Water Strategies
Irrigation
WOF

# Irrigation WOF

## Irrigation Performance Test

## X Farm

X 2020

| | |
|---|---|
| Report Number: | WSXXX |
| Report Prepared By: | X |
| Date | X/X/2020 |
| Report Reviewed By: | X |
| Date | X/X/2020 |

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## Assessment Summary

An assessment of X Farm pivots 2, 4 and 6 was undertaken by X of Water Strategies in on X 2020.

The scope of the assessment was an ***Irrigation Performance Test***:

- A performance test of the irrigator pressures, flows, actual irrigation depth and the uniformity of application.

The testing methodologies used comply with ISO 11545, ANSI/ASAE S346.1 and the New Zealand Performance Assessment code of practice 2014.

The wind speed during the performance tests was between 0 m/s and 1.5 m/s. This is within permissible testing limits.

### Findings:

*Specific results can be found in the test results table on page 6*

- All pivots had adequate pressure for them to operate, however there was significant fluctuation in the water supply pressure to each.
- The flow rates to the pivots were adequate for them to operate.
- The application depth of pivot 2 and 6 was within 10 % of the control panel and for pivot 4 it was within 20%.
- The application depth for the pivot 6 corner arm was almost 40% less than the other spans.
- None of the pivots met the minimum lower quartile distribution uniformity ($DU_{lq}$) standard of >0.80. However, if the flood jet nozzle impacted data was removed from the calculations for pivot 4 the result improved to 0.85; and if the corner arm results were excluded for pivot 6 the uniformity improved to 0.87.
- Pivots 4 and 6 met the recommended upper quartile distribution uniformity ($DU_{uq}$) standard of < 1.25, however pivot 2 did not. If the flood jet nozzle impacted data was removed from the calculations for pivot 4 the result improved to 1.15; and if the corner arm results were excluded for pivot 6 the uniformity improved to 1.12.
- Pivot 4 met the international coefficient of uniformity (CU) standard of > 85%, however pivots 2 and 6 did not. If the flood jet nozzle impacted data was removed from the calculations for pivot 4 the result improved to 90.41; and if the corner arm results were excluded for pivot 6 the uniformity improved to 92.47.

- The instantaneous application rates (IAR) of all pivots were within the maximum infiltration rate of the soils found on the property (stony silt loams are typically between 30 and 40 mm/hr).

### Recommendations:

- For pivot 2 the sprinkler pack is likely not installed correctly and the endgun arc settings also need to be checked, noting for optimum performance they should typically be 130°.
- For pivot 4 the flood jet nozzle after the last tower should be removed and replaced with a pivot sprinkler. Due to the pivots position the endgun was not able to be tested, however it would be advisable to also check the arc settings for it.
- For pivot 6 the corner arm sprinkler pack needs checking and if no issues are found it then needs reprogramming so it is applying the same depth as the rest of the pivot. Due to the pivots position the endgun was not able to be tested, however it would be advisable to also check the arc settings for it.
- There were significant pressure variations observed with the water supply during the tests which is being caused by the CPW water supply. Although the pressure variation is having minimal impact upon system performance (it only impacts endgun performance as these are not pressure regulated) you should ask CPW if anything can be done to stabilise your water supply pressure.

## Good Farming Practice Assessment

| Expectation | Comment |
|---|---|
| New and upgraded irrigation systems | None of the pivots currently meet Good Farming Practice requirements. For pivots 4 and 6 if the recommendations are implemented they will meet Good Farming Practice requirements, however, pivot 2 will require a re-test. |
| Annual assessment & maintenance | N/A |
| Timing & depth of irrigation meet plant demand | N/A |
| Management systems | N/A |

## Irrigation Assessment Results

| | | | |
|---|---|---|---|
| Full Irrigation Assessment (Performance Test & Scheduling Assessment) | | | ☐ |
| Irrigator Performance Test | ☒ | Irrigation Scheduling Assessment | ☐ |

