0	0		88	0	12		52	8	40		92	8	0
44	12	44		100	0	0		88	0	12		56	4	40		84	12	4
36	20	44		100	0	0		96	0	4		60	12	28		76	20	4
24	16	60		100	0	0		96	0	4		64	4	32		76	24	0
12	12	76		100	0	0		92	0	8		64	4	32		88	12	0
8	12	80		100	0	0		88	0	12		64	0	36		76	24	0
0	20	80		100	0	0		84	0	16		68	0	32		72	28	0
4	12	84		100	0	0		88	0	12		60	0	40		76	24	0
12	12	76		100	0	0		88	0	12		60	0	40		80	20	0
16	8	76		100	0	0		92	0	8		52	0	48		88	12	0
16	8	76		100	0	0		88	0	12		32	8	60		84	12	4
16	4	80		100	0	0		84	0	16		28	16	56		84	8	8
16	0	84		100	0	0		88	0	12		24	24	52		92	0	8
20	0	80		100	0	0		88	0	12		92	0	8		88	0	12
20	0	80		100	0	0		88	0	12		100	0	0		84	0	16
16	0	84		100	0	0		92	0	8		100	0	0		80	4	16
24	0	76		100	0	0		96	0	4		96	0	4		76	4	20
20	0	80		100	0	0		92	0	8		96	0	4		80	4	16
32	0	68		100	0	0		100	0	0		96	0	4		80	8	12
36	0	64		100	0	0		96	0	4		96	0	4		84	8	8

40	0	60		100	0	0		92	0	8		92	0	8		88	0	12
48	0	52		100	0	0		84	0	16		96	0	4		80	0	20
48	0	52		96	0	4		92	0	8		88	0	12		64	0	36
40	0	60		96	0	4		92	0	8		84	0	16		64	0	36
36	0	64		96	0	4		88	0	12		92	0	8		52	0	48
20	0	80		88	0	12		88	0	12		92	0	8		44	0	56
20	0	80		80	0	20		92	0	8		92	0	8		40	0	60
20	0	80		76	0	24		84	0	16		96	0	4		40	0	60
24	0	76		80	0	20		88	0	12		88	0	12		44	0	56
28	0	72		84	0	16		92	0	8		84	0	16		60	0	40
40	0	60		84	0	16		92	0	8		84	4	12		64	0	36
52	0	48		80	0	20		96	0	4		68	4	28		68	4	28
76	0	24		68	4	28		100	0	0		80	4	16		76	0	24
80	0	20		52	4	44		100	0	0		92	0	8		88	0	12
76	0	24		36	0	64		96	0	4		88	4	8		96	0	4
80	0	20		36	0	64		96	0	4		84	8	8		100	0	0
88	0	12		40	0	60		96	0	4		92	4	4		96	0	4
88	0	12		40	0	60		100	0	0		88	4	8		96	0	4
88	0	12		60	0	40		92	0	8		80	8	12		96	0	4
88	0	12		80	0	20		96	0	4		84	4	12		84	8	8
96	0	4		96	0	4		96	0	4		80	4	16		92	4	4
88	0	12		100	0	0		96	0	4		88	8	4		84	4	12
96	0	4		100	0	0		96	0	4		76	4	20		84	0	16
88	0	12		84	0	16		96	0	4		68	4	28		84	0	16
88	0	12		64	0	36		100	0	0		60	12	28		84	0	16
84	0	16		44	0	56		88	0	12		68	12	20		84	0	16
80	4	16		44	0	56		92	0	8		68	4	28		80	4	16
84	4	12		28	4	68		92	0	8		72	12	16		76	0	24
88	0	12		28	4	68		92	0	8		68	12	20		72	0	28
76	8	16		36	4	60		88	0	12		92	8	0		76	0	24
84	4	12		68	0	32		96	0	4		92	0	8		80	0	20
80	8	12		88	0	12		100	0	0		92	0	8		80	0	20
72	4	24		76	0	24		96	0	4		84	0	16		72	4	24
56	4	40		80	0	20		100	0	0		84	0	16		72	0	28
48	4	48		72	0	28		96	0	4		76	4	20		84	4	12
44	4	52		72	0	28		92	0	8		84	4	12		76	4	20
36	0	64		68	0	32		88	0	12		80	4	16		88	0	12
20	0	80		76	0	24		88	0	12		88	4	8		80	4	16
8	4	88		88	0	12		92	0	8		76	4	20		84	0	16
12	0	88		88	0	12		92	0	8		76	4	20		80	4	16
20	0	80		92	4	4		84	0	16		80	0	20		76	4	20
24	0	76		96	4	0		84	0	16		68	0	32		76	4	20
32	4	64		96	4	0		88	0	12		76	0	24		80	8	12
36	4	60		100	0	0		92	0	8		76	0	24		92	4	4
52	0	48		96	0	4		80	0	20		88	0	12		84	0	16
64	4	32		92	0	8		84	0	16		88	0	12		88	0	12
64	4	32		88	0	12		96	0	4		80	0	20		84	4	12
80	4	16		84	0	16		96	0	4		80	0	20		88	4	8
80	0	20		64	0	36		100	0	0		84	0	16		84	0	16
84	0	16		60	0	40		100	0	0		84	4	12		84	0	16
88	0	12		56	0	44		100	0	0		80	4	16		88	4	8
96	0	4		36	0	64		100	0	0		84	4	12		92	0	8
92	0	8		24	0	76		100	0	0		76	4	20		96	0	4
100	0	0		12	0	88		100	0	0		76	4	20		92	0	8
88	0	12		16	0	84		100	0	0		84	0	16		96	0	4

92	0	8		32	0	68		100	0	0		92	0	8		92	0	8
92	0	8		48	0	52		100	0	0		96	0	4		88	0	12
92	0	8		68	0	32		100	0	0		88	0	12		80	0	20
96	0	4		92	0	8		100	0	0		92	0	8		80	0	20
88	4	8		100	0	0		100	0	0		88	0	12		80	0	20
84	12	4		96	0	4		100	0	0		84	0	16		84	0	16
88	8	4		96	0	4		100	0	0		96	0	4		80	0	20
84	12	4		96	0	4		100	0	0		88	0	12		84	0	16
72	24	4		96	0	4		100	0	0		96	0	4		84	0	16
72	24	4		96	0	4		100	0	0		96	0	4		80	0	20
68	24	8		100	0	0		92	0	8		84	0	16		76	0	24
60	24	16		100	0	0		92	0	8		72	4	24		92	0	8
76	16	8		100	0	0		84	0	16		68	0	32		88	0	12
64	28	8		100	0	0		76	0	24		68	0	32		76	4	20
76	12	12		100	0	0		72	0	28		68	4	28		80	8	12
80	12	8		100	0	0		64	0	36		76	4	20		80	4	16
92	4	4		96	0	4		68	0	32		68	0	32		88	4	8
100	0	0		96	0	4		76	0	24		64	8	28		88	0	12
100	0	0		84	0	16		76	0	24		64	0	36		80	0	20
92	0	8		72	0	28		72	0	28		72	0	28		80	0	20
88	0	12		60	0	40		80	0	20		88	0	12		68	4	28
76	0	24		64	0	36		84	0	16		88	0	12		68	4	28
60	0	40		64	0	36		84	0	16		84	0	16		68	0	32
48	0	52		64	0	36		84	0	16		88	0	12		64	8	28
44	4	52		72	0	28		84	0	16		80	0	20		72	4	24
40	4	56		76	0	24		80	0	20		76	0	24		60	4	36
44	0	56		92	0	8		80	0	20		76	0	24		64	4	32
52	0	48		92	0	8		84	0	16		80	4	16		76	0	24
52	0	48		92	0	8		80	0	20		84	0	16		80	0	20
52	0	48		88	0	12		76	0	24		80	0	20		84	0	16
60	0	40		100	0	0		72	0	28		72	0	28		84	4	12
52	0	48		96	0	4		72	0	28		60	0	40		88	4	8
44	0	56		88	0	12		80	0	20		64	0	36		92	0	8
36	0	64		88	0	12		80	0	20		72	0	28		92	0	8
36	0	64		96	0	4		80	0	20		56	0	44		92	0	8
40	0	60		84	0	16		84	0	16		68	0	32		88	0	12
32	0	68		92	0	8		84	0	16		68	0	32		88	0	12
36	0	64		92	0	8		92	0	8		76	0	24		84	0	16
28	0	72		92	0	8		88	0	12		84	0	16		76	0	24
32	4	64		100	0	0		92	0	8		92	0	8		80	0	20
32	0	68		96	0	4		88	0	12		96	0	4		80	0	20
28	4	68		100	0	0		92	0	8		96	0	4		80	0	20
32	0	68		100	0	0		96	0	4		100	0	0		88	0	12
36	0	64		96	4	0		100	0	0		100	0	0		80	0	20
36	0	64		96	4	0		96	0	4		100	0	0		88	0	12
52	0	48		100	0	0		96	0	4		100	0	0		96	0	4
68	0	32		96	4	0		96	0	4		100	0	0		88	4	8
76	0	24		96	4	0		96	0	4		100	0	0		100	0	0
88	0	12		92	4	4		100	0	0		88	0	12		92	0	8
88	0	12		88	4	8		96	0	4		96	0	4		80	8	12
84	0	16		88	4	8		96	0	4		84	0	16		84	4	12
80	0	20		92	4	4		96	0	4		88	0	12		84	0	16
80	0	20		96	4	0		92	0	8		92	0	8		84	4	12
80	0	20		100	0	0		96	0	4		92	0	8		80	0	20
76	0	24		100	0	0		96	0	4		92	0	8		92	4	4

72	8	20		100	0	0		96	0	4		88	0	12		92	0	8
80	4	16		100	0	0		92	0	8		84	0	16		88	0	12
76	4	20		96	0	4		96	0	4		84	0	16		92	0	8
80	4	16		96	0	4		92	0	8		80	0	20		84	0	16
68	4	28		96	0	4		96	0	4		80	4	16		84	0	16
60	4	36		100	0	0		100	0	0		72	12	16		76	0	24
60	4	36		100	0	0		100	0	0		76	12	12		68	8	24
64	4	32		100	0	0		100	0	0		76	4	20		60	0	40
56	0	44		96	0	4		100	0	0		80	4	16		64	0	36
64	0	36		88	0	12		100	0	0		88	0	12		64	0	36
68	0	32		80	0	20		96	0	4		88	4	8		64	0	36
68	0	32		80	0	20		96	0	4		88	0	12		60	0	40
76	0	24		64	4	32		96	0	4		88	0	12		64	4	32
76	0	24		52	4	44		100	0	0		92	0	8		76	0	24
68	0	32		44	4	52		96	0	4		96	0	4		80	0	20
52	0	48		52	0	48		96	0	4		92	0	8		84	0	16
52	0	48		76	0	24		92	0	8		84	0	16		88	0	12
52	0	48		88	0	12		92	0	8		88	0	12		84	8	8
60	0	40		96	0	4		92	0	8		92	0	8		88	8	4
64	0	36		100	0	0		92	0	8		84	0	16		80	12	8
68	0	32		100	0	0		96	0	4		96	0	4		80	8	12
76	0	24		100	0	0		100	0	0		88	4	8		68	20	12
72	0	28		100	0	0		96	0	4		92	0	8		72	12	16
80	0	20		100	0	0		100	0	0		88	0	12		68	16	16
84	0	16		100	0	0		100	0	0		84	0	16		68	20	12
88	0	12		100	0	0		100	0	0		84	0	16		72	16	12
84	0	16		100	0	0		96	0	4		76	0	24		80	8	12
88	0	12		100	0	0		100	0	0		76	0	24		76	16	8
88	0	12		100	0	0		100	0	0		64	0	36		76	12	12
92	0	8		100	0	0		100	0	0		76	0	24		84	4	12
92	0	8		96	0	4		100	0	0		68	0	32		84	4	12
88	0	12		100	0	0		100	0	0		72	0	28		88	0	12
96	0	4		92	0	8		100	0	0		80	0	20		84	0	16
96	0	4		96	0	4		100	0	0		80	4	16		76	0	24
100	0	0		80	0	20		92	0	8		84	0	16		68	0	32
100	0	0		76	4	20		96	0	4		88	0	12		56	0	44
96	0	4		72	4	24		96	0	4		80	0	20		60	0	40
96	0	4		72	8	20		96	0	4		88	0	12		56	4	40
84	0	16		72	8	20		92	0	8		92	0	8		60	8	32
92	0	8		80	4	16		96	0	4		96	0	4		60	4	36
84	0	16		92	4	4		92	0	8		88	0	12		60	4	36
84	0	16		84	4	12		96	0	4		96	0	4		64	4	32
84	0	16		92	4	4		96	0	4		100	0	0		72	4	24
84	0	16		96	0	4		100	0	0		96	0	4		80	4	16
84	0	16		100	0	0		100	0	0		84	0	16		84	8	8
84	0	16		100	0	0		100	0	0		88	0	12		96	4	0
88	0	12		100	0	0		100	0	0		88	0	12		88	8	4
92	0	8		96	0	4		100	0	0		92	0	8		92	0	8
88	0	12		96	4	0		100	0	0		92	0	8		88	0	12
92	0	8		96	0	4		100	0	0		96	0	4		84	0	16
100	0	0		92	4	4		100	0	0		92	0	8		76	0	24
88	0	12		88	4	8		100	0	0		88	0	12		68	0	32
88	0	12		88	4	8		100	0	0		88	0	12		60	4	36
92	0	8		92	4	4		92	0	8		80	4	16		60	4	36
84	0	16		88	0	12		100	0	0		84	0	16		64	4	32

76	0	24		96	0	4		88	0	12		76	4	20		60	8	32
72	0	28		88	0	12		88	0	12		72	4	24		60	8	32
64	0	36		84	8	8		88	0	12		64	4	32		60	12	28
52	0	48		84	8	8		84	0	16		68	4	28		52	16	32
56	0	44		88	4	8		80	0	20		64	4	32		68	8	24
68	0	32		84	4	12		80	0	20		64	4	32		60	20	20
64	0	36		88	4	8		76	0	24		80	0	20		64	28	8
68	0	32		84	0	16		76	0	24		72	0	28		80	20	0
56	0	44		96	0	4		72	0	28		80	0	20		84	16	0
48	0	52		92	0	8		72	0	28		76	0	24		84	16	0
44	0	56		92	0	8		76	0	24		80	4	16		80	16	4
52	0	48		96	0	4		68	0	32		80	0	20		80	16	4
48	0	52		100	0	0		68	4	28		84	0	16		80	12	8
44	0	56		100	0	0		80	0	20		84	4	12		84	12	4
44	0	56		100	0	0		72	0	28		84	4	12		88	8	4
44	0	56		100	0	0		80	0	20		88	0	12		84	16	0
32	0	68		100	0	0		76	0	24		92	0	8		76	20	4
44	0	56		100	0	0		80	0	20		88	4	8		80	16	4
28	8	64		100	0	0		84	0	16		80	8	12		76	24	0
32	12	56		100	0	0		76	0	24		80	12	8		88	8	4
24	16	60		100	0	0		72	0	28		76	8	16		88	12	0
12	20	68		100	0	0		72	0	28		76	8	16		80	16	4
12	8	80		100	0	0		60	0	40		88	0	12		72	24	4
4	24	72		100	0	0		68	0	32		88	0	12		80	16	4
8	28	64		100	0	0		60	0	40		84	8	8		80	16	4
4	36	60		100	0	0		60	0	40		84	8	8		76	20	4
8	36	56		100	0	0		56	0	44		80	8	12		84	12	4
4	44	52		100	0	0		56	0	44		84	4	12		80	12	8
4	32	64		100	0	0		64	0	36		80	8	12		76	16	8
12	48	40		100	0	0		60	0	40		88	4	8		76	16	8
16	48	36		100	0	0		64	0	36		88	4	8		92	4	4
8	44	48		100	0	0		60	0	40		88	8	4		80	8	12
0	48	52		100	0	0		60	0	40		84	8	8		88	4	8
8	36	56		100	0	0		56	0	44		84	8	8		84	4	12
12	36	52		100	0	0		60	0	40		84	8	8		84	4	12
12	32	56		100	0	0		60	0	40		88	8	4		88	0	12
24	32	44		100	0	0		60	0	40		84	8	8		88	0	12
32	24	44		100	0	0		64	0	36		92	4	4		88	0	12
44	20	36		100	0	0		68	0	32		88	8	4		88	0	12
48	16	36		100	0	0		64	0	36		88	4	8		88	0	12

Figure B.4 Video Stream Data – 4th Run

14-May				4-Jun				12-Jun				17-Jul				13-Aug		
G	D	B		G	D	B		G	D	B		G	D	B		G	D	B
64	4	32		96	0	4		96	4	0		68	4	28		76	16	8
64	0	36		96	0	4		100	0	0		72	4	24		72	16	12
56	0	44		96	0	4		100	0	0		80	4	16		76	16	8
60	0	40		96	0	4		96	4	0		84	4	12		72	16	12
60	8	32		100	0	0		100	0	0		88	0	12		72	16	12
56	4	40		96	0	4		96	4	0		80	0	20		72	16	12

