Updating Critical Sewers

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- The need for change
- The OCC methodology
- Cost element examples
- Case study
- Next steps

Critical Sewers

- National Collapse Reporting Study (Pet
  1982) found skew distribution between
  collapse occurrence and cost
- 10% of incidents account for 80% of co
- Make savings if these expensive failure
  can be prevented, achieved by categori
  - Category A sewers - failure is most expens
  - Category B sewers - Intermediate costs
  - Category C sewers – failure is relatively ch

Characteristics of Critical Sewers

- Above average depth
- Bad ground and/or high water table
- Brick or stone construction
- Man entry size
- Close proximity to buildings or major underground services

Theory

- Ratio of:
  - ⇨ Cost of collapse to Cost of rehabilitation
- Three categories:
  - ⇨ **Category A** - most critical (proactive rehabilitati be applied)
  - ⇨ **Category B** - less critical (some proactive rehabilitation - lower priority)
  - ⇨ **Category C** - not critical (reactive maintenance assumed)

Method

- Screening
- Separate models
  - repair cost factor
  - overall cost factor
- Factors based largely on:
  - asset data (depth, diameter, material)
  - ground conditions
  - traffic

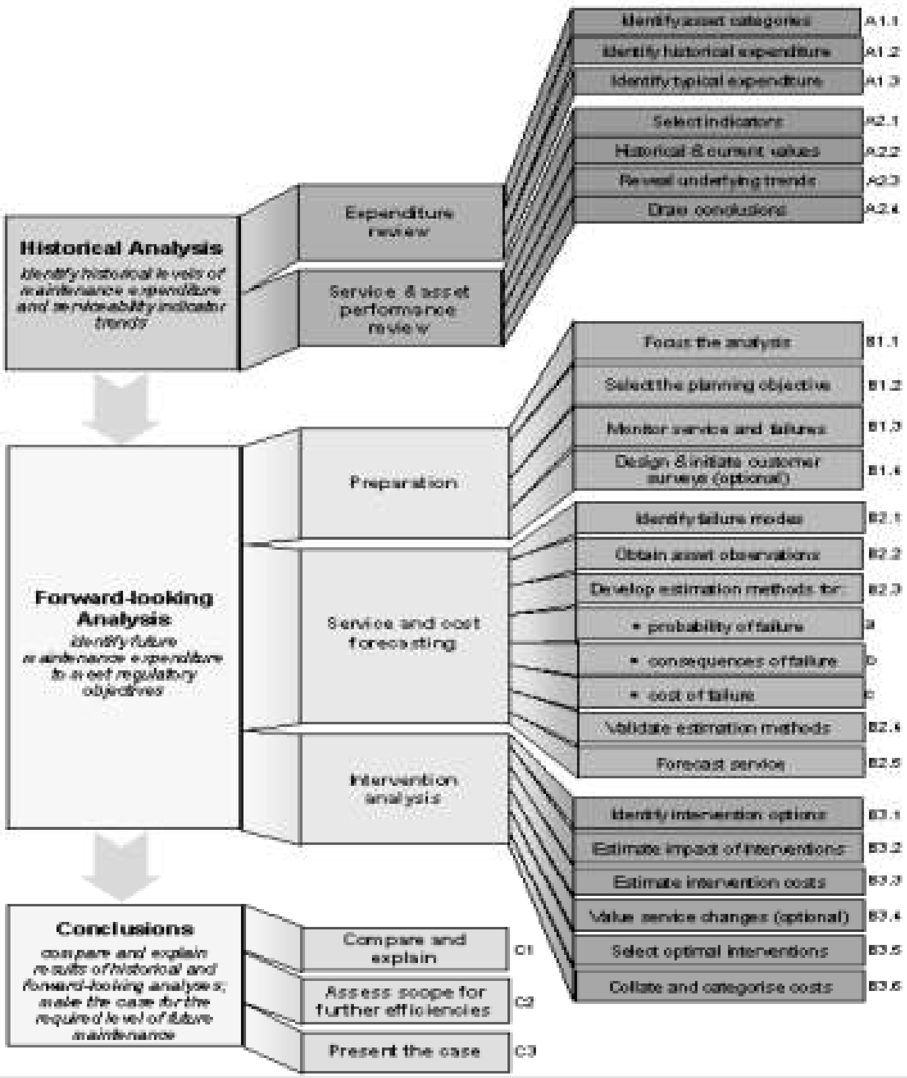
Screening - Category A (1)