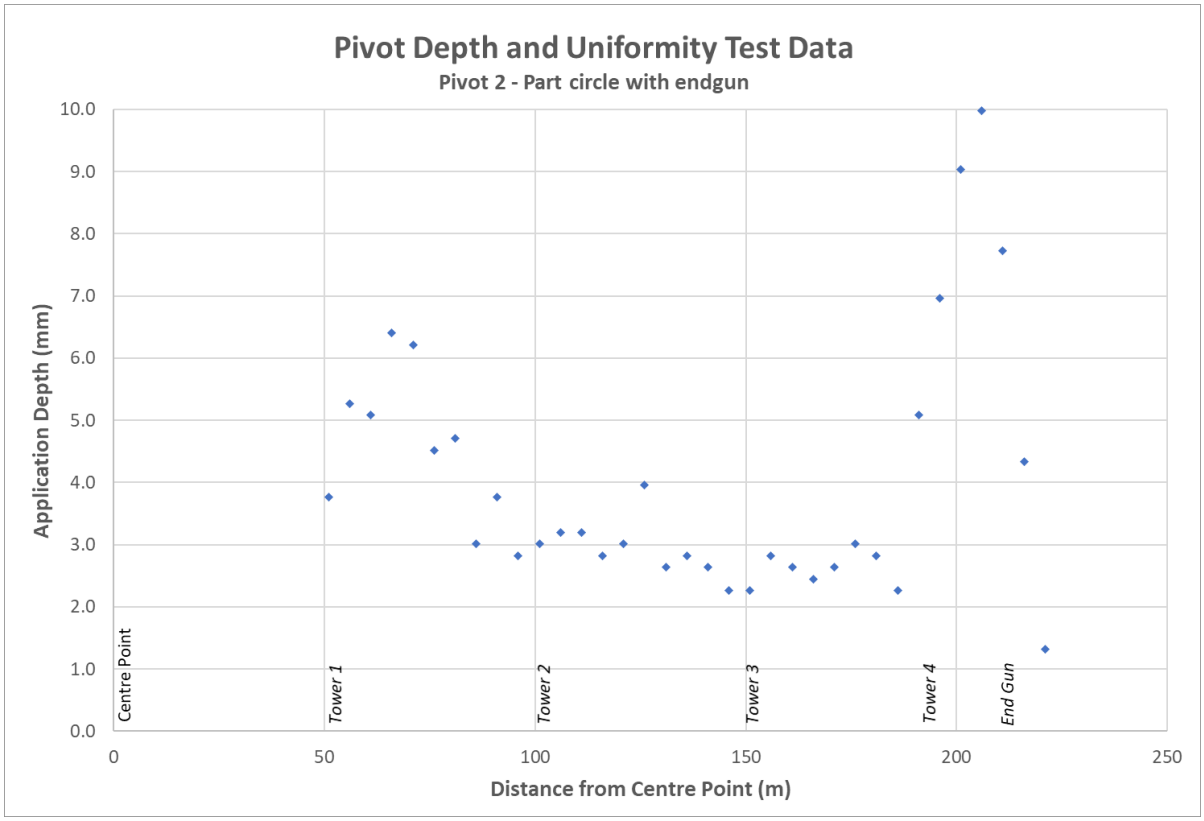
### Performance Test:

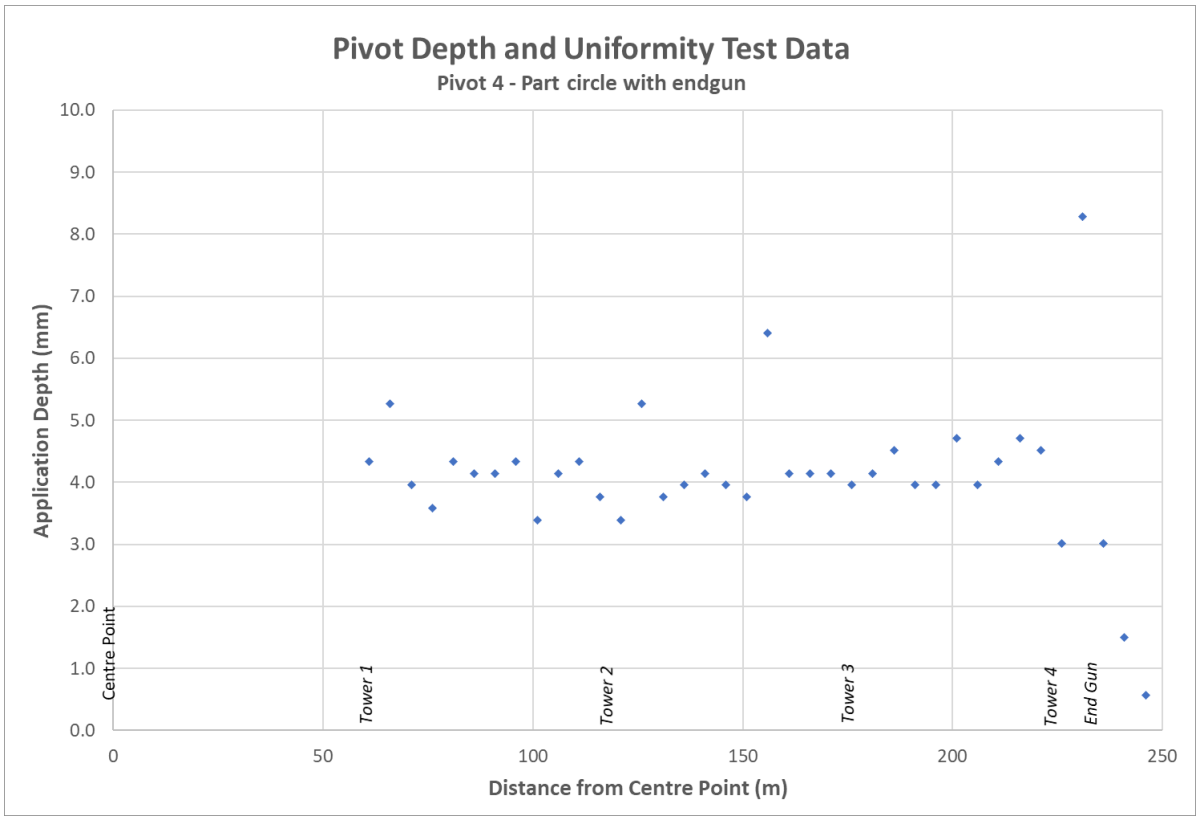
| Irrigator Performance | Pivot 2 | Pivot 4 | Pivot 6 |
|---|---|---|---|
| Application depth (mm) (control panel) | 5.0 | 5.0 | 3.75 |
| Application depth (mm) (measured) | 5.2 | 4.1 | 3.7 |
| Flow Rate (l/s) (design) | 13.0 | 13.0 | 56.0 |
| Flow Rate (l/s) (check flow meter) | 5.7 | 6.3 | 52.0 |
| Centre Pressure (kPa) (centre point design) | 210 | 215 | 380 |
| Centre Pressure (kPa) (centre point) | 280-480 | 350-520 | 260-510 |
| End Pressure (kPa) (above end regulator) | 250-420 | 330-510 | 180-320 |
| End Pressure (kPa) (below end regulator) | 110 | 110 | 100 |
| Pivot Speed (m/min) (at test depth) | 0.53 | 0.64 | 2.4 |
| Rotation time (hours) (at test depth) | 21.5 | 23.15 | 19.2 |
| System capacity (mm/day) (design) | 13.0 | 8.6 | 5.0 |
| System capacity (mm/day) (calculated) | 5.7 | 4.2 | 5.0 |
| *Weighted Distribution Uniformity ($DU_{lq}$)[1] | 0.76 | 0.79 | 0.74 |
| Weighted Distribution Uniformity ($DU_{uq}$)[2] | 1.55 | 1.24 | 1.21 |
| Weighted Co-efficient of Uniformity (CU)[3] | 71.97 | 85.69 | 83.74 |
| Instantaneous Application Rate (IAR) (mm/hour) | 13.8 | 12.7 | 38.1 |