56	0	44		96	0	4		92	8	0		80	0	20		68	16	16
32	8	60		96	0	4		88	8	4		84	0	16		64	16	20
24	4	72		92	4	4		84	12	4		76	0	24		68	16	16
20	0	80		96	0	4		88	8	4		88	0	12		68	16	16
16	8	76		96	0	4		92	8	0		76	0	24		72	16	12
16	8	76		100	0	0		88	12	0		76	0	24		68	16	16
20	12	68		100	0	0		92	4	4		76	0	24		72	16	12
24	12	64		96	0	4		88	8	4		80	0	20		76	12	12
36	12	52		100	0	0		92	4	4		88	0	12		80	8	12
40	20	40		96	4	0		92	4	4		96	0	4		76	4	20
44	12	44		88	4	8		100	0	0		96	4	0		84	0	16
48	12	40		84	8	8		100	0	0		84	4	12		84	0	16
56	8	36		88	4	8		100	0	0		92	4	4		80	4	16
68	8	24		84	8	8		100	0	0		96	4	0		88	4	8
76	0	24		80	8	12		100	0	0		92	4	4		84	4	12
80	0	20		88	4	8		100	0	0		96	4	0		92	0	8
76	0	24		88	4	8		100	0	0		92	4	4		88	4	8
68	0	32		92	4	4		96	0	4		96	0	4		88	4	8
84	0	16		84	8	8		96	0	4		96	0	4		88	0	12
76	0	24		88	4	8		92	0	8		92	0	8		84	0	16
76	0	24		92	4	4		72	4	24		92	0	8		88	0	12
68	0	32		92	0	8		64	8	28		80	0	20		84	4	12
60	0	40		96	4	0		64	4	32		72	0	28		72	8	20
56	0	44		100	0	0		56	16	28		64	0	36		72	12	16
44	0	56		100	0	0		44	20	36		52	0	48		68	8	24
32	0	68		100	0	0		40	28	32		56	0	44		68	8	24
28	0	72		100	0	0		36	28	36		52	0	48		76	8	16
20	8	72		96	0	4		24	36	40		48	0	52		72	8	20
16	8	76		100	0	0		44	28	28		40	0	60		80	8	12
12	8	80		100	0	0		68	24	8		44	0	56		84	8	8
4	16	80		100	0	0		72	16	12		40	0	60		84	12	4
8	8	84		96	0	4		76	4	20		28	0	72		80	8	12
16	8	76		92	0	8		84	0	16		20	0	80		84	16	0
12	8	80		88	0	12		100	0	0		28	0	72		96	4	0
8	8	84		76	0	24		96	0	4		24	0	76		92	4	4
8	0	92		68	4	28		96	0	4		32	0	68		84	0	16
4	4	92		64	0	36		96	0	4		40	0	60		88	4	8
20	4	76		56	0	44		100	0	0		52	0	48		80	4	16
24	8	68		52	0	48		100	0	0		72	0	28		84	8	8
32	4	64		56	0	44		100	0	0		92	0	8		84	4	12
32	0	68		44	0	56		100	0	0		92	0	8		80	8	12
48	0	52		36	0	64		100	0	0		92	0	8		76	8	16
56	4	40		36	0	64		100	0	0		96	0	4		80	8	12
64	0	36		40	0	60		100	0	0		100	0	0		72	12	16
68	0	32		60	0	40		100	0	0		100	0	0		76	4	20
72	0	28		56	0	44		100	0	0		100	0	0		68	12	20
84	0	16		76	0	24		100	0	0		100	0	0		80	8	12
84	0	16		64	0	36		100	0	0		100	0	0		84	8	8
96	0	4		68	0	32		100	0	0		92	4	4		84	12	4
92	0	8		80	0	20		100	0	0		88	4	8		80	12	8
88	0	12		84	0	16		100	0	0		88	4	8		88	8	4
72	0	28		92	0	8		92	0	8		92	0	8		88	8	4
56	0	44		88	8	4		92	0	8		88	4	8		84	8	8
36	0	64		88	12	0		92	0	8		92	4	4		92	4	4
36	0	64		80	12	8		92	0	8		100	0	0		96	0	4

24	0	76		80	16	4		88	0	12		92	0	8		100	0	0
12	0	88		80	16	4		84	0	16		92	0	8		96	0	4
0	0	100		80	12	8		88	0	12		88	0	12		100	0	0
0	0	100		88	8	4		88	0	12		92	0	8		92	0	8
4	0	96		76	16	8		84	0	16		96	0	4		92	0	8
8	0	92		84	4	12		80	0	20		96	0	4		80	0	20
16	0	84		88	0	12		76	0	24		96	0	4		76	0	24
28	0	72		96	0	4		76	0	24		88	0	12		64	0	36
36	0	64		96	0	4		72	0	28		88	0	12		64	0	36
44	0	56		100	0	0		68	0	32		88	0	12		64	0	36
56	0	44		100	0	0		44	0	56		88	0	12		52	4	44
56	4	40		96	0	4		32	4	64		92	0	8		60	0	40
56	4	40		88	0	12		16	4	80		80	0	20		60	4	36
52	4	44		92	0	8		8	4	88		84	0	16		64	8	28
44	4	52		88	0	12		12	4	84		84	4	12		80	4	16
32	4	64		88	4	8		28	0	72		76	0	24		84	8	8
32	0	68		88	4	8		32	0	68		64	0	36		88	8	4
32	0	68		88	8	4		32	4	64		44	0	56		96	0	4
32	0	68		88	4	8		40	0	60		36	0	64		96	0	4
40	0	60		96	0	4		56	0	44		32	0	68		92	0	8
44	0	56		100	0	0		68	0	32		20	0	80		88	0	12
48	0	52		96	0	4		68	0	32		16	0	84		88	0	12
44	0	56		100	0	0		72	0	28		16	4	80		80	4	16
36	0	64		96	0	4		72	0	28		32	4	64		80	4	16
16	0	84		100	0	0		68	0	32		52	4	44		72	0	28
16	0	84		100	0	0		72	0	28		68	4	28		76	4	20
16	0	84		100	0	0		68	0	32		88	0	12		76	0	24
8	0	92		100	0	0		76	0	24		88	0	12		84	0	16
8	0	92		100	0	0		72	0	28		96	0	4		84	8	8
0	0	100		100	0	0		84	0	16		92	0	8		84	4	12
0	0	100		100	0	0		92	0	8		96	0	4		84	8	8
0	0	100		100	0	0		96	0	4		100	0	0		88	4	8
0	0	100		100	0	0		92	0	8		100	0	0		88	0	12
0	0	100		100	0	0		92	0	8		100	0	0		84	0	16
4	0	96		100	0	0		96	0	4		100	0	0		72	8	20
12	4	84		100	0	0		92	0	8		100	0	0		68	12	20
20	4	76		100	0	0		92	0	8		96	0	4		56	12	32
24	4	72		100	0	0		92	0	8		84	0	16		52	16	32
28	4	68		100	0	0		92	0	8		76	0	24		56	16	28
48	0	52		100	0	0		88	0	12		68	0	32		52	16	32
60	0	40		100	0	0		88	0	12		72	0	28		64	8	28
60	0	40		100	0	0		88	0	12		68	0	32		60	8	32
72	0	28		92	0	8		92	0	8		72	0	28		64	4	32
68	0	32		96	0	4		92	0	8		72	0	28		64	4	32
72	0	28		84	0	16		92	0	8		92	0	8		80	0	20
60	0	40		88	0	12		100	0	0		92	0	8		88	4	8
48	0	52		76	0	24		92	0	8		88	0	12		96	0	4
40	4	56		60	0	40		92	0	8		88	0	12		100	0	0
48	0	52		56	0	44		96	0	4		88	0	12		100	0	0
48	4	48		44	0	56		96	0	4		88	0	12		100	0	0
48	4	48		28	0	72		88	0	12		80	0	20		100	0	0
56	0	44		24	0	76		92	0	8		80	0	20		100	0	0
68	0	32		12	0	88		96	0	4		84	0	16		100	0	0
76	0	24		20	0	80		92	0	8		88	0	12		96	0	4
80	0	20		8	0	92		92	0	8		88	0	12		96	0	4

84	0	16		12	0	88		88	0	12		88	0	12		96	0	4
76	0	24		8	0	92		88	0	12		92	0	8		100	0	0
72	0	28		4	0	96		80	0	20		92	0	8		92	0	8
80	0	20		4	0	96		84	0	16		80	0	20		88	0	12
80	0	20		0	0	100		84	0	16		88	0	12		88	4	8
88	0	12		0	0	100		84	0	16		88	0	12		92	0	8
84	4	12		0	0	100		84	0	16		80	0	20		80	4	16
72	4	24		0	0	100		80	0	20		76	0	24		92	0	8
80	0	20		0	0	100		76	0	24		84	0	16		76	8	16
88	0	12		0	4	96		80	0	20		84	0	16		84	0	16
88	0	12		12	0	88		84	0	16		76	0	24		72	8	20
80	4	16		8	0	92		88	0	12		72	0	28		72	4	24
72	4	24		28	0	72		84	0	16		60	0	40		68	4	28
72	4	24		40	0	60		84	0	16		48	0	52		68	4	28
56	0	44		48	0	52		84	0	16		48	0	52		76	4	20
52	4	44		72	0	28		88	0	12		36	0	64		72	0	28
44	0	56		72	0	28		96	0	4		44	0	56		72	4	24
40	0	60		92	0	8		100	0	0		60	0	40		64	0	36
36	0	64		96	0	4		100	0	0		72	8	20		60	0	40
20	0	80		100	0	0		100	0	0		88	0	12		64	0	36
28	0	72		100	0	0		100	0	0		92	4	4		64	0	36
24	0	76		100	0	0		100	0	0		100	0	0		56	0	44
32	0	68		100	0	0		100	0	0		100	0	0		52	0	48
48	0	52		100	0	0		100	0	0		92	0	8		44	0	56
52	0	48		100	0	0		100	0	0		88	0	12		36	0	64
64	0	36		100	0	0		100	0	0		88	0	12		28	0	72
80	0	20		100	0	0		100	0	0		84	0	16		24	0	76
88	0	12		100	0	0		100	0	0		84	0	16		12	0	88
96	0	4		96	0	4		100	0	0		84	4	12		0	4	96
100	0	0		100	0	0		100	0	0		84	0	16		0	8	92
100	0	0		100	0	0		92	8	0		96	0	4		0	4	96
100	0	0		92	0	8		100	0	0		88	0	12		0	8	92
96	0	4		96	0	4		100	0	0		88	0	12		0	4	96
88	0	12		88	0	12		100	0	0		76	4	20		12	0	88
84	0	16		76	0	24		100	0	0		72	4	24		16	0	84
72	0	28		84	0	16		100	0	0		60	0	40		32	0	68
60	4	36		76	4	20		100	0	0		68	0	32		40	0	60
56	8	36		72	0	28		100	0	0		68	0	32		52	0	48
52	12	36		76	0	24		100	0	0		80	0	20		60	0	40
60	20	20		80	0	20		100	0	0		80	0	20		80	0	20
64	12	24		84	0	16		100	0	0		84	0	16		88	0	12
76	12	12		84	0	16		100	0	0		96	0	4		92	0	8
88	8	4		92	0	8		100	0	0		92	0	8		100	0	0
92	4	4		92	0	8		100	0	0		96	0	4		100	0	0
92	8	0		100	0	0		100	0	0		96	0	4		100	0	0
92	8	0		100	0	0		100	0	0		92	0	8		100	0	0
88	12	0		100	0	0		100	0	0		92	0	8		96	0	4
92	8	0		100	0	0		100	0	0		96	0	4		96	0	4
92	8	0		100	0	0		100	0	0		88	0	12		88	4	8
88	8	4		100	0	0		100	0	0		92	0	8		88	4	8
92	8	0		100	0	0		100	0	0		92	0	8		88	4	8
100	0	0		100	0	0		100	0	0		84	4	12		80	8	12
96	0	4		100	0	0		100	0	0		76	0	24		88	0	12
84	0	16		100	0	0		100	0	0		68	4	28		88	0	12
64	4	32		100	0	0		100	0	0		72	4	24		88	0	12

60	0	40		100	0	0		100	0	0		72	4	24		92	0	8
72	0	28		100	0	0		100	0	0		84	0	16		96	0	4
52	0	48		100	0	0		96	0	4		88	0	12		100	0	0
40	0	60		100	0	0		96	0	4		96	0	4		100	0	0
28	0	72		100	0	0		92	0	8		92	0	8		100	0	0
44	0	56		100	0	0		88	0	12		92	0	8		92	0	8
36	0	64		100	0	0		92	0	8		92	0	8		92	0	8
28	0	72		96	0	4		96	0	4		84	8	8		92	0	8
44	0	56		96	0	4		96	0	4		84	4	12		92	0	8
40	0	60		88	4	8		100	0	0		92	4	4		96	0	4
48	0	52		88	4	8		100	0	0		92	4	4		96	0	4
40	0	60		92	4	4		100	0	0		96	0	4		88	0	12
40	4	56		92	0	8		100	0	0		88	0	12		88	4	8
44	4	52		96	0	4		100	0	0		92	0	8		96	0	4
48	4	48		96	4	0		100	0	0		92	0	8		84	0	16
44	8	48		100	0	0		100	0	0		84	0	16		88	0	12
60	4	36		100	0	0		96	0	4		80	0	20		88	0	12
64	8	28		100	0	0		100	0	0		76	4	20		84	0	16
80	4	16		100	0	0		92	0	8		76	0	24		88	0	12
88	0	12		100	0	0		92	0	8		68	4	28		88	0	12
84	0	16		100	0	0		96	0	4		60	4	36		88	0	12
80	0	20		100	0	0		96	0	4		68	0	32		92	0	8
84	0	16		100	0	0		96	0	4		68	0	32		92	0	8
80	0	20		100	0	0		92	0	8		72	0	28		84	4	12
64	0	36		100	0	0		92	0	8		76	0	24		76	0	24
64	0	36		100	0	0		84	0	16		84	0	16		88	4	8
52	0	48		100	0	0		88	0	12		84	0	16		92	0	8
48	0	52		100	0	0		84	0	16		88	0	12		96	0	4
44	0	56		96	0	4		88	0	12		88	0	12		92	0	8
44	4	52		100	0	0		88	0	12		84	0	16		88	0	12
52	4	44		100	0	0		88	0	12		84	0	16		88	0	12
68	4	28		100	0	0		92	0	8		88	0	12		80	0	20
72	0	28		100	0	0		92	0	8		84	4	12		68	0	32
72	0	28		100	0	0		88	0	12		76	0	24		68	0	32
72	0	28		96	0	4		88	0	12		72	4	24		72	4	24
76	0	24		96	0	4		80	0	20		80	0	20		60	8	32
68	0	32		92	0	8		80	0	20		80	0	20		52	12	36
68	0	32		88	0	12		84	0	16		84	0	16		52	12	36
64	0	36		92	0	8		92	0	8		84	0	16		52	16	32
68	0	32		80	0	20		96	0	4		76	0	24		60	12	28
68	0	32		68	0	32		92	0	8		80	0	20		68	4	28
80	0	20		68	0	32		96	0	4		88	0	12		80	4	16
84	0	16		68	4	28		96	0	4		84	4	12		80	4	16
80	0	20		60	0	40		92	0	8		92	4	4		76	4	20
84	0	16		60	0	40		92	0	8		92	4	4		80	0	20
80	0	20		60	0	40		88	0	12		80	8	12		84	0	16
84	0	16		64	0	36		88	0	12		80	16	4		80	0	20
92	0	8		64	4	32		96	0	4		64	20	16		84	0	16
96	0	4		72	4	24		96	0	4		76	12	12		84	4	12
96	0	4		76	4	20		100	0	0		88	4	8		84	4	12
88	0	12		80	4	16		92	0	8		88	4	8		84	8	8
76	0	24		88	0	12		96	0	4		88	8	4		92	4	4
60	0	40		84	4	12		96	0	4		100	0	0		84	4	12
56	0	44		92	4	4		96	0	4		96	0	4		84	4	12
48	0	52		92	4	4		96	0	4		88	4	8		88	0	12

