# BIRMINGHAM CONURBATION RAINFALL STUDY

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## 1 Introduction

Reid Crowther was retained by Severn Trent Water Ltd to assess the spatial and temporal variation of rainfall over the Birmingham and Black Country conurbation. The objectives were:

- to investigate the degree of spatial variation of rainfall over the catchment.
- to consider whether the variation is such that real time control systems could improve the operation of the sewerage system.

The total area of the catchment is approximately 450 square kilometres with a population of approximately 1.7 million. The total length of the main sewers is approximately 48 km with a maximum diameter of 4.3 m. The maximum flow into Minworth Sewage Treatment Works from the catchment is 30 $m^3/s$.

## 2 Choice of data

Fifteen rain gauges were identified inside and on the edge of the catchment and data from the gauges was obtained from the NRA Severn Trent Region. The gauges are all tipping bucket gauges providing digital data. However some of the gauges have only been operating in digital form since 1986 and this limited the data which was available. Typical years of record were selected by looking at the total rainfall in each year. The four year period from 1989 to 1992 was chosen to represent average, dry and wet years.

**Table 1 Annual rainfall for Ray Hall**

| Year | 1987 | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 |
|---|---|---|---|---|---|---|---|
| Total (mm) | 688 | 589 | 676 | 560 | 533 | 807 | 710 |

The rainfall data was converted to rainfall intensities for 60 minute and 15 minute periods and divided into storm periods. A storm was defined as ending if there was a period of 12 hours without rainfall. Storms of more than 30 mm total depth at any of the gauges were identified as being those most likely to cause problems in the sewerage system and these storms were selected for investigation. This gave 13 storms for the four years of record.

There is only a slight relationship between the number of significant storms and whether it was a dry or wet year as defined by the total annual rainfall. The wettest of the years had four storms selected. The average year also had four, and the two dry years had three and two storms selected.

Of the thirteen storms only four were in the summer months (April to September) and nine were in the winter months. This is as might be expected as the storms were selected based on total depth of rain with no restriction on the duration of the storm. This will tend to cause a bias towards long duration low intensity winter storms.

A summary of the characteristics of the storms is given in Table 2.

### *4.1 Rainfall duration*

The results for analysis of rainfall duration were not found to be very useful because of the way in which storms were defined. Even a small amount of rainfall several hours away from the main body of rain was sufficient to cause a large difference in storm duration. The effective duration was therefore determined by inspecting the hyetograph.

For the summer storms the main body of the rainfall of each storm had a duration of about four hours, with the exception of storm 7 in April 1991 which was longer. For the winter storms, the duration of the main body of rainfall was at least 12 hours with some up to 72 hours.

A more complex analysis to identify the duration of the main body of the storm would be required in order to produce better results for this.

### *4.2 Rainfall depth*

The total depth of rain generally gives a good measure of the pattern of the storm and the variation of rainfall across the catchment. Individual raingauges which recorded no rainfall or very small volumes of rainfall were ignored if adjacent raingauges showed large volumes of rainfall.

For the prevailing storms approaching from the south-west (pattern 1) there tends to be a larger volume of rain in the south-west of the catchment.

Storms of pattern 2 tend to have more spatial variation in the volume of rainfall than pattern 1 storms.

#### 4.2.1 Peak intensity

The peak intensity generally shows a similar pattern to the total depth of rain in the storm. However for some of the storms with low average intensity there is insufficient variation between gauges to show any significant pattern.

#### 4.2.2 Time of peak

The analysis of the time of the peak hourly rainfall volume does show useful patterns which reflect the movement of the rainfall front across the catchment. However for multi-peaked storms the results can be very confusing as different peaks may be identified as the largest at different gauges.

Storms of pattern 1 generally show a movement across the catchment from south west to north east with a travel time of between 1 and 4 hours.

Storms of pattern 2 tend to show a larger variation in time of peak rainfall but with no clear direction of movement.