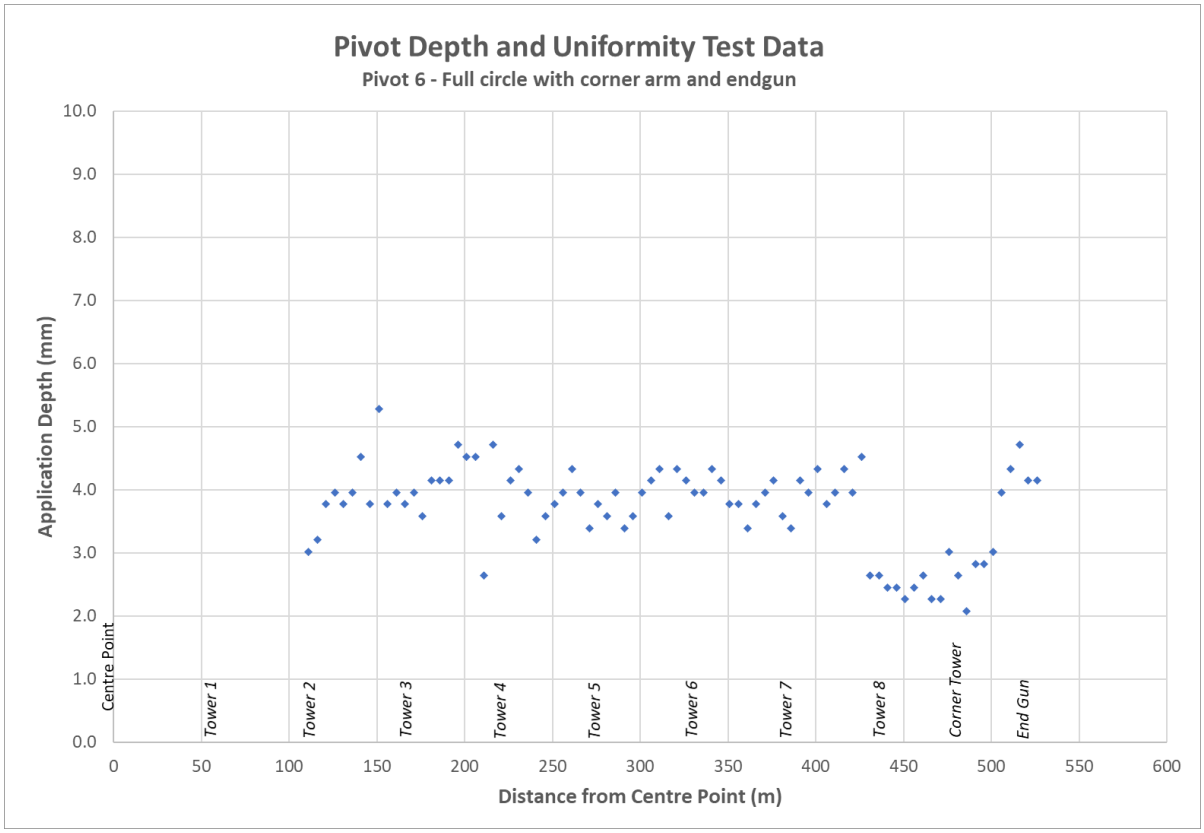
**Calculations exclude the end gun test results.*

[1] See Appendix A for an explanation of lower quartile distribution uniformity
[2] See Appendix A for an explanation of upper quartile distribution uniformity
[3] See Appendix A for an explanation of coefficient of uniformity

## Uniformity and Depth Graphs




Pivot Depth and Uniformity Test Data
Pivot 6 - Full circle with corner arm and endgun
Application Depth (mm)
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
Centre Point
Tower 1
Tower 2
Tower 3
Tower 4
Tower 5
Tower 6
Tower 7
Tower 8
Corner Tower
End Gun
0
50
100
150
200
250
300
350
400
450
500
550
600
Distance from Centre Point (m)

## Irrigation Assessment Methodology

An assessment of X Farm pivots 2 and 4 was undertaken by X of Water Strategies on X 2020 and X on X 2020.

The wind speed during the performance tests was between 0 m/s (X date) and up to 1.5 m/s (X date). These are within permissible testing limits.

The scope of the assessment was an ***Irrigation Performance Test***.

- A performance test of the irrigator pressures, flows, actual irrigation depth, the uniformity of application and topography in relation to individual tower location.