52	0	48		92	4	4		92	0	8		88	4	8		100	0	0
40	0	60		92	4	4		84	0	16		76	8	16		96	0	4
44	0	56		96	4	0		84	0	16		68	16	16		92	0	8
48	0	52		100	0	0		88	0	12		80	12	8		92	0	8
40	0	60		88	0	12		92	0	8		88	4	8		84	0	16
44	0	56		76	0	24		92	0	8		88	0	12		76	8	16
36	0	64		64	0	36		88	0	12		96	4	0		68	12	20
28	0	72		52	0	48		92	0	8		88	4	8		80	4	16
24	0	76		40	0	60		100	0	0		92	4	4		80	4	16
16	0	84		20	0	80		100	0	0		88	0	12		88	4	8
12	0	88		4	0	96		96	0	4		92	0	8		92	0	8
0	0	100		4	0	96		96	0	4		80	8	12		84	8	8
0	0	100		0	0	100		96	0	4		96	4	0		84	0	16
0	0	100		0	0	100		96	0	4		96	4	0		88	0	12
0	0	100		0	0	100		92	0	8		92	8	0		84	8	8
4	0	96		4	0	96		100	0	0		80	12	8		72	8	20
8	0	92		16	0	84		96	0	4		92	4	4		80	0	20
16	0	84		20	4	76		92	0	8		84	8	8		76	0	24
20	0	80		36	0	64		84	0	16		92	0	8		76	0	24
16	0	84		52	0	48		80	0	20		92	0	8		88	0	12
24	4	72		64	0	36		80	0	20		88	0	12		80	4	16
24	0	76		76	0	24		80	4	16		88	4	8		84	0	16
28	4	68		88	0	12		92	0	8		88	0	12		96	0	4
24	12	64		96	0	4		96	4	0		88	0	12		92	0	8
28	16	56		92	0	8		100	0	0		80	4	16		96	0	4
32	16	52		96	0	4		100	0	0		84	8	8		92	0	8
32	20	48		100	0	0		100	0	0		68	8	24		100	0	0
40	20	40		100	0	0		100	0	0		80	8	12		100	0	0
52	16	32		96	0	4		96	0	4		68	12	20		96	0	4
52	24	24		88	0	12		88	0	12		64	16	20		92	0	8
48	20	32		84	0	16		92	0	8		68	12	20		88	0	12
44	12	44		84	0	16		88	4	8		68	8	24		88	4	8
48	12	40		84	0	16		92	0	8		76	8	16		92	0	8
52	4	44		80	0	20		72	4	24		72	4	24		92	0	8
64	4	32		88	0	12		76	4	20		84	4	12		96	0	4
64	0	36		88	0	12		80	4	16		88	0	12		84	0	16
64	4	32		92	0	8		80	4	16		88	0	12		76	0	24
60	0	40		92	0	8		72	4	24		80	0	20		76	0	24
52	0	48		84	0	16		72	4	24		80	0	20		68	0	32
64	0	36		84	0	16		68	4	28		68	8	24		56	0	44
80	4	16		80	0	20		72	4	24		64	8	28		48	0	52
84	0	16		76	0	24		84	0	16		56	12	32		36	0	64
84	4	12		76	0	24		84	4	12		48	12	40		20	0	80
84	0	16		68	0	32		84	4	12		48	8	44		16	0	84
80	8	12		60	0	40		80	4	16		32	16	52		12	0	88
84	4	12		44	0	56		80	4	16		32	8	60		12	0	88
96	4	0		40	0	60		80	4	16		20	12	68		24	12	64
100	0	0		40	0	60		76	8	16		16	12	72		28	12	60
92	0	8		36	0	64		84	0	16		4	20	76		44	12	44
92	0	8		24	0	76		80	4	16		12	16	72		48	12	40
84	0	16		40	0	60		76	8	16		16	20	64		64	12	24
80	0	20		48	0	52		72	8	20		12	32	56		80	8	12
80	0	20		52	0	48		80	0	20		24	32	44		80	12	8
76	0	24		56	0	44		68	12	20		36	28	36		92	4	4
76	4	20		72	0	28		68	12	20		48	28	24		100	0	0

76	0	24		68	0	32		68	12	20		52	28	20		100	0	0
72	0	28		64	0	36		72	8	20		64	24	12		100	0	0
68	0	32		72	0	28		76	4	20		72	20	8		100	0	0
68	0	32		72	0	28		76	4	20		84	12	4		100	0	0
64	4	32		76	0	24		72	4	24		92	8	0		100	0	0
64	4	32		80	0	20		72	8	20		96	4	0		100	0	0
60	12	28		84	0	16		72	4	24		96	4	0		100	0	0

Figure B.5 Video Stream Data – 5th Run

14-May				4-Jun				12-Jun				17-Jul				13-Aug		
G	D	B		G	D	B		G	D	B		G	D	B		G	D	B
84	4	12		76	0	24		92	4	4		80	4	16		64	0	36
88	4	8		68	0	32		92	4	4		76	4	20		48	4	48
84	4	12		72	0	28		96	4	0		76	8	16		44	8	48
84	4	12		68	0	32		96	4	0		72	16	12		48	8	44
84	4	12		72	0	28		92	4	4		88	4	8		48	12	40
84	4	12		72	0	28		92	4	4		76	16	8		44	4	52
84	4	12		72	0	28		88	4	8		76	16	8		52	12	36
84	4	12		68	0	32		88	4	8		72	28	0		56	12	32
84	4	12		64	0	36		88	4	8		76	16	8		56	4	40
84	4	12		60	0	40		92	4	4		76	20	4		56	16	28
84	4	12		60	0	40		92	4	4		84	8	8		64	8	28
84	4	12		64	4	32		96	0	4		80	16	4		84	4	12
88	4	8		56	0	44		92	4	4		80	20	0		96	0	4
84	4	12		60	4	36		92	4	4		84	16	0		88	0	12
84	4	12		60	4	36		88	0	12		92	8	0		84	0	16
84	4	12		64	4	32		88	0	12		92	0	8		84	4	12
84	4	12		68	8	24		88	0	12		100	0	0		76	0	24
84	4	12		68	8	24		88	0	12		84	4	12		80	8	12
88	4	8		72	4	24		88	0	12		92	8	0		76	0	24
88	4	8		72	4	24		88	4	8		84	4	12		80	4	16
80	4	16		68	8	24		80	0	20		92	0	8		84	0	16
84	4	12		72	4	24		80	4	16		100	0	0		92	0	8
92	0	8		68	8	24		76	4	20		92	8	0		92	0	8
88	0	12		76	4	20		64	4	32		92	4	4		96	4	0
84	0	16		76	8	16		64	4	32		92	4	4		96	0	4
92	0	8		80	4	16		56	8	36		84	12	4		96	0	4
84	0	16		80	4	16		48	4	48		72	20	8		96	0	4
88	0	12		80	4	16		48	8	44		60	24	16		96	0	4
96	0	4		80	4	16		40	4	56		64	20	16		100	0	0
84	12	4		88	4	8		28	4	68		60	32	8		100	0	0
92	4	4		84	0	16		28	4	68		80	20	0		100	0	0
92	4	4		88	0	12		28	0	72		56	28	16		100	0	0
92	4	4		92	0	8		32	8	60		80	12	8		96	0	4
88	12	0		88	0	12		28	8	64		64	20	16		96	0	4
88	12	0		88	0	12		24	12	64		84	12	4		96	0	4
88	8	4		88	0	12		28	8	64		76	12	12		88	0	12
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64	0	36		36	0	64		96	0	4		92	0	8		68	32	0
68	0	32		48	0	52		92	0	8		92	0	8		72	28	0
76	0	24		60	0	40		100	0	0		76	0	24		80	20	0
84	0	16		60	0	40		100	0	0		76	0	24		68	28	4
88	0	12		56	0	44		100	0	0		60	0	40		80	20	0
100	0	0		56	0	44		100	0	0		72	0	28		84	12	4
100	0	0		48	0	52		100	0	0		80	0	20		88	8	4
100	0	0		48	0	52		100	0	0		84	0	16		96	0	4
100	0	0		56	0	44		100	0	0		80	0	20		92	0	8
100	0	0		64	0	36		100	0	0		80	0	20		96	0	4
100	0	0		72	0	28		100	0	0		92	0	8		92	8	0
100	0	0		92	0	8		100	0	0		96	0	4		84	12	4
100	0	0		96	0	4		100	0	0		100	0	0		84	12	4
96	0	4		100	0	0		100	0	0		96	0	4		84	12	4
100	0	0		100	0	0		100	0	0		84	0	16		76	16	8
96	0	4		100	0	0		100	0	0		92	0	8		84	12	4
92	0	8		100	0	0		100	0	0		88	0	12		76	16	8
100	0	0		100	0	0		100	0	0		88	0	12		84	8	8
100	0	0		92	0	8		100	0	0		88	0	12		88	4	8
100	0	0		76	0	24		100	0	0		84	0	16		92	0	8
100	0	0		76	0	24		100	0	0		96	0	4		96	0	4
100	0	0		76	0	24		100	0	0		92	0	8		92	0	8
100	0	0		84	0	16		100	0	0		96	0	4		88	0	12
100	0	0		80	0	20		100	0	0		96	0	4		88	0	12
96	0	4		84	0	16		100	0	0		96	0	4		88	0	12
96	0	4		84	0	16		100	0	0		88	0	12		88	0	12
96	0	4		88	0	12		100	0	0		84	0	16		88	0	12
100	0	0		96	0	4		100	0	0		72	0	28		76	4	20
92	0	8		96	0	4		100	0	0		76	0	24		80	0	20
88	0	12		100	0	0		100	0	0		76	0	24		72	4	24
88	0	12		100	0	0		100	0	0		88	0	12		76	0	24
76	0	24		100	0	0		100	0	0		88	0	12		72	0	28
72	0	28		100	0	0		100	0	0		84	0	16		72	0	28
68	0	32		100	0	0		100	0	0		88	4	8		68	0	32
64	0	36		100	0	0		100	0	0		80	4	16		80	0	20
72	0	28		96	0	4		100	0	0		80	4	16		76	0	24
72	0	28		96	0	4		100	0	0		88	0	12		80	0	20
80	0	20		92	0	8		100	0	0		80	0	20		84	0	16
72	0	28		80	0	20		100	0	0		76	0	24		92	0	8
80	0	20		72	0	28		100	0	0		80	0	20		84	0	16
68	0	32		56	4	40		100	0	0		84	0	16		88	0	12
64	0	36		44	8	48		100	0	0		80	0	20		92	0	8
52	0	48		56	4	40		100	0	0		84	0	16		92	0	8
40	0	60		56	4	40		100	0	0		84	0	16		88	0	12
40	0	60		56	0	44		100	0	0		84	0	16		96	0	4
32	0	68		56	0	44		100	0	0		76	0	24		88	0	12
32	0	68		56	0	44		100	0	0		68	0	32		88	4	8
28	0	72		52	0	48		100	0	0		68	0	32		76	8	16
32	0	68		56	0	44		100	0	0		72	0	28		80	4	16
44	0	56		44	0	56		100	0	0		72	0	28		80	4	16
44	0	56		56	0	44		100	0	0		76	0	24		76	4	20

64	0	36		68	0	32		100	0	0		72	0	28		76	8	16
60	0	40		76	0	24		100	0	0		80	0	20		80	4	16
76	0	24		92	0	8		100	0	0		88	0	12		84	4	12
80	0	20		88	0	12		100	0	0		80	0	20		88	0	12
84	0	16		100	0	0		100	0	0		92	0	8		84	4	12
76	0	24		96	0	4		100	0	0		84	0	16		88	0	12
76	0	24		100	0	0		100	0	0		92	0	8		80	0	20
64	0	36		100	0	0		100	0	0		92	0	8		80	0	20
48	0	52		96	0	4		100	0	0		84	0	16		72	0	28
52	0	48		96	0	4		100	0	0		92	0	8		64	0	36
56	0	44		88	0	12		100	0	0		88	8	4		64	0	36
60	0	40		84	4	12		100	0	0		92	8	0		56	0	44
56	0	44		84	0	16		100	0	0		88	4	8		40	0	60
68	0	32		76	4	20		100	0	0		84	4	12		36	4	60
64	0	36		72	0	28		100	0	0		88	0	12		36	4	60
68	0	32		76	0	24		100	0	0		76	0	24		32	0	68
80	0	20		80	0	20		100	0	0		84	0	16		24	0	76
88	0	12		76	0	24		100	0	0		84	0	16		28	0	72
84	0	16		80	0	20		100	0	0		76	0	24		20	0	80
84	0	16		88	0	12		100	0	0		72	0	28		32	0	68
80	0	20		92	0	8		100	0	0		68	4	28		36	0	64
76	0	24		92	0	8		100	0	0		88	0	12		44	4	52
76	0	24		96	0	4		100	0	0		88	0	12		60	0	40
72	0	28		96	0	4		100	0	0		100	0	0		64	4	32
68	0	32		96	0	4		100	0	0		92	0	8		80	0	20
64	0	36		96	0	4		100	0	0		84	0	16		80	4	16
64	0	36		80	4	16		100	0	0		84	0	16		76	8	16
60	0	40		88	0	12		100	0	0		84	0	16		88	4	8
56	0	44		84	0	16		100	0	0		84	0	16		88	12	0
56	0	44		80	0	20		100	0	0		88	0	12		88	4	8
64	0	36		80	4	16		100	0	0		88	0	12		76	12	12
84	0	16		60	0	40		100	0	0		88	0	12		76	8	16
80	0	20		64	0	36		100	0	0		84	0	16		88	4	8
88	0	12		60	0	40		100	0	0		88	0	12		80	4	16
76	0	24		48	0	52		100	0	0		92	0	8		80	4	16
84	0	16		48	0	52		100	0	0		80	0	20		76	8	16
76	0	24		48	0	52		100	0	0		80	0	20		76	8	16
64	0	36		60	0	40		100	0	0		84	0	16		76	4	20
56	0	44		60	0	40		100	0	0		92	0	8		84	0	16
36	0	64		56	0	44		100	0	0		84	0	16		84	4	12
32	0	68		60	0	40		100	0	0		84	0	16		88	0	12
20	0	80		64	0	36		100	0	0		76	0	24		84	0	16
24	0	76		76	4	20		100	0	0		72	0	28		84	0	16
20	0	80		68	4	28		100	0	0		60	0	40		88	0	12
12	0	88		76	0	24		100	0	0		60	0	40		88	0	12
24	0	76		80	0	20		100	0	0		60	0	40		88	0	12
16	0	84		84	0	16		100	0	0		64	0	36		88	0	12
24	0	76		80	0	20		100	0	0		72	0	28		84	0	16
36	0	64		84	4	12		100	0	0		68	0	32		84	0	16
48	0	52		88	0	12		100	0	0		80	0	20		84	0	16
56	0	44		100	0	0		100	0	0		80	4	16		80	4	16
60	0	40		96	0	4		100	0	0		92	0	8		76	8	16
80	0	20		100	0	0		100	0	0		88	4	8		72	12	16
84	0	16		100	0	0		100	0	0		84	4	12		76	8	16
88	0	12		96	4	0		100	0	0		96	0	4		76	8	16

84	0	16		96	4	0		100	0	0		88	0	12		76	8	16
92	0	8		92	4	4		100	0	0		88	0	12		76	8	16
92	0	8		88	8	4		100	0	0		88	0	12		76	8	16
100	0	0		92	4	4		100	0	0		88	0	12		76	8	16
96	4	0		92	4	4		100	0	0		80	0	20		76	8	16
88	8	4		88	8	4		100	0	0		88	8	4		76	8	16
92	8	0		92	8	0		100	0	0		84	12	4		76	8	16
88	12	0		96	4	0		100	0	0		76	16	8		76	8	16
84	16	0		96	4	0		100	0	0		68	16	16		76	8	16
80	16	4		84	12	4		100	0	0		80	8	12		76	8	16
72	16	12		84	12	4		100	0	0		68	16	16		76	8	16
76	12	12		80	8	12		100	0	0		48	32	20		76	8	16
64	20	16		76	8	16		100	0	0		44	32	24		76	8	16
64	12	24		80	12	8		100	0	0		56	24	20		76	8	16
56	16	28		76	4	20		100	0	0		52	24	24		76	8	16
68	12	20		80	8	12		100	0	0		56	24	20		76	8	16

Figure B.6 Video Stream Data – 6th Run

14-May				4-Jun				12-Jun				17-Jul				13-Aug		
G	D	B		G	D	B		G	D	B		G	D	B		G	D	B
100	0	0		56	4	40		100	0	0		52	44	4		92	0	8
100	0	0		56	4	40		100	0	0		52	44	4		92	8	0
100	0	0		52	4	44		100	0	0		56	40	4		96	4	0
96	4	0		52	4	44		100	0	0		56	44	0		96	4	0
96	4	0		56	0	44		100	0	0		64	36	0		92	4	4
88	8	4		56	4	40		100	0	0		64	36	0		92	8	0
88	8	4		56	4	40		100	0	0		60	40	0		92	4	4
92	4	4		60	0	40		100	0	0		68	32	0		96	0	4
88	8	4		68	4	28		100	0	0		68	32	0		96	0	4
84	16	0		68	0	32		100	0	0		60	40	0		88	0	12
80	12	8		68	0	32		100	0	0		68	32	0		88	0	12
80	20	0		68	0	32		100	0	0		72	28	0		88	0	12
76	24	0		68	0	32		100	0	0		76	24	0		76	0	24
72	28	0		76	0	24		100	0	0		80	20	0		72	0	28
72	24	4		72	0	28		100	0	0		76	24	0		76	0	24
68	28	4		72	0	28		100	0	0		80	20	0		80	0	20
72	28	0		72	0	28		100	0	0		84	16	0		76	4	20
76	20	4		76	0	24		100	0	0		80	20	0		72	4	24
76	16	8		80	0	20		100	0	0		84	16	0		80	0	20
72	12	16		84	0	16		100	0	0		80	20	0		84	0	16
76	8	16		84	0	16		100	0	0		84	16	0		88	0	12
80	0	20		84	0	16		100	0	0		88	12	0		80	0	20
80	0	20		88	0	12		100	0	0		80	20	0		80	0	20
76	0	24		92	0	8		100	0	0		84	16	0		76	0	24
56	4	40		88	0	12		100	0	0		84	16	0		80	0	20
64	4	32		96	4	0		100	0	0		88	4	8		84	0	16
52	4	44		96	4	0		100	0	0		88	8	4		84	0	16
56	0	44		96	4	0		100	0	0		84	4	12		80	0	20
52	0	48		96	4	0		100	0	0		80	8	12		88	0	12
56	4	40		100	0	0		100	0	0		80	4	16		76	0	24
48	4	48		96	4	0		100	0	0		68	8	24		76	0	24
64	8	28		100	0	0		96	0	4		80	0	20		76	0	24
52	12	36		96	4	0		100	0	0		88	0	12		84	0	16

