Background
The supply of drinking water in the required quality and quantity depends largely on a sure water treatment at Water Treatment Works (WTWs). United Utilities (UU) faces considerable challenges in ensuring that WTWs operate effectively and efficiently. Reliable and accurate sensor data from WTWs, can be beneficially used for the rapid detection and diagnosis of abnormal WTWs’ process conditions.

Aim
To develop and test a new technology for real-time sensor data validation and predictive recognition of failure events including precursor features of sensors and/or processes events.

Work done on the development of the new ERS
1) Collection, verification and analysis of historical sensor data for a selected UU WTWs (Figure 1);
2) Identification and analyses of major (i.e. cases of complete shutdown) and minor events in the past 5 years;
3) Review of UU’s existing alarm system (based on alarms on single signals) and evaluation of its performance;
4) Identification of correlations/relationships across multiple signals and seeking out leading indicators, e.g. raw water quality (Figure 2);
5) Development of methods to detect faulty sensor data and to verify how/when the data can be trusted;
6) Development of a sensor data pre-processing method to remove of unusual spikes (Figure 3);
7) Development of preliminary detection methods and their initial testing;

Results
Evaluation of the current event detection system showed that it has moderate true detection ability and suffers from a high rate of false alarms. The modified detection system (Figure 4) is based on statistical process control charts and uses cumulative sums of deviations to detect small shifts in the mean of a process. It showed the best performance of all tested methods with a significant increase of true detections and a minor decrease of false alarms compared to the corresponding detection rates of UU’s current used system (Table 1).

Future Work Plan
The focus is set on a further reduction of false alarms using more complex detection rules and/or signal combinations.

Table 1: Detection Rates Existing - New System

<table>
<thead>
<tr>
<th></th>
<th>Major Events</th>
<th>Minor Events</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>True Positive Rate</td>
<td>False Positive Rate</td>
</tr>
<tr>
<td>Existing System (Validation period)</td>
<td>97%</td>
<td>19%</td>
</tr>
<tr>
<td>New System (Validation period)</td>
<td>99%</td>
<td>89%</td>
</tr>
</tbody>
</table>