Memorandum

Mott MacDonald

To	From	Our reference
Gary Pearson	Adam Grove	306857\Reports
Office	**Date**	**Your Reference**
Cambridge	08/07/13	

Subject Deterioration Model Report Statistical Report

A statistical review of the *Review of Mains Deterioration Models v2.0* has been undertaken by Mott MacDonald at the request of South Staffordshire Water (SSW), the following is a summary of the main points of feedback (feedback was also given over the phone on 05/07/13).

Summary of Approach:

- The Water Statistics User Groups (WSUG) *Good Practice Guide* to statistical analysis approaches has been followed.
- Initial data analysis has identified the pipes of greatest significance; further analysis has focused on these pipes with simpler approaches used and data aggregated for less significant pipes.
- Regression models of varying forms (linear, exponential, logarithms etc.) based on best fit to the data have been created. The regression has been done through SPSS (please note, the statistical modelling has not been reviewed only the approach and results/outputs of the modelling).
- In a few instances an average burst rate has been used due to lack of data, this is the best approach in these instances and will have little impact on the final use of the models as they represent a small percentage of the network.
- 3 Assumed models have been created for MDPE and HPPE for future deterioration as both currently show an improving failure rate (perhaps the initial downward trend of a bathtub curve) and there is no data on the deterioration phase of these pipes. A conservative rate of deterioration has been assumed. Again this will make little impact on modelling as these pipes are unlikely to be replaced in the near future as they are newer and more reliable.
- The number of models/cohorts of pipes has been derived statistically (using SPSS) and with engineering judgement.
- The deterioration models are then used in an investment tool to predict the effect different renewal strategies will have on the future burst rate. The deterioration modelling and investment tool accomplish SSWs initial aim of deriving new models and linking top-down and bottom-up analysis.
- This is a good first step for in-house data derived deterioration models for SSW.

Feedback:

- Though the work has been done it is not always obvious why one regression curve has been selected over another, all curves could be documented with a statement on why a particular curve has been selected (and where relevant others rejected).

- Where (AC and steel) age has been used as a factor to sub-divide into different deterioration models judgment should be made to if this is due to age (e.g. from a step change in deterioration such as a bathtub curve) of install year (e.g. from different installation methods or material specification).

- No section on the analysis for the 'other' steel model (model 14 in section 6.3) has been included.

- A sense check / engineering judgment check should be used at the least to validate the curves. For example, are the pipes that are expected to burst most doing so? It is predicated that in general there is not enough data for some data to be set apart for validation, though this could potentially be done for some CI models.

- Some curves will go below zero (a negative burst rate is impossible) these need to be explained (i.e. not applicable time frame when negative) or another curve created for this time period.

- Some curves show an improving trend for at least some of the time period covered, these need to be explained. It could be the initial phase of a bathtub curve, or in a time period that is no longer applicable (i.e. it is for ages that cannot occur again for that material).

- Where different curves have been created for a material these could be compared against a single curve for the material to see if the extra complexity improves the burst prediction, i.e. is creating new sub-cohorts justified.

- No analysis of variability/uncertainty in the modelled burst rate has been undertaken, I believe this is not necessary at present for SSWs initial goals and how the models are to be used but this should be the next step of analysis. In many models there is a large range of uncertainty around the fitted curve.

- Related to the above point GLM models using different probability distributions may better fit the data as well as model uncertainty, this is a more complex approach that should be explored in the future but the current approach is a very good first step.

- Models should be reviewed at regular intervals as new data becomes available especially for HPPE and MDPE as the future deterioration of these assets is unknown and is becoming an increasing large percentage of the asset stock as HPPE is the new standard material.

- The 'yes' and 'no' for the 'Would scheme now exceed max length?' diamond on page 89 should to be swapped.