72	8	20		96	4	0		84	4	12		72	8	20		72	4	24
80	8	12		100	0	0		72	12	16		84	0	16		80	0	20
84	4	12		96	4	0		68	12	20		84	0	16		72	0	28
84	4	12		96	4	0		64	24	12		88	0	12		68	0	32
88	4	8		100	0	0		76	20	4		80	0	20		72	0	28
96	0	4		96	4	0		76	16	8		80	0	20		64	0	36
88	4	8		100	0	0		84	8	8		80	0	20		64	0	36
92	4	4		100	0	0		96	0	4		84	0	16		72	0	28
92	4	4		100	0	0		100	0	0		84	0	16		68	0	32
96	4	0		100	0	0		100	0	0		100	0	0		64	0	36
92	4	4		96	0	4		100	0	0		96	0	4		60	0	40
96	0	4		100	0	0		100	0	0		96	4	0		56	0	44
100	0	0		100	0	0		100	0	0		92	0	8		64	0	36
96	0	4		100	0	0		96	0	4		84	8	8		56	0	44
100	0	0		100	0	0		96	0	4		76	4	20		52	0	48
100	0	0		100	0	0		92	0	8		84	8	8		60	4	36
96	0	4		100	0	0		100	0	0		80	8	12		72	0	28
92	4	4		100	0	0		100	0	0		80	8	12		72	0	28
92	4	4		100	0	0		100	0	0		76	12	12		72	0	28
88	4	8		100	0	0		100	0	0		76	8	16		68	0	32
92	4	4		100	0	0		100	0	0		72	8	20		68	0	32
92	8	0		100	0	0		100	0	0		80	0	20		60	4	36
92	4	4		100	0	0		96	0	4		76	4	20		52	0	48
92	4	4		100	0	0		88	0	12		84	0	16		52	0	48
92	8	0		100	0	0		88	0	12		80	0	20		40	4	56
88	12	0		100	0	0		84	0	16		88	0	12		48	8	44
92	4	4		100	0	0		88	0	12		96	0	4		48	4	48
96	0	4		100	0	0		76	0	24		96	0	4		52	4	44
88	0	12		100	0	0		76	0	24		100	0	0		64	0	36
84	0	16		100	0	0		76	0	24		100	0	0		60	4	36
88	0	12		100	0	0		80	0	20		100	0	0		56	8	36
84	0	16		100	0	0		88	4	8		100	0	0		60	12	28
76	0	24		100	0	0		92	0	8		96	0	4		52	20	28
76	0	24		100	0	0		100	0	0		88	0	12		68	12	20
72	0	28		100	0	0		100	0	0		84	4	12		72	16	12
72	0	28		100	0	0		100	0	0		72	0	28		68	20	12
72	0	28		100	0	0		100	0	0		80	0	20		72	20	8
76	0	24		100	0	0		100	0	0		64	0	36		88	8	4
88	0	12		96	0	4		92	0	8		56	0	44		76	8	16
84	0	16		88	0	12		88	0	12		44	0	56		84	12	4
92	0	8		80	0	20		80	4	16		48	0	52		84	8	8
96	0	4		72	0	28		80	4	16		48	0	52		88	4	8
92	0	8		80	0	20		88	0	12		60	0	40		100	0	0
92	0	8		80	0	20		96	0	4		76	0	24		88	4	8
92	0	8		64	0	36		92	0	8		80	0	20		84	4	12
96	0	4		72	0	28		96	0	4		92	0	8		76	12	12
88	0	12		76	0	24		100	0	0		88	0	12		88	0	12
88	0	12		96	0	4		100	0	0		92	0	8		92	4	4
92	0	8		100	0	0		100	0	0		84	0	16		88	4	8
92	0	8		100	0	0		100	0	0		72	0	28		76	8	16
96	0	4		100	0	0		100	0	0		68	0	32		84	4	12
88	4	8		100	0	0		100	0	0		60	0	40		68	4	28
92	0	8		100	0	0		100	0	0		56	0	44		72	8	20
88	0	12		100	0	0		100	0	0		48	0	52		64	8	28
84	4	12		100	0	0		100	0	0		40	0	60		80	4	16

80	12	8		100	0	0		100	0	0		40	0	60		84	0	16
88	8	4		100	0	0		100	0	0		40	0	60		76	0	24
84	8	8		100	0	0		100	0	0		44	0	56		68	0	32
84	4	12		100	0	0		100	0	0		48	0	52		64	0	36
84	4	12		100	0	0		100	0	0		48	0	52		72	0	28
84	0	16		100	0	0		100	0	0		56	0	44		72	0	28
72	0	28		100	0	0		100	0	0		60	0	40		80	0	20
64	4	32		100	0	0		100	0	0		76	0	24		80	0	20
48	0	52		100	0	0		100	0	0		72	0	28		76	4	20
40	8	52		100	0	0		100	0	0		80	0	20		88	0	12
28	4	68		100	0	0		100	0	0		84	0	16		96	0	4
28	4	68		100	0	0		96	0	4		88	0	12		92	0	8
28	0	72		100	0	0		100	0	0		96	4	0		96	0	4
48	0	52		100	0	0		100	0	0		100	0	0		84	0	16
52	0	48		100	0	0		100	0	0		96	4	0		88	0	12
72	0	28		100	0	0		100	0	0		96	4	0		88	0	12
80	0	20		100	0	0		100	0	0		96	4	0		80	0	20
80	0	20		100	0	0		100	0	0		100	0	0		88	0	12
96	0	4		100	0	0		96	0	4		96	0	4		72	0	28
88	0	12		100	0	0		96	0	4		92	0	8		72	0	28
88	0	12		100	0	0		100	0	0		80	0	20		60	0	40
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0	40	60		52	4	44		100	0	0		80	0	20		76	4	20
8	28	64		44	8	48		100	0	0		76	0	24		72	12	16
8	36	56		32	8	60		100	0	0		80	0	20		60	8	32
16	32	52		20	4	76		100	0	0		88	0	12		68	8	24
20	32	48		12	4	84		100	0	0		84	0	16		72	4	24
32	24	44		16	4	80		100	0	0		96	0	4		76	0	24
40	20	40		24	0	76		100	0	0		96	0	4		76	0	24
44	16	40		36	0	64		100	0	0		92	8	0		68	0	32
40	20	40		52	0	48		100	0	0		92	4	4		64	4	32
56	8	36		64	0	36		100	0	0		88	8	4		64	4	32
56	12	32		76	0	24		100	0	0		88	12	0		60	8	32
56	12	32		84	0	16		100	0	0		84	16	0		60	16	24

72	4	24		88	0	12		100	0	0		96	4	0		60	12	28
72	8	20		92	0	8		100	0	0		80	16	4		60	4	36
68	12	20		100	0	0		100	0	0		92	4	4		44	8	48
72	0	28		100	0	0		100	0	0		84	0	16		52	4	44
64	4	32		100	0	0		100	0	0		72	0	28		56	4	40
60	16	24		88	0	12		100	0	0		64	0	36		64	4	32
52	20	28		72	4	24		100	0	0		72	0	28		80	0	20
48	12	40		60	4	36		100	0	0		72	0	28		72	4	24
52	16	32		64	4	32		100	0	0		72	0	28		84	0	16
40	8	52		64	4	32		100	0	0		84	0	16		80	4	16
40	16	44		56	0	44		100	0	0		88	0	12		88	0	12
44	16	40		64	0	36		100	0	0		96	0	4		88	4	8
52	12	36		80	0	20		100	0	0		100	0	0		84	4	12
40	20	40		96	0	4		100	0	0		100	0	0		80	0	20
36	24	40		100	0	0		100	0	0		96	0	4		80	0	20
24	32	44		100	0	0		100	0	0		96	0	4		80	0	20
28	32	40		100	0	0		100	0	0		84	4	12		72	0	28
12	40	48		100	0	0		100	0	0		72	4	24		80	0	20
8	40	52		100	0	0		100	0	0		64	12	24		72	0	28
0	48	52		100	0	0		100	0	0		68	8	24		72	4	24
0	44	56		100	0	0		100	0	0		68	4	28		80	8	12
0	32	68		100	0	0		100	0	0		64	0	36		80	4	16
0	48	52		100	0	0		100	0	0		64	0	36		84	0	16
0	48	52		100	0	0		100	0	0		80	4	16		80	8	12
0	44	56		100	0	0		100	0	0		80	4	16		80	4	16
4	44	52		96	4	0		100	0	0		84	0	16		80	0	20
4	48	48		96	4	0		100	0	0		80	0	20		76	0	24
0	40	60		84	12	4		100	0	0		88	0	12		68	0	32
0	48	52		68	20	12		100	0	0		80	4	16		60	8	32
0	56	44		64	20	16		96	0	4		72	8	20		56	0	44
0	52	48		72	16	12		96	0	4		72	12	16		44	16	40
4	48	48		88	4	8		96	0	4		72	12	16		52	16	32
0	52	48		92	4	4		100	0	0		72	12	16		52	24	24
4	40	56		96	0	4		100	0	0		88	8	4		56	32	12
4	48	48		100	0	0		100	0	0		84	16	0		60	24	16
8	48	44		96	0	4		100	0	0		80	20	0		72	28	0
20	44	36		92	0	8		100	0	0		68	20	12		76	20	4
20	44	36		88	0	12		100	0	0		72	20	8		88	8	4
40	36	24		92	0	8		100	0	0		72	16	12		92	4	4
48	28	24		96	0	4		100	0	0		80	4	16		92	0	8
60	20	20		96	0	4		100	0	0		72	0	28		80	0	20
72	16	12		92	0	8		100	0	0		88	0	12		60	0	40
88	8	4		96	4	0		100	0	0		84	0	16		68	0	32
96	0	4		92	8	0		100	0	0		88	0	12		64	0	36
88	0	12		96	4	0		100	0	0		88	4	8		60	0	40
88	0	12		92	8	0		100	0	0		84	4	12		60	0	40
80	0	20		96	4	0		100	0	0		92	4	4		40	4	56
72	4	24		100	0	0		100	0	0		84	0	16		36	0	64
56	0	44		100	0	0		100	0	0		84	0	16		32	8	60
44	0	56		100	0	0		100	0	0		80	4	16		40	0	60
36	0	64		100	0	0		100	0	0		76	4	20		40	0	60
20	0	80		100	0	0		100	0	0		68	12	20		40	0	60
12	4	84		100	0	0		100	0	0		80	12	8		52	0	48
4	20	76		100	0	0		100	0	0		92	8	0		44	4	52
0	24	76		100	0	0		100	0	0		100	0	0		56	4	40

0	16	84		100	0	0		100	0	0		96	0	4		72	12	16
0	24	76		100	0	0		100	0	0		96	0	4		88	12	0
0	20	80		100	0	0		100	0	0		100	0	0		88	8	4
0	32	68		100	0	0		100	0	0		96	0	4		88	8	4
0	32	68		100	0	0		100	0	0		84	4	12		76	12	12
0	28	72		100	0	0		100	0	0		76	8	16		80	12	8
0	36	64		100	0	0		100	0	0		80	4	16		92	0	8
0	40	60		100	0	0		100	0	0		72	8	20		88	0	12
0	36	64		100	0	0		100	0	0		80	0	20		88	4	8
4	32	64		96	0	4		100	0	0		88	4	8		92	0	8
4	40	56		92	8	0		100	0	0		96	0	4		96	0	4
8	32	60		92	8	0		100	0	0		96	0	4		88	0	12
8	36	56		100	0	0		100	0	0		100	0	0		96	0	4
24	28	48		100	0	0		100	0	0		100	0	0		84	0	16
20	32	48		100	0	0		100	0	0		96	4	0		80	0	20
16	36	48		100	0	0		100	0	0		96	4	0		64	4	32
16	48	36		100	0	0		100	0	0		96	4	0		60	4	36
28	48	24		96	0	4		100	0	0		92	4	4		52	0	48
28	36	36		96	0	4		100	0	0		100	0	0		40	0	60
32	32	36		96	0	4		100	0	0		100	0	0		56	0	44

Figure B.7 Video Stream Data – 7th Run

14-May			4-Jun			12-Jun			17-Jul			13-Aug		
G	D	B	G	D	B	G	D	B	G	D	B	G	D	B
92	8	0	72	8	20	100	0	0	84	4	12	84	16	0
92	8	0	68	8	24	100	0	0	80	8	12	92	8	0
80	12	8	72	8	20	100	0	0	76	4	20	92	8	0
84	8	8	72	8	20	100	0	0	84	4	12	88	8	4
84	8	8	72	4	24	100	0	0	88	8	4	80	12	8
84	4	12	68	8	24	100	0	0	84	4	12	68	20	12
84	4	12	76	4	20	100	0	0	92	8	0	60	20	20
80	4	16	72	8	20	100	0	0	84	8	8	64	16	20
68	16	16	76	4	20	100	0	0	88	4	8	60	24	16
72	16	12	72	8	20	100	0	0	88	8	4	60	24	16
80	12	8	76	4	20	100	0	0	92	0	8	68	16	16
76	12	12	76	8	16	100	0	0	84	12	4	80	8	12
72	16	12	72	8	20	100	0	0	88	8	4	96	0	4
72	12	16	76	0	24	100	0	0	88	8	4	100	0	0
80	20	0	72	4	24	100	0	0	88	12	0	100	0	0
72	20	8	64	12	24	100	0	0	88	12	0	92	4	4
72	24	4	64	12	24	100	0	0	92	8	0	92	0	8
72	24	4	76	4	20	100	0	0	92	8	0	84	4	12
72	24	4	68	4	28	100	0	0	96	4	0	80	4	16
72	20	8	68	4	28	100	0	0	100	0	0	76	4	20
68	20	12	68	4	28	100	0	0	100	0	0	68	8	24
64	28	8	76	4	20	100	0	0	100	0	0	48	16	36
68	24	8	72	4	24	100	0	0	100	0	0	44	12	44
72	16	12	68	4	28	100	0	0	96	4	0	36	16	48
76	12	12	68	0	32	100	0	0	96	4	0	36	24	40
72	20	8	72	0	28	100	0	0	96	4	0	40	24	36
76	8	16	72	4	24	100	0	0	96	4	0	48	28	24
76	20	4	80	4	16	100	0	0	92	8	0	56	28	16

80	8	12	92	0	8	100	0	0	92	4	4	72	16	12
80	12	8	96	0	4	96	4	0	84	12	4	80	16	4
76	12	12	96	0	4	96	4	0	84	12	4	96	4	0
84	4	12	96	0	4	96	4	0	84	16	0	96	4	0
80	4	16	100	0	0	96	4	0	84	16	0	96	4	0
88	4	8	100	0	0	100	0	0	88	12	0	88	4	8
84	4	12	100	0	0	100	0	0	92	4	4	80	8	12
84	4	12	100	0	0	100	0	0	100	0	0	72	16	12
72	4	24	100	0	0	100	0	0	96	0	4	64	20	16
68	8	24	100	0	0	100	0	0	88	0	12	56	28	16
76	4	20	100	0	0	100	0	0	88	0	12	64	24	12
68	16	16	100	0	0	100	0	0	84	0	16	48	28	24
72	8	20	100	0	0	100	0	0	80	0	20	44	32	24
76	8	16	100	0	0	100	0	0	76	0	24	56	20	24
64	12	24	100	0	0	100	0	0	80	0	20	60	16	24
64	0	36	100	0	0	100	0	0	76	0	24	52	24	24
60	4	36	100	0	0	100	0	0	76	4	20	76	8	16
76	4	20	100	0	0	100	0	0	80	4	16	84	4	12
76	0	24	100	0	0	100	0	0	76	4	20	84	4	12
72	4	24	100	0	0	100	0	0	76	8	16	96	0	4
84	4	12	100	0	0	100	0	0	80	4	16	88	8	4
80	8	12	100	0	0	100	0	0	84	0	16	92	8	0
80	8	12	100	0	0	100	0	0	88	4	8	92	8	0
88	8	4	100	0	0	100	0	0	92	0	8	92	8	0
88	4	8	100	0	0	100	0	0	88	0	12	100	0	0
96	0	4	100	0	0	100	0	0	80	0	20	96	0	4
100	0	0	96	0	4	100	0	0	84	0	16	88	8	4
96	0	4	100	0	0	100	0	0	80	0	20	84	16	0
96	0	4	100	0	0	100	0	0	76	4	20	72	24	4
96	0	4	100	0	0	100	0	0	76	4	20	76	20	4
96	0	4	100	0	0	100	0	0	72	0	28	80	16	4
88	0	12	100	0	0	100	0	0	68	0	32	84	16	0
88	0	12	100	0	0	100	0	0	72	0	28	84	12	4
88	4	8	100	0	0	100	0	0	72	4	24	88	8	4
68	4	28	100	0	0	100	0	0	84	0	16	88	4	8
64	16	20	100	0	0	100	0	0	88	4	8	88	4	8
56	24	20	100	0	0	100	0	0	88	0	12	84	8	8
52	16	32	100	0	0	100	0	0	96	0	4	84	8	8
44	20	36	92	0	8	100	0	0	96	0	4	80	16	4
48	20	32	72	0	28	100	0	0	88	0	12	72	20	8
48	12	40	56	0	44	100	0	0	84	4	12	68	20	12
48	24	28	40	12	48	100	0	0	76	8	16	52	28	20
44	24	32	44	8	48	100	0	0	84	4	12	56	20	24
40	24	36	40	4	56	100	0	0	68	4	28	64	16	20
44	12	44	44	4	52	100	0	0	60	16	24	60	20	20
52	4	44	60	0	40	100	0	0	68	24	8	48	12	40
60	8	32	80	0	20	100	0	0	76	16	8	48	8	44
68	4	28	96	0	4	100	0	0	64	24	12	56	4	40
76	4	20	92	0	8	100	0	0	76	16	8	84	4	12
88	0	12	88	0	12	100	0	0	84	8	8	92	4	4
96	0	4	88	0	12	100	0	0	88	8	4	92	0	8
96	0	4	80	0	20	100	0	0	96	4	0	92	0	8
100	0	0	80	0	20	100	0	0	100	0	0	84	4	12