The irrigation system assessment methodology used complies with:

- ISO 11545;
- ANSI/ASAE S346.1; and
- IrrigationNZ Code of Practice for Performance Assessment (2014).

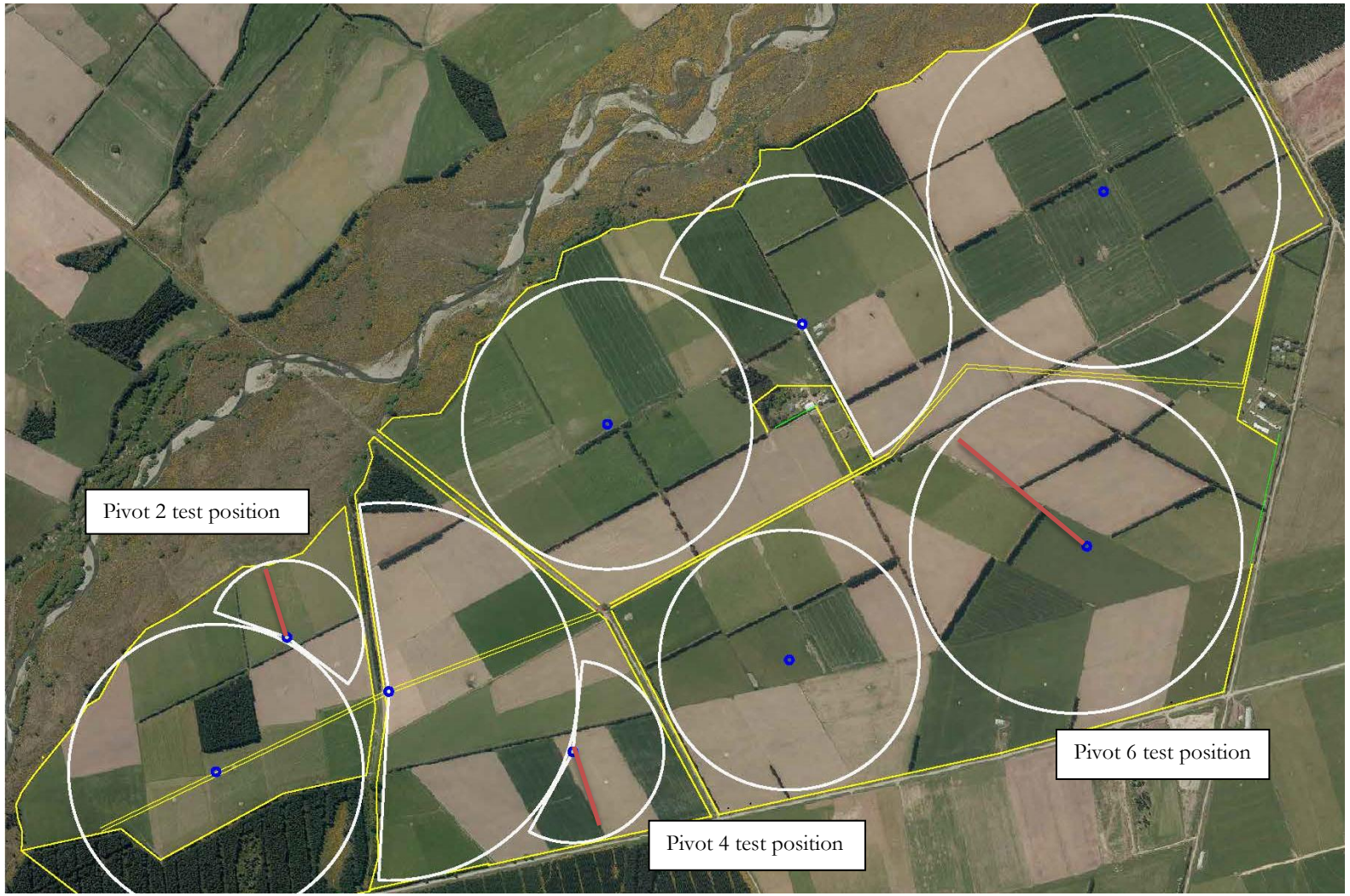
Appendix B contains a detailed description of the irrigation system performance testing procedures.