- Brick sewers > 2m deep
- Pipe sewers > 6m deep (5m in bad ground)
- Combined sewers >1500mm diameter (foul >600mm)
- Designated streets under NRSWA 1991:
  - ⇨ protected streets
  - ⇨ traffic sensitive streets without a adequate diver
  - ⇨ Other heavily trafficked routes (calculation requi

How the criticality grade is used

- SRM currently uses criticality as a mea
of cost and benefit of pre-emptive work
- Criticality grade informs survey needs
- Criticality grade combined with conditic
information to determine structural risk
- Sewer rehabilitated according to risk

Risk based approach now needs to be refined in light of CMPCF



- Need to streng
consequence
cost forecastin
- Need to suppo
whole of life co
benefit analysi
- Need to quant
range of cost a
benefit param

Updating Critical Sewers in SRM

- **Critical sewers:**
  - Largely rule based – cost consequence
  - CMPCF – risk of failure of levels of service to cus
    and environment
- **Revisit definition of critical sewers to incl**
  - Sewers where failure impacts on serviceability wi
    direct cost consequence
- **Link criticality to any consequence:**
  - Cost impacts (direct, indirect)
  - Benefit impacts (service delivery)

Managing the Risk of Critic
Sewers

The Overall Cost of
Consequence Methodolog

Introduction

- Overall Cost of Consequence (OCC) method is a means by which criticality of a pipeline ca quantified
  - The *criticality* of a pipeline is defined by the conse of it failing
- Consequence expressed in terms of cost, eitl
  - Water / sewerage company
  - Their customers
  - To society at large
- The OCC Methodology is intended as a means of a management based on assessing criticality, regardle size, material etc

Summary of the OCC methodology

- Basic premise is the determination of a value for each cost element, then summation of these values
- Not all cost elements will be applicable screening rules
- Likelihood that a particular consequenc occur should there be a failure event

The CP220 Cost Elements

Cost Element	Description
Repair of potential failure	Direct costs associated with the repair pipeline.
Environmental Damage – Clean up of pollution	Pipeline failure events that result in po requires a subsequent clean up operat
Environmental damage – prosecution fines	Costs associated with a successful pro following pollution resulting from a failu
Flood Damage to Properties	Tangible costs associated with flood da the fabric and content of buildings.
Traffic Disruption	The extent of vehicle traffic disruption r from a failure event.

Cost Elements (Cont.)

Cost Element	Description
Transport of sewage from a pumping station as a result of a rising main failure	The cost of hiring tankers to transport s from a pumping station to a suitable dis point.
Personal injury	Personal injury resulting from a failure i including fatalities and injury.
Interruption to supply	Cost to the water/ sewerage company b that is associated with reputation dama by provision of a poor service, or loss c
Provision of alternative water supplies	Costs associated with providing an alte water supply during prolonged periods interruption.
Guaranteed Standards of Service (GSS) Payments	Cost of payments made under the GSS

Steps to Determine OCC value

1. Determine unit of pipeline
2. Data collection for screening
3. Apply screening rules
4. Further prioritised data collection
5. Calculate monetary value for each cos
   element
6. Sum the value for all appropriate cost
   elements

Typical information required

Information
Diameter
Depth
Material
Pipe Pressure
Ground Type
Sewer Type
Soil Type
Terrain

Information
Daily Traffic Flow
Under a Carriageway?
Number of Properties Affected
Commercial / Industrial Premises
Parks / Open Spaces
Gardens
Watercourses
Length of Interruption

The cost of traffic delays

Example 1

How do you value delays?