96	4	0	72	0	28	96	4	0	100	0	0	80	0	20
100	0	0	48	0	52	92	8	0	96	4	0	84	4	12
100	0	0	36	0	64	92	8	0	100	0	0	80	8	12
100	0	0	24	0	76	92	8	0	96	4	0	72	0	28
100	0	0	36	0	64	92	8	0	96	4	0	68	4	28
100	0	0	36	0	64	100	0	0	96	4	0	64	4	32
96	0	4	32	0	68	100	0	0	84	4	12	56	4	40
88	0	12	56	4	40	100	0	0	84	4	12	64	4	32
84	0	16	72	4	24	100	0	0	92	4	4	68	0	32
76	0	24	88	4	8	100	0	0	92	4	4	80	0	20
68	0	32	92	4	4	100	0	0	92	0	8	92	0	8
60	0	40	96	0	4	100	0	0	84	0	16	88	0	12
56	0	44	100	0	0	100	0	0	88	0	12	68	0	32
48	0	52	100	0	0	100	0	0	80	0	20	36	0	64
32	0	68	84	0	16	100	0	0	60	0	40	40	0	60
28	0	72	84	0	16	100	0	0	68	0	32	48	0	52
40	0	60	80	0	20	100	0	0	84	0	16	92	0	8
48	0	52	68	0	32	100	0	0	76	0	24	92	0	8
56	0	44	60	4	36	100	0	0	76	0	24	92	0	8
56	0	44	52	4	44	100	0	0	76	0	24	92	0	8
68	0	32	56	4	40	100	0	0	80	0	20	96	4	0
76	0	24	64	0	36	100	0	0	72	4	24	96	4	0
72	0	28	72	0	28	100	0	0	76	12	12	76	16	8
80	0	20	84	0	16	100	0	0	68	24	8	80	12	8
68	4	28	100	0	0	100	0	0	60	24	16	84	12	4
68	4	28	96	0	4	100	0	0	64	28	8	72	20	8
64	8	28	92	0	8	100	0	0	64	28	8	88	4	8
52	4	44	88	0	12	100	0	0	76	20	4	88	8	4
64	0	36	84	4	12	100	0	0	72	28	0	96	0	4
72	0	28	92	0	8	100	0	0	84	12	4	76	4	20
88	0	12	84	0	16	100	0	0	80	8	12	64	0	36
80	0	20	88	0	12	100	0	0	76	8	16	52	8	40
76	0	24	88	4	8	100	0	0	76	8	16	60	8	32
60	0	40	88	4	8	100	0	0	80	4	16	60	16	24
48	0	52	84	4	12	100	0	0	92	4	4	60	16	24
36	0	64	92	4	4	100	0	0	84	8	8	68	16	16
28	4	68	100	0	0	100	0	0	80	12	8	92	0	8
12	8	80	100	0	0	100	0	0	76	16	8	84	4	12
8	8	84	100	0	0	100	0	0	84	12	4	84	8	8
4	12	84	100	0	0	100	0	0	76	16	8	80	16	4
12	8	80	100	0	0	100	0	0	76	12	12	92	0	8
4	16	80	96	0	4	100	0	0	80	8	12	92	0	8
12	12	76	96	0	4	100	0	0	80	4	16	88	0	12
24	12	64	84	0	16	100	0	0	72	4	24	88	0	12
28	12	60	72	4	24	100	0	0	68	0	32	80	0	20
52	4	44	60	4	36	100	0	0	68	4	28	76	0	24
56	12	32	60	4	36	100	0	0	56	4	40	76	4	20
72	8	20	48	4	48	100	0	0	60	4	36	76	0	24
88	4	8	52	4	44	100	0	0	68	12	20	80	0	20
92	4	4	52	4	44	100	0	0	92	0	8	68	0	32
100	0	0	24	0	76	100	0	0	96	4	0	80	0	20
100	0	0	40	0	60	100	0	0	96	0	4	72	0	28
92	0	8	36	0	64	100	0	0	96	0	4	80	0	20

72	8	20	40	0	60	100	0	0	96	0	4	76	4	20
56	12	32	28	0	72	100	0	0	88	4	8	72	0	28
52	12	36	16	0	84	100	0	0	96	0	4	80	0	20
56	20	24	16	0	84	100	0	0	100	0	0	92	0	8
40	12	48	16	0	84	100	0	0	96	0	4	92	0	8
36	12	52	36	0	64	100	0	0	92	0	8	80	0	20
48	12	40	44	0	56	100	0	0	92	0	8	92	4	4
56	0	44	52	0	48	100	0	0	92	4	4	92	4	4
64	4	32	64	0	36	100	0	0	96	0	4	96	0	4
72	0	28	76	0	24	100	0	0	84	4	12	92	4	4
76	4	20	92	0	8	100	0	0	96	0	4	88	4	8
68	4	28	96	0	4	100	0	0	88	0	12	84	4	12
72	8	20	100	0	0	100	0	0	84	0	16	92	0	8
72	4	24	100	0	0	100	0	0	84	0	16	88	0	12
68	4	28	100	0	0	100	0	0	84	0	16	96	0	4
48	4	48	100	0	0	100	0	0	84	4	12	88	4	8
40	8	52	100	0	0	100	0	0	72	0	28	92	8	0
28	12	60	100	0	0	100	0	0	72	0	28	80	16	4
24	16	60	100	0	0	100	0	0	68	0	32	76	16	8
20	20	60	100	0	0	100	0	0	68	4	28	76	12	12
16	32	52	100	0	0	100	0	0	76	0	24	72	20	8
24	24	52	100	0	0	100	0	0	72	0	28	72	24	4
24	20	56	100	0	0	100	0	0	80	0	20	72	24	4
32	32	36	100	0	0	100	0	0	80	0	20	76	20	4
36	32	32	100	0	0	100	0	0	84	0	16	72	20	8
44	28	28	100	0	0	100	0	0	92	0	8	80	16	4
68	16	16	96	0	4	100	0	0	92	0	8	92	8	0
64	24	12	92	0	8	100	0	0	92	0	8	96	4	0
72	12	16	68	0	32	100	0	0	100	0	0	96	0	4
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56	4	40	52	8	40	100	0	0	88	12	0	60	12	28
64	0	36	44	4	52	100	0	0	92	4	4	48	16	36
56	0	44	28	0	72	100	0	0	92	0	8	32	20	48
52	0	48	24	0	76	100	0	0	88	0	12	28	8	64
52	0	48	20	4	76	100	0	0	80	16	4	36	8	56
48	0	52	24	8	68	100	0	0	72	28	0	40	8	52
48	0	52	36	8	56	100	0	0	80	20	0	44	12	44
44	0	56	60	4	36	100	0	0	76	24	0	64	12	24
40	0	60	80	4	16	100	0	0	80	20	0	80	12	8
44	8	48	80	8	12	100	0	0	76	12	12	92	4	4
28	8	64	84	8	8	96	0	4	76	8	16	92	0	8
36	12	52	96	4	0	100	0	0	92	4	4	96	0	4
40	8	52	96	4	0	100	0	0	80	4	16	100	0	0
36	12	52	92	8	0	96	0	4	88	4	8	100	0	0
36	12	52	88	4	8	96	0	4	92	0	8	100	0	0
44	8	48	84	8	8	100	0	0	92	0	8	100	0	0
52	8	40	80	8	12	100	0	0	88	0	12	96	0	4
52	8	40	64	8	28	100	0	0	92	4	4	100	0	0
52	12	36	44	8	48	100	0	0	92	0	8	88	0	12
56	8	36	40	8	52	100	0	0	96	4	0	72	0	28
64	16	20	28	4	68	100	0	0	92	4	4	60	4	36
56	20	24	36	0	64	96	0	4	88	0	12	56	0	44
60	16	24	36	0	64	84	4	12	84	0	16	44	0	56
56	8	36	28	0	72	64	0	36	76	4	20	44	0	56
72	4	24	40	0	60	64	0	36	80	0	20	36	0	64
80	4	16	56	0	44	64	4	32	76	8	16	20	0	80
80	4	16	64	0	36	60	0	40	72	8	20	40	0	60
92	0	8	68	0	32	40	4	56	72	0	28	32	0	68
92	0	8	68	0	32	28	12	60	68	8	24	40	16	44

80	0	20	68	4	28	24	0	76	72	4	24	48	16	36
68	0	32	64	8	28	28	0	72	68	8	24	56	16	28
80	0	20	56	8	36	32	4	64	52	12	36	64	16	20
68	4	28	56	4	40	44	8	48	40	0	60	72	12	16
72	0	28	48	0	52	68	0	32	32	0	68	76	4	20
68	8	24	40	0	60	84	0	16	28	0	72	84	0	16
72	12	16	36	0	64	100	0	0	20	0	80	84	4	12
80	12	8	24	0	76	100	0	0	40	0	60	92	4	4
88	12	0	20	0	80	100	0	0	52	0	48	92	0	8
92	8	0	8	4	88	100	0	0	60	0	40	76	0	24
92	8	0	0	8	92	100	0	0	76	0	24	80	0	20
96	0	4	0	12	88	100	0	0	72	0	28	80	0	20
96	0	4	0	8	92	100	0	0	84	0	16	92	4	4
100	0	0	16	0	84	100	0	0	92	0	8	88	4	8
96	0	4	16	0	84	100	0	0	100	0	0	88	8	4
96	0	4	32	0	68	100	0	0	100	0	0	96	4	0
84	4	12	48	0	52	100	0	0	100	0	0	84	0	16
72	4	24	60	0	40	100	0	0	96	0	4	68	4	28
60	4	36	76	0	24	100	0	0	100	0	0	56	8	36
48	8	44	88	0	12	100	0	0	92	0	8	64	4	32
64	8	28	88	4	8	100	0	0	92	0	8	56	4	40
64	0	36	96	0	4	100	0	0	84	4	12	56	4	40
72	0	28	100	0	0	100	0	0	84	0	16	60	0	40
76	0	24	100	0	0	96	0	4	80	0	20	68	4	28
92	0	8	100	0	0	84	0	16	80	0	20	84	0	16
92	0	8	96	0	4	72	8	20	88	0	12	96	0	4
96	0	4	96	0	4	68	12	20	76	0	24	96	0	4
96	0	4	100	0	0	60	8	32	72	0	28	100	0	0
96	0	4	92	0	8	56	4	40	60	4	36	100	0	0
92	0	8	96	0	4	64	0	36	48	4	48	100	0	0
96	0	4	92	4	4	64	8	28	36	0	64	100	0	0
88	0	12	100	0	0	72	4	24	20	0	80	100	0	0
80	0	20	100	0	0	88	0	12	20	0	80	96	4	0
68	0	32	100	0	0	96	0	4	20	4	76	96	4	0
56	0	44	100	0	0	96	0	4	32	4	64	100	0	0
48	0	52	100	0	0	100	0	0	40	0	60	92	8	0
36	0	64	100	0	0	100	0	0	56	4	40	92	8	0
40	0	60	100	0	0	100	0	0	72	0	28	80	16	4
48	0	52	100	0	0	100	0	0	80	0	20	80	16	4
52	0	48	100	0	0	100	0	0	96	0	4	80	16	4
60	0	40	100	0	0	100	0	0	100	0	0	72	16	12
76	0	24	100	0	0	100	0	0	100	0	0	80	8	12
88	0	12	100	0	0	100	0	0	100	0	0	84	4	12
92	0	8	100	0	0	100	0	0	100	0	0	72	0	28
92	0	8	100	0	0	100	0	0	100	0	0	72	8	20
84	0	16	100	0	0	100	0	0	96	4	0	64	16	20
92	0	8	100	0	0	100	0	0	92	4	4	60	24	16
88	0	12	100	0	0	92	0	8	92	4	4	72	16	12
88	0	12	100	0	0	92	0	8	100	0	0	72	20	8
84	0	16	100	0	0	88	0	12	88	0	12	76	16	8
80	0	20	100	0	0	88	0	12	84	4	12	72	24	4
72	8	20	100	0	0	96	0	4	88	4	8	76	20	4
64	4	32	100	0	0	100	0	0	100	0	0	72	16	12

52	8	40	100	0	0	100	0	0	96	0	4	76	16	8
52	8	40	100	0	0	100	0	0	96	0	4	76	8	16
48	4	48	100	0	0	100	0	0	96	0	4	72	8	20
48	0	52	100	0	0	100	0	0	92	0	8	68	8	24
68	0	32	100	0	0	100	0	0	96	0	4	64	16	20
64	0	36	100	0	0	100	0	0	96	0	4	56	24	20
72	0	28	100	0	0	100	0	0	92	0	8	52	16	32
72	0	28	96	4	0	100	0	0	88	0	12	60	12	28
60	0	40	100	0	0	100	0	0	76	0	24	68	8	24
52	0	48	96	4	0	100	0	0	88	0	12	68	8	24
40	0	60	100	0	0	96	0	4	88	0	12	64	12	24
36	0	64	100	0	0	96	0	4	84	0	16	88	4	8
24	0	76	96	0	4	100	0	0	92	0	8	84	8	8
8	0	92	84	4	12	100	0	0	92	0	8	84	4	12
4	0	96	76	12	12	100	0	0	100	0	0	96	4	0
4	0	96	76	4	20	100	0	0	92	4	4	88	4	8
0	0	100	72	8	20	96	0	4	84	8	8	96	0	4
0	0	100	76	4	20	96	4	0	76	4	20	92	0	8
4	0	96	72	4	24	92	8	0	88	0	12	84	4	12
12	0	88	92	4	4	88	12	0	72	4	24	84	8	8
20	0	80	92	0	8	88	12	0	80	0	20	76	8	16
12	0	88	88	4	8	96	4	0	72	4	24	64	16	20
20	0	80	100	0	0	100	0	0	60	8	32	72	8	20
24	0	76	100	0	0	100	0	0	68	4	28	68	16	16
16	0	84	96	4	0	92	0	8	64	4	32	84	8	8
8	4	88	96	4	0	88	0	12	64	0	36	80	8	12
4	0	96	100	0	0	96	0	4	68	0	32	84	4	12
0	0	100	96	4	0	92	0	8	80	0	20	80	0	20
0	4	96	100	0	0	96	0	4	88	0	12	88	4	8
4	0	96	100	0	0	96	0	4	84	0	16	96	0	4
16	4	80	100	0	0	100	0	0	96	0	4	92	4	4
24	4	72	100	0	0	100	0	0	100	0	0	76	8	16
24	4	72	100	0	0	100	0	0	96	0	4	92	4	4
28	4	68	100	0	0	100	0	0	84	4	12	96	4	0
32	0	68	100	0	0	100	0	0	68	8	24	92	0	8
40	0	60	100	0	0	100	0	0	80	8	12	92	0	8
40	0	60	100	0	0	96	0	4	88	8	4	84	0	16
32	4	64	100	0	0	100	0	0	80	8	12	88	0	12
20	4	76	100	0	0	100	0	0	92	4	4	84	8	8
16	4	80	100	0	0	100	0	0	84	8	8	88	4	8
8	8	84	100	0	0	96	0	4	84	8	8	92	4	4
16	8	76	100	0	0	100	0	0	92	0	8	92	0	8
28	12	60	100	0	0	100	0	0	92	0	8	96	0	4
20	8	72	100	0	0	100	0	0	96	0	4	100	0	0
24	8	68	100	0	0	100	0	0	92	0	8	96	0	4
28	4	68	100	0	0	100	0	0	92	0	8	92	0	8
28	4	68	100	0	0	100	0	0	92	0	8	88	4	8
28	4	68	100	0	0	100	0	0	96	0	4	84	0	16
44	0	56	100	0	0	100	0	0	96	0	4	76	12	12
32	0	68	100	0	0	100	0	0	96	4	0	68	12	20
44	0	56	100	0	0	100	0	0	88	8	4	64	16	20
48	0	52	100	0	0	100	0	0	80	0	20	44	16	40
60	0	40	100	0	0	100	0	0	76	8	16	52	8	40