# Background Information

## Irrigators

| System | Description | Design Specifications (where available) |
|---|---|---|
| Pivot 2 | • Part-circle – 200°<br>• 196 m length<br>• 8.6 ha<br>• 1 year | • Flow Rate – 13.0 l/s<br>• Centre Pressure – 210 kPa<br>• System Capacity – 13 mm/day |
| Pivot 4 | • Part circle – 220°<br>• 240 m length<br>• 12.9 ha<br>• 1 year | • Flow Rate – 13.0 l/s<br>• Centre Pressure – 215 kPa<br>• System Capacity – 8.6 mm/day |
| Pivot 6 | • Full circle<br>• 526 m length<br>• 97.0 ha<br>• 1 year | • Flow Rate – 56.0 l/s<br>• Centre Pressure – 380 kPa<br>• System Capacity – 5.0 mm/day |

## Farm Irrigation Layout



# Appendix A: Uniformity Explanation

## Distribution Uniformity

Distribution uniformity (DU) is a measure of how evenly water is applied to the area being watered. It is expressed as a ratio. The DU should not be confused with the coefficient of uniformity (CU) which is explained below.

The most common measure of DU for is the low quarter DU expressed as $DU_{lq}$. This is a measure of the average of the lowest quarter of samples, divided by the average of all samples. The higher the $DU_{lq}$, the better the uniformity of application, i.e. if all samples are equal, the $DU_{lq}$ is 1.0.

For pivots Water Strategies uses the weighted version of the above formula. This recognises that a greater area is irrigated as you move from the centre outwards.

The table below provides a performance rating in relation to the $DU_{lq}$ value. A value of >0.80 is regarded as the minimum standard in NZ.

| | |
|---|---|
| > 0.90 | Excellent |
| 0.80 – 0.89 | Good |
| 0.70 – 0.79 | Fair |
| 0.60 – 0.69 | Poor |
| > 0.59 | Extremely Poor |

*Source: NZ Performance Assessment Code of Practice 2014*

The other DU measure, which can be used for irrigation but is more commonly used for land based effluent applications, is the upper quartile DU expressed as $DU_{uq}$. It provides a measure of the overwatering risk. Its calculation differs from the lower quartile as the upper quartile of samples is instead divided by the average of all samples. The $DU_{uq}$ standard for land based effluent application is <1.25 (Farm Dairy Effluent Code of practice 2013).

## Christiansen's uniformity coefficient

Christiansen's uniformity coefficient (CU) is widely used overseas as a method of calculating the uniformity of irrigation applications. It is calculated by the average depth of irrigation water applied minus the average absolute deviation from this depth then being divided by the average depth applied. A low coefficient of uniformity indicates that water is distributed unevenly over the irrigated area. Well-designed systems should operate at a CU of > 85%.

For pivots the weighted version (Heermann-Hein) of the above formula is used. This recognises that a greater area is irrigated as you move from the centre outwards.

# Appendix B: Methodology Detail

## Testing Methodology – Center Pivot

The following methodology was used in addition to the methodology set out in the New Zealand Performance Assessment Code of Practice (2014):

1) Pressure test points were installed at the start and end, and for each test point pressures were taken above and below the regulator.
2) For the standard pivot systems one line of collectors was used and the collectors were placed 5 metres apart.
3) For the variable rate systems two lines of collectors were used with the collectors placed at 10 metre spacings in each line and offset by 5 metres between each line.
4) Each collectors position was measured to provides an accurate reading of distance from the centre point. This ensures the weighting of the volumes collected was accurate and any issues arising from the test results can be related to a specific location point on the machine.
5) A Siemens FUP1010 flow meter was installed at the centre point to provide flow measurement readings during the test.
6) The pivot was run at a 5 mm application rate.
7) The following data was recorded:
    - Centre pressure
    - Pressure readings above and below the end regulator
    - Flow rate
    - Machine speed at the last span tower
    - Span lengths, overhang length and where applicable endgun radius and corner arm length
    - Wetted width at the end and at two-thirds the distance along the machine
    - Wind speed and temperature
    - Any general comments