76	0	24	100	0	0	100	0	0	72	4	24	44	8	48
80	0	20	100	0	0	100	0	0	64	12	24	48	4	48
76	0	24	100	0	0	100	0	0	68	8	24	48	0	52
92	0	8	100	0	0	100	0	0	76	16	8	40	0	60
96	0	4	100	0	0	100	0	0	80	16	4	48	0	52
96	0	4	100	0	0	100	0	0	76	16	8	48	0	52
96	0	4	100	0	0	100	0	0	76	12	12	52	0	48
96	0	4	100	0	0	100	0	0	88	4	8	56	4	40
96	0	4	100	0	0	100	0	0	100	0	0	64	0	36
100	0	0	100	0	0	100	0	0	100	0	0	68	4	28
100	0	0	100	0	0	100	0	0	88	12	0	72	4	24
96	0	4	96	4	0	100	0	0	88	12	0	88	0	12
96	0	4	96	4	0	100	0	0	80	16	4	88	0	12
96	4	0	80	12	8	100	0	0	80	12	8	96	0	4
96	0	4	68	12	20	100	0	0	84	8	8	92	0	8
96	4	0	56	20	24	96	0	4	76	8	16	92	0	8
88	8	4	44	20	36	96	4	0	84	0	16	100	0	0
96	4	0	36	16	48	88	8	4	84	4	12	96	0	4
92	4	4	32	12	56	88	8	4	84	8	8	92	0	8
92	0	8	20	4	76	76	12	12	84	8	8	96	0	4
88	4	8	32	0	68	84	4	12	96	0	4	88	0	12
84	0	16	40	4	56	88	0	12	92	0	8	92	0	8
88	0	12	44	0	56	92	0	8	92	0	8	92	0	8
84	0	16	64	0	36	92	0	8	88	0	12	92	0	8
92	0	8	88	0	12	96	0	4	84	8	8	84	0	16
84	0	16	96	0	4	96	0	4	84	4	12	88	0	12
92	0	8	96	0	4	96	0	4	80	4	16	88	0	12
84	4	12	100	0	0	96	0	4	76	4	20	88	0	12
80	8	12	100	0	0	100	0	0	72	0	28	92	0	8
72	8	20	100	0	0	100	0	0	72	0	28	88	0	12
64	8	28	100	0	0	100	0	0	64	8	28	88	0	12
64	8	28	100	0	0	96	0	4	72	4	24	84	0	16
60	8	32	100	0	0	100	0	0	88	0	12	88	0	12
68	8	24	92	0	8	96	0	4	96	0	4	84	0	16
68	4	28	92	0	8	96	0	4	96	0	4	80	0	20
80	0	20	100	0	0	96	4	0	96	4	0	88	0	12
92	0	8	100	0	0	92	4	4	92	8	0	80	0	20
100	0	0	100	0	0	100	0	0	92	4	4	80	0	20
80	4	16	96	4	0	100	0	0	100	0	0	80	0	20
76	8	16	100	0	0	100	0	0	92	0	8	88	0	12
68	0	32	100	0	0	100	0	0	92	0	8	84	0	16
48	8	44	100	0	0	100	0	0	100	0	0	84	0	16
44	4	52	100	0	0	100	0	0	100	0	0	84	0	16
32	4	64	96	0	4	100	0	0	96	0	4	80	0	20
24	0	76	96	0	4	100	0	0	100	0	0	80	0	20
16	0	84	80	8	12	100	0	0	100	0	0	80	0	20
4	0	96	80	8	12	100	0	0	88	0	12	80	0	20
8	0	92	84	4	12	100	0	0	80	0	20	84	0	16
20	4	76	88	4	8	100	0	0	76	0	24	88	0	12
32	8	60	72	12	16	100	0	0	76	0	24	84	0	16
32	12	56	68	12	20	100	0	0	72	0	28	76	0	24
36	12	52	56	16	28	100	0	0	60	4	36	84	0	16
40	12	48	48	20	32	100	0	0	60	4	36	84	0	16

68	0	32	36	28	36	100	0	0	68	4	28	84	0	16
76	0	24	36	24	40	100	0	0	68	0	32	84	0	16
76	4	20	40	24	36	100	0	0	56	4	40	88	0	12
68	8	24	56	12	32	100	0	0	60	0	40	84	0	16
48	8	44	64	8	28	96	4	0	64	8	28	84	0	16
32	16	52	80	4	16	100	0	0	60	12	28	84	0	16
36	4	60	88	4	8	100	0	0	68	8	24	88	0	12
36	12	52	92	4	4	96	4	0	80	4	16	80	0	20
48	4	48	96	0	4	96	4	0	92	0	8	76	0	24
44	8	48	100	0	0	96	4	0	92	0	8	80	0	20
40	4	56	100	0	0	100	0	0	88	0	12	84	0	16
48	4	48	100	0	0	100	0	0	88	0	12	80	0	20
56	0	44	100	0	0	100	0	0	92	0	8	76	0	24
56	0	44	100	0	0	96	4	0	88	8	4	76	0	24
52	8	40	100	0	0	100	0	0	88	8	4	84	0	16
44	16	40	100	0	0	100	0	0	92	4	4	84	0	16
44	12	44	100	0	0	100	0	0	84	8	8	80	0	20
36	20	44	96	4	0	100	0	0	80	8	12	80	4	16
28	20	52	84	12	4	100	0	0	76	8	16	84	0	16
28	20	52	68	20	12	100	0	0	76	8	16	76	0	24
12	28	60	52	24	24	96	4	0	92	4	4	80	0	20

Figure B.8 Video Stream Data – 8th Run

14-May				4-Jun				12-Jun				17-Jul				13-Aug		
G	D	B		G	D	B		G	D	B		G	D	B		G	D	B
20	8	72		100	0	0		92	0	8		92	0	8		80	16	4
24	8	68		100	0	0		92	0	8		96	0	4		80	12	8
20	4	76		100	0	0		92	0	8		92	0	8		84	12	4
20	4	76		100	0	0		96	0	4		96	0	4		92	8	0
12	0	88		100	0	0		92	0	8		92	4	4		88	8	4
4	0	96		100	0	0		96	0	4		88	4	8		92	8	0
4	0	96		100	0	0		92	0	8		84	4	12		92	8	0
8	0	92		100	0	0		88	0	12		96	0	4		88	12	0
20	0	80		100	0	0		88	0	12		88	4	8		88	0	12
28	0	72		100	0	0		84	0	16		84	0	16		80	4	16
36	0	64		100	0	0		84	0	16		84	0	16		72	12	16
40	8	52		100	0	0		80	0	20		80	4	16		80	8	12
52	4	44		100	0	0		84	0	16		80	4	16		76	12	12
60	4	36		100	0	0		88	0	12		72	4	24		76	16	8
72	0	28		100	0	0		88	4	8		84	4	12		76	16	8
72	0	28		100	0	0		88	0	12		84	0	16		84	12	4
80	0	20		100	0	0		92	0	8		84	0	16		80	20	0
80	0	20		100	0	0		96	0	4		80	0	20		84	12	4
72	0	28		100	0	0		84	0	16		80	0	20		92	8	0
72	0	28		100	0	0		96	0	4		88	0	12		76	16	8
64	0	36		100	0	0		88	0	12		76	4	20		80	16	4
76	0	24		100	0	0		92	0	8		84	0	16		76	24	0
72	0	28		100	0	0		100	0	0		88	4	8		80	16	4
72	0	28		100	0	0		100	0	0		88	0	12		84	12	4
56	0	44		100	0	0		100	0	0		76	4	20		92	8	0
68	0	32		100	0	0		100	0	0		76	4	20		92	4	4
60	0	40		96	0	4		100	0	0		80	0	20		88	8	4

64	0	36		96	0	4		100	0	0		80	0	20		80	16	4
56	0	44		96	0	4		100	0	0		80	0	20		72	24	4
56	0	44		92	8	0		100	0	0		76	4	20		72	24	4
64	0	36		88	8	4		100	0	0		76	4	20		68	28	4
56	0	44		88	12	0		100	0	0		76	4	20		68	28	4
60	0	40		96	4	0		100	0	0		64	8	28		72	28	0
72	0	28		88	8	4		96	0	4		76	4	20		80	20	0
84	0	16		84	12	4		96	0	4		64	8	28		84	16	0
68	0	32		80	8	12		100	0	0		68	8	24		80	20	0
80	0	20		68	8	24		96	0	4		60	4	36		92	8	0
80	0	20		48	4	48		100	0	0		76	4	20		84	12	4
84	0	16		48	12	40		100	0	0		64	8	28		88	8	4
76	0	24		52	16	32		100	0	0		76	0	24		88	4	8
72	0	28		64	16	20		100	0	0		72	0	28		88	8	4
80	0	20		64	20	16		100	0	0		72	0	28		88	8	4
72	4	24		84	12	4		96	0	4		72	0	28		80	12	8
64	8	28		88	12	0		88	0	12		80	0	20		72	16	12
52	4	44		92	8	0		84	0	16		72	0	28		76	16	8
68	0	32		92	8	0		84	0	16		64	0	36		72	16	12
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32	12	56		100	0	0		88	0	12		84	0	16		88	0	12
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28	8	64		72	20	8		68	12	20		92	0	8		76	4	20
28	4	68		76	16	8		76	12	12		88	0	12		68	4	28
40	12	48		100	0	0		80	8	12		88	0	12		72	0	28
56	12	32		100	0	0		88	4	8		100	0	0		72	8	20
68	4	28		84	12	4		100	0	0		96	0	4		72	4	24
72	4	24		92	4	4		100	0	0		100	0	0		72	4	24
72	0	28		100	0	0		100	0	0		88	0	12		76	8	16
64	0	36		100	0	0		96	0	4		88	0	12		72	16	12
64	12	24		96	0	4		96	0	4		88	0	12		80	20	0
64	8	28		100	0	0		88	4	8		80	0	20		76	20	4
72	4	24		100	0	0		96	0	4		80	0	20		80	12	8
72	0	28		100	0	0		100	0	0		76	0	24		88	12	0

80	0	20		96	4	0		100	0	0		64	0	36		92	4	4
84	4	12		92	8	0		96	0	4		56	0	44		92	4	4
92	0	8		100	0	0		88	0	12		68	0	32		88	8	4
96	0	4		100	0	0		92	0	8		68	0	32		80	8	12
100	0	0		84	8	8		88	0	12		72	0	28		68	24	8
100	0	0		76	8	16		88	4	8		72	0	28		56	28	16
96	0	4		100	0	0		72	20	8		64	0	36		56	24	20
96	0	4		100	0	0		52	28	20		64	0	36		48	24	28
96	0	4		72	8	20		48	28	24		60	0	40		64	12	24
96	0	4		80	8	12		40	20	40		60	0	40		72	12	16
84	0	16		100	0	0		40	16	44		72	0	28		84	4	12
88	4	8		100	0	0		44	20	36		72	0	28		80	4	16
88	8	4		84	4	12		48	28	24		80	0	20		88	0	12
76	4	20		88	4	8		68	16	16		72	0	28		88	0	12
64	8	28		100	0	0		80	12	8		80	0	20		96	0	4
40	24	36		100	0	0		96	0	4		92	0	8		96	0	4
32	24	44		100	0	0		96	4	0		92	0	8		84	0	16
32	24	44		100	0	0		84	16	0		92	0	8		80	4	16
32	28	40		100	0	0		84	16	0		96	0	4		84	4	12
32	28	40		100	0	0		84	16	0		96	0	4		80	4	16
44	12	44		100	0	0		80	16	4		100	0	0		68	8	24
40	16	44		92	8	0		92	8	0		96	0	4		68	4	28
68	4	28		100	0	0		100	0	0		92	0	8		76	8	16
72	0	28		100	0	0		100	0	0		96	0	4		76	8	16
76	0	24		96	4	0		92	8	0		100	0	0		72	12	16
84	0	16		92	8	0		88	12	0		100	0	0		76	8	16
92	0	8		100	0	0		88	12	0		92	0	8		88	4	8
100	0	0		100	0	0		92	8	0		88	0	12		92	4	4
100	0	0		92	8	0		96	4	0		84	0	16		84	0	16
96	0	4		92	8	0		96	4	0		84	0	16		84	0	16
100	0	0		100	0	0		92	8	0		68	0	32		76	8	16
92	0	8		100	0	0		96	4	0		64	0	36		84	8	8
76	0	24		92	8	0		92	8	0		60	0	40		76	8	16
76	0	24		100	0	0		100	0	0		68	0	32		80	4	16
72	0	28		100	0	0		100	0	0		76	0	24		92	0	8
56	8	36		100	0	0		96	0	4		76	0	24		84	4	12
44	12	44		100	0	0		92	0	8		80	0	20		84	4	12
44	16	40		100	0	0		84	4	12		84	0	16		88	0	12
44	20	36		96	0	4		68	12	20		76	0	24		76	0	24
44	28	28		96	0	4		72	12	16		76	0	24		80	0	20
48	32	20		100	0	0		68	8	24		80	0	20		80	4	16
48	28	24		100	0	0		68	4	28		80	0	20		76	4	20
60	24	16		96	0	4		72	0	28		72	0	28		72	8	20
60	24	16		92	8	0		72	4	24		64	0	36		80	4	16
76	12	12		100	0	0		80	0	20		68	0	32		76	12	12
84	0	16		100	0	0		92	0	8		76	0	24		88	4	8
84	0	16		88	8	4		92	0	8		76	0	24		76	4	20
92	0	8		88	12	0		96	0	4		72	0	28		72	8	20
80	4	16		100	0	0		88	0	12		84	0	16		76	4	20
76	8	16		100	0	0		96	0	4		88	0	12		68	4	28
60	4	36		96	4	0		96	0	4		84	0	16		68	4	28
56	0	44		88	8	4		92	0	8		76	0	24		84	0	16
56	8	36		100	0	0		92	0	8		76	0	24		80	0	20
56	4	40		100	0	0		92	0	8		76	0	24		72	4	24
56	8	36		84	12	4		96	0	4		76	0	24		72	0	28

60	8	32		80	8	12		96	0	4		80	0	20		60	8	32
56	12	32		100	0	0		96	0	4		80	0	20		68	4	28
72	8	20		100	0	0		100	0	0		88	0	12		72	0	28
72	8	20		68	8	24		96	0	4		92	4	4		76	0	24
64	20	16		48	4	48		100	0	0		88	4	8		76	0	24
64	24	12		100	0	0		100	0	0		88	0	12		68	4	28
60	32	8		100	0	0		100	0	0		76	0	24		64	4	32
76	20	4		48	12	40		100	0	0		72	4	24		76	0	24
68	20	12		52	16	32		100	0	0		68	0	32		68	0	32
68	28	4		100	0	0		92	0	8		68	0	32		68	4	28
68	32	0		100	0	0		92	0	8		60	0	40		60	8	32
76	20	4		64	16	20		92	0	8		60	4	36		60	12	28
60	20	20		64	20	16		96	0	4		64	0	36		52	24	24
48	20	32		100	0	0		96	0	4		60	0	40		52	28	20
44	12	44		100	0	0		100	0	0		64	0	36		56	24	20
32	20	48		84	12	4		96	0	4		60	0	40		56	24	20
20	4	76		88	12	0		100	0	0		64	0	36		60	28	12
0	12	88		100	0	0		96	0	4		56	0	44		72	20	8
0	0	100		100	0	0		96	0	4		48	0	52		88	12	0
8	0	92		92	8	0		96	0	4		52	0	48		80	4	16
12	0	88		92	8	0		92	0	8		64	0	36		76	12	12
16	0	84		100	0	0		100	0	0		56	0	44		76	8	16
12	0	88		100	0	0		100	0	0		72	0	28		80	12	8
16	0	84		100	0	0		100	0	0		80	0	20		84	4	12
28	4	68		100	0	0		100	0	0		80	0	20		76	8	16
36	0	64		96	0	4		100	0	0		92	0	8		76	8	16
52	0	48		92	0	8		100	0	0		80	4	16		92	0	8
52	4	44		100	0	0		100	0	0		80	0	20		96	4	0
68	0	32		100	0	0		100	0	0		80	0	20		76	8	16
80	0	20		100	0	0		100	0	0		60	0	40		68	12	20
92	0	8		100	0	0		100	0	0		56	0	44		68	8	24
100	0	0		100	0	0		100	0	0		52	0	48		48	20	32
96	0	4		100	0	0		100	0	0		44	4	52		40	24	36
88	0	12		100	0	0		100	0	0		40	8	52		48	12	40
88	0	12		100	0	0		100	0	0		60	12	28		60	12	28
88	0	12		96	4	0		100	0	0		48	8	44		56	16	28
84	0	16		92	8	0		100	0	0		40	4	56		40	24	36
84	0	16		100	0	0		96	0	4		44	8	48		56	12	32
88	0	12		96	4	0		100	0	0		48	8	44		56	20	24
88	0	12		92	8	0		100	0	0		44	8	48		64	16	20
76	0	24		92	8	0		100	0	0		64	8	28		64	12	24
60	0	40		100	0	0		100	0	0		80	4	16		68	12	20
56	0	44		100	0	0		100	0	0		80	4	16		60	16	24
44	0	56		92	8	0		100	0	0		88	0	12		60	16	24
32	0	68		100	0	0		100	0	0		92	0	8		56	24	20
36	0	64		100	0	0		100	0	0		92	0	8		56	20	24

Figure B.9 Video Stream Data – 9th Run

8	4	88		60	12	28		88	0	12		80	12	8		80	4	16
24	8	68		72	20	8		84	0	16		88	8	4		80	4	16
40	12	48		72	20	8		88	0	12		96	4	0		88	0	12
60	4	36		76	12	12		92	0	8		100	0	0		84	4	12
76	8	16		72	0	28		92	0	8		100	0	0		80	8	12
92	0	8		60	0	40		96	0	4		100	0	0		72	20	8

88	4	8	44	8	48	100	0	0	100	0	0	72	16	12
88	0	12	28	8	64	100	0	0	100	0	0	72	16	12
80	0	20	16	8	76	96	0	4	96	4	0	64	24	12
60	4	36	12	4	84	96	0	4	100	0	0	80	12	8
40	12	48	4	0	96	96	0	4	96	0	4	80	12	8
32	4	64	4	0	96	100	0	0	92	0	8	76	12	12
20	8	72	0	0	100	100	0	0	96	0	4	72	16	12
20	8	72	16	0	84	100	0	0	96	0	4	72	20	8
8	8	84	40	12	48	100	0	0	84	8	8	76	12	12
0	20	80	52	8	40	100	0	0	76	8	16	72	16	12
12	24	64	76	4	20	100	0	0	92	4	4	88	12	0
28	24	48	96	0	4	100	0	0	76	8	16	92	8	0
44	20	36	100	0	0	96	0	4	76	12	12	92	8	0
60	20	20	100	0	0	100	0	0	80	12	8	76	12	12
68	20	12	100	0	0	100	0	0	88	4	8	84	4	12
84	8	8	100	0	0	100	0	0	92	8	0	80	16	4
84	12	4	100	0	0	100	0	0	88	8	4	80	16	4
84	12	4	100	0	0	100	0	0	92	8	0	76	16	8
92	4	4	100	0	0	100	0	0	88	8	4	72	24	4
80	8	12	100	0	0	100	0	0	84	8	8	80	20	0
80	4	16	100	0	0	100	0	0	80	12	8	84	16	0
56	16	28	96	0	4	100	0	0	76	20	4	84	16	0
48	16	36	96	0	4	100	0	0	88	12	0	88	12	0
44	16	40	88	4	8	100	0	0	84	16	0	88	8	4
28	16	56	76	8	16	100	0	0	76	24	0	88	4	8
24	20	56	84	4	12	100	0	0	80	20	0	84	0	16
16	28	56	80	8	12	100	0	0	92	8	0	76	12	12
16	32	52	84	8	8	96	0	4	96	4	0	80	8	12
28	40	32	92	4	4	100	0	0	100	0	0	76	12	12
48	32	20	96	4	0	100	0	0	96	4	0	72	16	12
64	20	16	100	0	0	100	0	0	92	8	0	76	12	12
80	8	12	100	0	0	100	0	0	92	4	4	68	16	16
88	8	4	96	4	0	100	0	0	80	12	8	64	20	16
96	4	0	100	0	0	100	0	0	88	8	4	68	24	8
96	4	0	100	0	0	100	0	0	88	8	4	80	12	8
84	12	4	100	0	0	100	0	0	96	4	0	76	8	16
76	20	4	100	0	0	96	0	4	76	8	16	76	16	8
68	24	8	100	0	0	100	0	0	68	8	24	84	12	4
56	32	12	100	0	0	100	0	0	56	12	32	84	8	8
40	32	28	96	4	0	100	0	0	60	4	36	76	16	8
36	24	40	100	0	0	100	0	0	60	4	36	80	20	0
24	36	40	100	0	0	100	0	0	56	12	32	76	20	4
44	28	28	100	0	0	96	0	4	52	16	32	84	8	8
48	28	24	100	0	0	100	0	0	72	8	20	72	16	12
60	16	24	100	0	0	100	0	0	84	4	12	64	8	28
76	12	12	100	0	0	96	0	4	88	4	8	48	16	36
88	12	0	100	0	0	96	0	4	100	0	0	36	16	48
96	4	0	100	0	0	92	0	8	100	0	0	56	4	40
96	0	4	92	0	8	88	0	12	88	4	8	44	8	48
100	0	0	92	0	8	72	0	28	76	12	12	40	20	40
88	0	12	96	0	4	64	8	28	84	8	8	40	24	36
76	4	20	96	0	4	52	12	36	68	12	20	52	24	24
64	12	24	96	0	4	36	16	48	72	16	12	60	24	16

48	16	36		100	0	0		40	20	40		60	16	24		60	32	8
44	12	44		100	0	0		36	32	32		68	16	16		60	32	8
48	12	40		96	0	4		48	40	12		60	24	16		80	16	4
68	4	28		92	4	4		60	32	8		76	12	12		84	16	0
60	0	40		96	4	0		72	20	8		88	4	8		88	12	0
52	16	32		100	0	0		80	16	4		88	4	8		84	12	4
48	20	32		100	0	0		88	8	4		92	0	8		88	8	4
36	32	32		96	0	4		88	0	12		92	0	8		88	8	4
40	28	32		92	0	8		92	0	8		92	0	8		80	8	12
44	28	28		88	0	12		96	0	4		88	0	12		76	12	12
52	24	24		88	0	12		96	0	4		88	0	12		60	20	20
68	20	12		88	0	12		92	0	8		84	4	12		64	12	24
80	12	8		96	0	4		88	0	12		72	12	16		52	20	28
88	4	8		100	0	0		92	0	8		84	12	4		52	28	20
76	0	24		100	0	0		100	0	0		76	16	8		60	20	20
68	0	32		100	0	0		100	0	0		76	16	8		68	12	20
64	0	36		100	0	0		96	0	4		80	12	8		68	8	24
60	0	40		92	4	4		100	0	0		80	12	8		68	8	24
68	8	24		96	4	0		96	0	4		80	12	8		52	12	36
76	0	24		100	0	0		88	0	12		80	12	8		60	16	24
92	0	8		100	0	0		92	0	8		68	12	20		68	16	16
92	4	4		96	4	0		92	0	8		76	8	16		80	8	12
96	0	4		100	0	0		96	0	4		88	0	12		80	8	12
100	0	0		96	4	0		88	8	4		76	12	12		84	4	12
100	0	0		100	0	0		76	12	12		84	0	16		80	4	16
100	0	0		100	0	0		64	12	24		80	12	8		80	0	20
100	0	0		96	0	4		60	20	20		88	0	12		68	8	24
100	0	0		96	0	4		52	24	24		88	4	8		60	12	28
100	0	0		100	0	0		64	16	20		80	16	4		56	24	20
96	0	4		100	0	0		64	12	24		84	12	4		56	24	20
96	0	4		96	0	4		72	4	24		92	4	4		64	20	16
92	0	8		96	0	4		76	0	24		96	4	0		76	16	8

92	0	8		96	0	4		80	0	20		84	4	12		80	20	0
80	0	20		96	0	4		84	0	16		76	0	24		80	20	0
72	0	28		96	0	4		72	4	24		64	0	36		88	12	0
84	0	16		96	0	4		76	0	24		56	0	44		88	8	4
84	0	16		100	0	0		72	0	28		40	4	56		92	4	4
80	4	16		100	0	0		56	0	44		40	4	56		88	4	8
88	0	12		100	0	0		60	0	40		32	12	56		84	8	8
92	0	8		100	0	0		56	0	44		40	16	44		76	12	12
96	0	4		100	0	0		60	0	40		36	12	52		56	28	16
92	0	8		100	0	0		56	0	44		40	12	48		68	28	4
92	0	8		100	0	0		48	0	52		40	12	48		64	28	8
80	4	16		100	0	0		68	0	32		48	8	44		68	28	4
64	12	24		100	0	0		64	0	36		52	8	40		64	24	12
52	28	20		100	0	0		60	4	36		64	4	32		64	20	16
36	24	40		100	0	0		64	0	36		72	4	24		64	8	28
28	28	44		100	0	0		60	0	40		76	0	24		52	16	32
32	36	32		100	0	0		72	0	28		80	0	20		48	16	36
32	24	44		100	0	0		68	0	32		72	4	24		56	12	32
44	36	20		100	0	0		64	0	36		72	4	24		60	8	32
48	36	16		100	0	0		68	0	32		76	4	20		68	0	32
48	40	12		100	0	0		68	0	32		76	4	20		80	0	20

40	40	20		100	0	0		76	0	24		80	4	16		92	0	8
44	44	12		100	0	0		80	0	20		84	0	16		92	4	4
36	44	20		100	0	0		84	0	16		88	4	8		92	8	0
48	32	20		100	0	0		80	0	20		88	4	8		84	16	0
52	20	28		92	4	4		76	0	24		84	4	12		88	12	0
60	16	24		84	12	4		76	0	24		96	4	0		88	4	8
68	8	24		92	8	0		76	0	24		92	4	4		92	4	4
80	4	16		84	12	4		80	0	20		88	8	4		84	4	12
72	0	28		76	12	12		88	0	12		88	8	4		84	0	16
80	0	20		72	16	12		92	0	8		88	8	4		80	0	20
88	0	12		80	12	8		92	0	8		84	12	4		80	0	20
88	0	12		88	4	8		96	0	4		84	12	4		84	0	16
88	0	12		96	0	4		92	0	8		84	12	4		68	0	32
76	4	20		92	0	8		96	0	4		84	16	0		60	4	36
72	0	28		96	0	4		96	0	4		88	12	0		60	4	36
48	8	44		84	0	16		96	0	4		92	8	0		72	8	20
32	8	60		80	4	16		100	0	0		88	8	4		60	12	28
16	24	60		72	4	24		100	0	0		84	12	4		60	8	32
8	24	68		72	0	28		96	0	4		80	8	12		48	16	36
4	36	60		88	4	8		100	0	0		76	12	12		48	16	36
0	48	52		92	0	8		100	0	0		80	8	12		40	4	56
0	52	48		100	0	0		100	0	0		76	12	12		40	0	60
8	40	52		92	0	8		100	0	0		72	16	12		40	0	60
12	44	44		92	0	8		100	0	0		76	12	12		56	0	44
28	36	36		88	0	12		96	0	4		76	12	12		60	0	40
48	28	24		88	0	12		92	0	8		88	8	4		56	12	32
68	16	16		100	0	0		96	0	4		88	8	4		56	16	28
64	16	20		72	4	24		92	0	8		88	8	4		76	8	16
60	16	24		52	4	44		92	0	8		88	8	4		88	4	8

Figure B.10 Video Stream data – 10th Run

10. Appendix C

mm/hr for each catch can - 7005 sprinklers

4.21	3.79	5.47	8.84	9.05	9.89	10.31	8.84
5.05	4.63	6.52	8.00	8.84	9.05	10.31	9.05
5.89	3.16	3.79	7.58	11.36	8.63	8.63	12.00
4.42	4.21	2.53	5.89	6.73	10.73	10.94	9.05
5.26	4.63	4.63	5.68	8.84	9.68	10.52	13.05
10.94	10.31	10.10	11.15	11.57	11.79	13.05	11.79
10.10	14.73	15.57	16.20	13.89	12.21	8.84	10.31
9.26	12.21	14.94	13.47	16.42	8.21	4.21	6.10
8.84	11.36	9.26	8.84	8.21	7.79	9.47	6.31
10.10	6.94	8.21	6.31	6.52	6.94	9.05	8.63

Figure C.1 7005 Data from catch can test

mm/hr for each catch can - 8005 sprinklers

7.79	13.47	9.05	10.10	9.89	8.42	12.42	11.36
5.05	9.89	9.05	9.68	11.15	9.68	12.63	9.47
3.79	5.89	6.94	8.63	10.10	9.68	7.16	5.26
4.42	2.95	5.05	10.52	8.84	8.00	6.10	8.00
2.10	3.37	5.05	5.47	8.00	7.58	6.31	4.63
6.52	5.47	5.68	5.68	5.05	5.89	6.73	7.37
8.42	7.58	5.05	4.42	4.84	6.94	7.79	6.31
8.00	9.05	10.31	6.31	6.73	5.05	7.37	8.63
13.89	11.57	10.31	9.89	7.79	6.10	8.42	8.42
13.68	16.20	15.15	10.52	9.47	6.52	7.58	10.94

Figure C.2 8005 Data from catch can test

total mm of irrigation between 19-1-07 to 1-5-07

246.9	356.9	298.6	388.1	388.0	374.2	466.0	414.5
206.7	299.2	319.7	362.5	410.1	383.6	470.4	379.2
197.3	186.3	220.9	332.1	438.9	375.1	322.5	350.6
180.9	146.0	156.0	337.7	319.5	382.3	347.0	348.5
149.5	163.2	198.3	228.2	344.3	352.4	343.0	358.6
355.8	321.2	321.4	342.5	337.8	359.6	402.5	390.3
378.4	453.8	418.1	417.6	379.9	389.9	339.9	338.7
352.7	433.8	515.1	402.1	470.1	270.1	238.1	302.5
467.1	469.6	401.0	383.8	327.2	283.6	365.7	302.3
488.1	477.3	480.8	346.2	328.5	275.5	339.7	401.5

Figure C.3 Total irrigation quantities

total mm of irrigation and rain between 19-1-07 to 1-5-07

319.9	429.9	371.6	461.1	461.0	447.2	539.0	487.5
279.7	372.2	392.7	435.5	483.1	456.6	543.4	452.2
270.3	259.3	293.9	405.1	511.9	448.1	395.5	423.6
253.9	219.0	229.0	410.7	392.5	455.3	420.0	421.5
222.5	236.2	271.3	301.2	417.3	425.4	416.0	431.6
428.8	394.2	394.4	415.5	410.8	432.6	475.5	463.3
451.4	526.8	491.1	490.6	452.9	462.9	412.9	411.7
425.7	506.8	588.1	475.1	543.1	343.1	311.1	375.5
540.1	542.6	474.0	456.8	400.2	356.6	438.7	375.3
561.1	550.3	553.8	419.2	401.5	348.5	412.7	474.5

Figure C.4 Total water quantities for entire growth period

Catch Can Record Sheet

Type:	t Irrigator
Name:	- Sec 5 Bay 6
Run Time (min):	30
Sprinkler Spacing (m):	20
Lateral Spacing (m):	17
Catch Can Spacing Along Lateral (m):	2
tch Can Spacing Between Lateral (m):	2
Catch Can Diameter (mm):	110
Av. Dep (mm/hr) :	8.9
DU (%) :	54.2
CU (%) :	72.3
Max Dep (mm/hr) :	16.4
Mix Dep (mm/hr) :	2.5
Can Grid Size:	
Along Lateral -	10
Between Laterals -	8

Clear Data

Plot Graph

Volume Applied Grid (ml):

	1	2	3	4	5	6	7	8	9
1	20	18	26	42	43	47	49	42	
3	24	22	31	38	42	43	49	43	
5	28	15	18	36	54	41	41	57	
7	21	20	12	28	32	51	52	43	
9	25	22	22	27	42	46	50	62	
11	52	49	48	53	55	56	62	56	
13	48	70	74	77	66	58	42	49	
15	44	58	71	64	78	39	20	29	
17	42	54	44	42	39	37	45	30	
19	48	33	39	30	31	33	43	41	
21									
23									

Depth Applied Grid (mm/hr):

	1	3	5	7	9	11	13	15
1	4.21	3.79	5.47	8.84	9.05	9.89	10.31	8.84
3	5.05	4.63	6.52	8.00	8.84	9.05	10.31	9.05
5	5.89	3.16	3.79	7.58	11.36	8.63	8.63	12.00
7	4.42	4.21	2.53	5.89	6.73	10.73	10.94	9.05
9	5.26	4.63	4.63	5.68	8.84	9.68	10.52	13.05
11	10.94	10.31	10.10	11.15	11.57	11.79	13.05	11.79
13	10.10	14.73	15.57	16.20	13.89	12.21	8.84	10.31
15	9.26	12.21	14.94	13.47	16.42	8.21	4.21	6.10
17	8.84	11.36	9.26	8.84	8.21	7.79	9.47	6.31
19	10.10	6.94	8.21	6.31	6.52	6.94	9.05	8.63

Figure C5 Data for 7005 sprinkler heads, Efficiency Test on 28-2-07

Catch Can Record Sheet

Type:	Solid Set Irrigator
Name:	Cabarlah Park - Sec 5 Bay 6

Run Time (min): 30

Sprinkler Spacing (m):	20
Lateral Spacing (m):	17
Catch Can Spacing Along Lateral (m):	2
Catch Can Spacing Between Lateral (m):	2
Catch Can Diameter (mm):	110

Av. Dep (mm/hr) :	**8.4**
DU (%) :	**54.5**
CU (%) :	**68.8**

Max Dep (mm/hr) :	**17.3**
Mix Dep (mm/hr) :	**3.6**

Can Grid Size:

Along Lateral -	10
Between Laterals -	8

Volume Applied Grid (ml): *Can no.*

Clear Data

Plot Graph

Dist. (m)	1	3	5	7	9	11	13	15	17
1	1	75	61	42	38	45	40	69	70	
2	3	59	63	44	38	51	56	36	37	
3	5	48	65	45	54	52	39	40	30	
4	7	24	48	48	40	30	28	20	21	
5	9	24	33	37	37	30	28	25	18	
6	11	19	22	22	20	22	23	24	17	
7	13	20	32	30	21	30	29	23	23	
8	15	38	38	23	23	20	40	39	31	
9	17	44	37	24	30	39	39	50	41	
10	19	73	41	38	48	38	49	60	71	
11	21	82	62	58	50	50	48	51	71	
12	23									

Depth Applied Grid (mm/hr):

	1	3	5	7	9	11	13	15
1	15.78	12.84	8.84	8.00	9.47	8.42	14.52	14.73
3	12.42	13.26	9.26	8.00	10.73	11.79	7.58	7.79
5	10.10	13.68	9.47	11.36	10.94	8.21	8.42	6.31
7	5.05	10.10	10.10	8.42	6.31	5.89	4.21	4.42
9	5.05	6.94	7.79	7.79	6.31	5.89	5.26	3.79
11	4.00	4.63	4.63	4.21	4.63	4.84	5.05	3.58
13	4.21	6.73	6.31	4.42	6.31	6.10	4.84	4.84
15	8.00	8.00	4.84	4.84	4.21	8.42	8.21	6.52
17	9.26	7.79	5.05	6.31	8.21	8.21	10.52	8.63
19	15.36	8.63	8.00	10.10	8.00	10.31	12.63	14.94
	17.26	13.05	12.21	10.52	10.52	10.10	10.73	14.94

Figure C6 Data for 7005 sprinkler heads, Efficiency Test on 26-2-07

Catch Can Record Sheet

Type:	Pop-ups - Winter Green
Name:	Cabarlah Park - Sec 5 Bay 8

Run Time (min): 30

Sprinkler Spacing (m):	20.2
Lateral Spacing (m):	17
Catch Can Spacing Along Lateral (m):	2
Catch Can Spacing Between Lateral (m):	2
Catch Can Diameter (mm):	110

Av. Dep (mm/hr) :	**8**
DU (%) :	**57.7**
CU (%) :	**71.6**

Max Dep (mm/hr) :	**16.2**
Mix Dep (mm/hr) :	**2.1**

Can Grid Size:

Along Lateral -	10
Between Laterals -	8

Volume Applied Grid (ml): *Can no.*

Clear Data | Plot Graph

Dist. (m)	1	3	5	7	9	11	13	15	17
1	1	37	64	43	48	47	40	59	54	54
2	3	24	47	43	46	53	46	60	45	36
3	5	18	28	33	41	48	46	34	25	23
4	7	21	14	24	50	42	38	29	38	22
5	9	10	16	24	26	38	36	30	22	16
6	11	31	26	27	27	24	28	32	35	30
7	13	40	36	24	21	23	33	37	30	31
8	15	38	43	49	30	32	24	35	41	43
9	17	66	55	49	47	37	29	40	40	41
10	19	65	77	72	50	45	31	36	52	73
11	21									
12	23									

Depth Applied Grid (mm/hr):

	1	3	5	7	9	11	13	15	
1	7.79	13.47	9.05	10.10	9.89	8.42	12.42	11.36	11.36
3	5.05	9.89	9.05	9.68	11.15	9.68	12.63	9.47	7.58
5	3.79	5.89	6.94	8.63	10.10	9.68	7.16	5.26	4.84
7	4.42	2.95	5.05	10.52	8.84	8.00	6.10	8.00	4.63
9	2.10	3.37	5.05	5.47	8.00	7.58	6.31	4.63	3.37
11	6.52	5.47	5.68	5.68	5.05	5.89	6.73	7.37	6.31
13	8.42	7.58	5.05	4.42	4.84	6.94	7.79	6.31	6.52
15	8.00	9.05	10.31	6.31	6.73	5.05	7.37	8.63	9.05
17	13.89	11.57	10.31	9.89	7.79	6.10	8.42	8.42	8.63
19	13.68	16.20	15.15	10.52	9.47	6.52	7.58	10.94	15.36

Figure C7 Data for 8005 sprinkler heads, Efficiency Test on 15-3-07

Catch Can Record Sheet

Type:	Pop-ups - Winter Green
Name:	Cabarlah Park - Sec 5 Bay 6

Run Time (min): 30

Sprinkler Spacing (m):	20
Lateral Spacing (m):	20
Catch Can Spacing Along Lateral (m):	2
Catch Can Spacing Between Lateral (m):	2
Catch Can Diameter (mm):	110

Av. Dep (mm/hr) :	**8**
DU (%) :	**58.9**
CU (%) :	**72.3**

Max Dep (mm/hr) :	**16.2**
Mix Dep (mm/hr) :	**2.1**

Can Grid Size:

Along Lateral -	10
Between Laterals -	10

Volume Applied Grid (ml): *Can no.*

Clear Data | Plot Graph

Dist. (m)	1	3	5	7	9	11	13	15	17
1	37	64	43	48	47	40	59	54	
2	24	47	43	46	53	46	60	45	
3	18	28	33	41	48	46	34	25	
4	21	14	24	50	42	38	29	38	
5	10	16	24	26	38	36	30	22	
6	31	26	27	27	24	28	32	35	
7	40	36	24	21	23	33	37	30	
8	38	43	49	30	32	24	35	41	
9	66	55	49	47	37	29	40	40	
10	65	77	72	50	45	31	36	52	
11									
12									

Depth Applied Grid (mm/hr):

	1	3	5	7	9	11	13	15	17
1	7.79	13.47	9.05	10.10	9.89	8.42	12.42	11.36	
3	5.05	9.89	9.05	9.68	11.15	9.68	12.63	9.47	
5	3.79	5.89	6.94	8.63	10.10	9.68	7.16	5.26	
7	4.42	2.95	5.05	10.52	8.84	8.00	6.10	8.00	
9	2.10	3.37	5.05	5.47	8.00	7.58	6.31	4.63	
11	6.52	5.47	5.68	5.68	5.05	5.89	6.73	7.37	
13	8.42	7.58	5.05	4.42	4.84	6.94	7.79	6.31	
15	8.00	9.05	10.31	6.31	6.73	5.05	7.37	8.63	
17	13.89	11.57	10.31	9.89	7.79	6.10	8.42	8.42	
19	13.68	16.20	15.15	10.52	9.47	6.52	7.58	10.94	

Figure C8 Data for 8005 sprinkler heads, Efficiency Test on 17-3-07

Catch Can Record Sheet

Type:	Pop-ups - Kikuyu
Name:	Cabarlah Park - Sec 2 Bay 4

Run Time (min): 60

Sprinkler Spacing (m):	20
Lateral Spacing (m):	20
Catch Can Spacing Along Lateral (m):	2
Catch Can Spacing Between Lateral (m):	2
Catch Can Diameter (mm):	110

Av. Dep (mm/hr) : 9.7
DU (%) : 57
CU (%) : 71

Max Dep (mm/hr) : 18
Mix Dep (mm/hr) : 4.4

Can Grid Size:

Along Lateral -	11
Between Laterals -	10

Volume Applied Grid (ml): *Can no.*

Clear Data | Plot Graph

Dist. (m)	1	3	5	7	9	11	13	15	17	19
1	1									
2	3									
3	5									
4	7									
5	9									
6	11									
7	13									
8	15									
9	17									
10	19									
11	21									
12	23									

Depth Applied Grid (mm/hr):

	1	3	5	7	9	11	13	15	17	19
1	14	11	6.6	9.8	9.8	9.2	11	13	15	11
3	18	16	11	11	11	7.2	11	11	9	6.8
5	15	18	13	13	10	7.8	5	4.4	7.2	7.4
7	13	13	15	13	8	5.4	5	5.4	5.4	7.2
9	9	9.2	12	12	8.4	4.6	4.6	4.8	5.8	7.4
11	11	11	9.4	9	8	5.8	5	7.8	7.8	7.8
13	12	12	8.8	6	7.4	5	7	9.6	10	11
15	13	10	5	6	5.6	6.6	13	14	11	12
17	10	6.8	6	6	7.4	9.8	15	12	11	11
19	15	7.6	6.8	7.6	7.4	8.4	11	13	15	18
	10	16	10	9.2	9.2	8.8	11	12	16	8

Figure C9 Data for 7005 sprinkler heads, Efficiency Test on 10-9-07

Section 5 - Bay 7, Wintergreen Couch
Manual Data

Fertilizer Application

Urea – Setting 4 on spreader 18–1 -07
Urea – Setting 6 on spreader 13–2 -07
Urea – Setting 6 on spreader 12–3 -07

Aeration – 18-1-07

Total irrigation: 431mm

Rain

6mm 9-1-07
8mm 26-1-07
3mm 10-2-07
24mm 12-2-07
14mm 8-3-07
24mm 10-3-07

Total: 79mm

Pressure at nozzle
186kPa

Pressure at Pump
689kPa

Figure C10 Manual Data of milestones during the wintergreen trial

Daily Climatic Data

Cabarlah weather station

Date	Min Temp	Max Temp	Relative Humidity	Solar Radiation	Wind Run	Rainfall	ETo
	(C)	(C)	(%)	(cal/cm^2)	(km/d)	(mm)	(mm/d)
19/01/2007	14.78	28.43	90.80	567.825	367.92	0.00	4.57
20/01/2007	14.10	31.24	92.50	684.173	330.72	0.00	5.76
21/01/2007	18.19	34.08	85.90	605.735	319.44	0.00	6.40
22/01/2007	18.08	35.05	87.10	577.574	244.56	0.00	5.83
23/01/2007	21.21	33.90	79.40	535.719	288.48	0.00	5.88
24/01/2007	21.65	35.81	82.90	505.492	229.20	0.00	5.83
25/01/2007	22.96	36.35	85.30	507.342	275.76	6.61	6.26
26/01/2007	20.57	32.49	93.30	478.843	312.72	2.80	5.04
27/01/2007	20.27	36.21	94.20	647.349	239.76	0.00	6.78
28/01/2007	19.90	36.02	84.50	715.317	260.64	0.00	7.38
29/01/2007	13.77	35.92	99.60	735.789	178.56	0.00	6.65
30/01/2007	22.46	37.39	85.60	631.647	343.20	0.00	7.87
31/01/2007	20.06	35.04	89.50	683.591	280.08	0.00	7.02
1/02/2007	19.83	33.49	88.00	484.665	396.96	0.00	5.49
2/02/2007	19.66	27.44	80.40	327.141	424.08	0.00	3.92

3/02/2007	16.87	31.44	81.40	682.610	356.40	0.00	6.65
4/02/2007	18.96	31.14	82.60	653.171	398.88	0.00	6.61
5/02/2007	16.33	31.54	78.40	691.496	336.00	0.00	6.72
6/02/2007	14.17	34.74	86.50	627.183	235.92	0.00	6.12
7/02/2007	17.41	32.85	85.90	641.147	336.96	0.00	6.35
8/02/2007	19.22	31.85	77.00	566.162	394.08	0.00	6.62
9/02/2007	18.69	31.74	85.20	602.275	361.20	0.00	6.16
10/02/2007	18.52	34.79	86.30	665.039	327.12	0.00	7.24
11/02/2007	18.25	34.02	93.10	484.239	353.76	3.05	5.79
12/02/2007	18.32	29.89	88.20	439.002	366.24	21.59	4.68
13/02/2007	18.19	22.02	89.30	218.130	392.16	3.05	2.31
14/02/2007	18.29	27.95	89.80	544.506	337.20	0.00	5.15
15/02/2007	17.01	27.20	94.40	547.254	348.00	0.00	4.55
16/02/2007	17.85	25.92	88.70	224.691	367.20	0.00	2.76
17/02/2007	18.32	27.21	91.20	521.846	414.00	3.81	5.00
18/02/2007	16.74	28.24	88.90	573.474	390.72	0.00	5.38
19/02/2007	14.11	29.29	92.80	589.050	368.64	0.00	5.22
20/02/2007	17.38	28.98	87.70	505.285	356.16	0.00	4.90
21/02/2007	18.42	29.43	89.60	548.978	426.24	0.00	5.57
22/02/2007	19.09	30.22	86.00	602.171	477.12	0.00	6.57
23/02/2007	16.77	30.87	94.40	567.249	304.80	0.00	5.24
24/02/2007	16.40	30.73	93.50	589.929	274.56	0.00	5.32
25/02/2007	19.93	32.72	85.60	543.964	344.16	0.00	6.24
26/02/2007	19.25	31.41	87.70	605.200	391.20	0.00	6.31

27/02/2007	18.49	31.24	87.20	582.009	349.44	0.00	6.07
28/02/2007	20.13	32.35	87.80	403.458	334.08	0.00	4.82
1/03/2007	20.17	33.03	82.90	507.299	386.64	0.00	6.31
2/03/2007	18.95	35.54	91.30	585.857	280.32	0.76	6.59
3/03/2007	19.93	35.71	94.00	583.847	293.28	0.00	6.46
4/03/2007	19.16	33.52	89.70	613.167	333.36	0.00	6.47
5/03/2007	19.62	32.18	92.80	435.365	324.00	0.00	4.70
6/03/2007	19.46	31.44	94.90	421.436	359.04	11.69	4.79
7/03/2007	19.02	26.36	85.30	325.976	456.00	0.00	4.11
8/03/2007	17.99	31.44	91.00	408.541	259.20	4.83	4.56
9/03/2007	19.03	31.54	95.80	502.926	213.12	17.53	4.90
10/03/2007	19.06	34.11	87.80	495.441	349.92	0.00	6.26
11/03/2007	18.89	36.43	97.50	582.427	266.88	0.00	6.27
12/03/2007	19.29	37.22	96.30	614.411	225.60	0.00	6.59
13/03/2007	20.74	34.40	80.00	473.085	561.36	0.00	8.08
14/03/2007	17.82	28.21	79.10	515.426	475.20	0.00	6.22
15/03/2007	15.45	28.17	87.30	594.818	338.88	0.00	5.46
16/03/2007	11.01	31.10	94.60	598.800	235.20	0.00	5.27
17/03/2007	13.23	33.42	94.70	588.547	173.04	0.00	5.52
18/03/2007	16.23	32.22	88.70	577.515	263.52	0.00	5.86
19/03/2007	13.70	29.48	93.60	550.545	312.72	0.00	4.82
20/03/2007	13.56	29.68	95.20	547.161	266.40	0.00	4.76
21/03/2007	16.43	29.85	92.90	537.971	308.64	0.00	4.91
22/03/2007	17.85	28.48	92.70	416.525	324.96	0.00	3.94

23/03/2007	19.09	28.54	88.90	397.447	346.32	0.00	4.38
24/03/2007	17.62	31.41	93.70	449.181	235.68	0.00	4.68
25/03/2007	15.89	30.40	93.60	341.102	238.08	0.00	3.58
26/03/2007	15.66	26.90	77.50	520.610	333.60	0.00	5.52
27/03/2007	14.64	26.16	74.50	535.297	358.08	0.00	5.78
28/03/2007	14.14	29.95	80.40	559.843	297.60	0.00	6.01
29/03/2007	14.65	33.12	90.50	557.814	239.04	0.00	5.86
30/03/2007	15.55	30.97	68.48	442.663	255.60	0.00	5.28
31/03/2007	6.19	30.19	64.12	547.509	141.60	0.00	5.39
1/04/2007	14.88	27.89	76.10	533.515	428.88	0.00	6.10
2/04/2007	9.49	26.33	89.40	398.549	292.32	0.00	3.67
3/04/2007	13.43	29.35	89.10	532.935	279.60	0.00	5.14
4/04/2007	12.02	27.30	94.10	499.684	277.92	0.00	4.17
5/04/2007	10.87	28.17	94.50	503.219	242.40	0.00	4.32
6/04/2007	11.24	27.76	90.00	468.792	208.80	0.00	4.08
7/04/2007	14.07	25.18	78.70	457.673	379.92	3.30	4.87
8/04/2007	11.38	24.74	82.00	510.852	374.88	0.00	4.87
9/04/2007	9.38	24.84	83.30	484.187	316.80	0.00	4.28
10/04/2007	11.65	25.32	81.90	518.584	323.76	0.00	4.82
11/04/2007	9.72	27.60	94.30	513.569	235.44	0.00	4.31
12/04/2007	8.95	26.16	90.60	419.465	312.00	0.00	3.67
13/04/2007	12.35	25.28	85.30	494.141	294.72	0.00	4.40
14/04/2007	8.18	25.48	91.60	475.803	250.32	0.00	3.84
15/04/2007	10.67	28.48	93.30	416.124	186.72	0.00	3.90

16/04/2007	9.86	29.18	95.00	470.205	205.44	0.00	4.14
17/04/2007	10.60	30.46	88.10	455.740	188.64	0.00	4.50
18/04/2007	14.11	32.05	77.40	427.499	221.04	0.00	5.09
19/04/2007	14.74	32.08	90.40	451.277	213.12	0.00	4.69
20/04/2007	17.01	30.83	84.20	436.126	238.80	0.00	4.82
21/04/2007	13.27	29.08	92.80	447.428	255.12	0.00	4.17
22/04/2007	14.14	29.89	94.40	385.720	219.84	0.00	3.87
23/04/2007	10.03	30.02	94.10	442.432	162.72	0.00	4.07
24/04/2007	14.78	29.00	95.50	426.123	226.80	0.00	4.14
25/04/2007	15.72	27.24	90.70	361.911	332.64	0.00	3.88
26/04/2007	16.33	26.19	89.70	250.855	291.84	0.00	2.99
27/04/2007	17.88	26.80	88.10	225.321	308.64	0.00	2.98
28/04/2007	15.08	23.83	82.00	46.231	321.12	5.34	1.84
29/04/2007	12.52	23.54	97.80	307.767	219.36	3.05	2.85
30/04/2007	9.48	23.83	91.50	456.691	255.60	0.00	3.94
1/05/2007	5.25	24.34	95.60	448.107	185.52	0.00	3.61
Total	1,649.70	3,118.05	9,089.50	52,002.80	31,537.92	87.41	532.38
Minimum	5.25	22.02	64.12	46.23	141.60	0.00	1.84
Maximum	22.96	37.39	99.60	735.79	561.36	21.59	8.08
Average	16.02	30.27	88.25	504.88	306.19	0.85	5.17

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Figure C11 Daily Weather information for Cabarlah Park used for the wintergreen trial