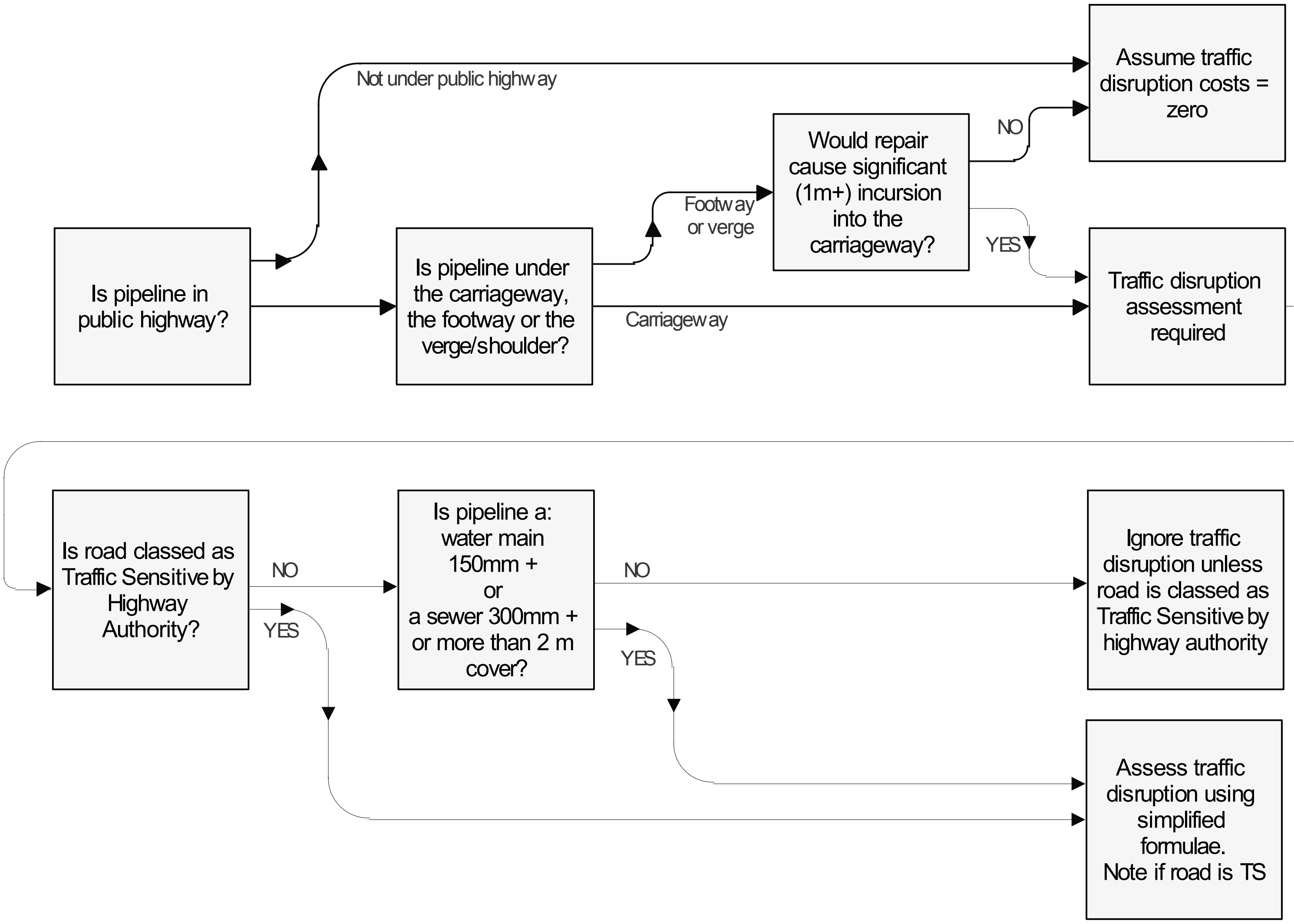
- Dept for Transport methodology
- Based on long history of past work
- A well established process & values
- Some have questioned its use in this co
- No currently agreed alternative.
- Likely to be acceptable to Govt & OFW

How do you predict delays?

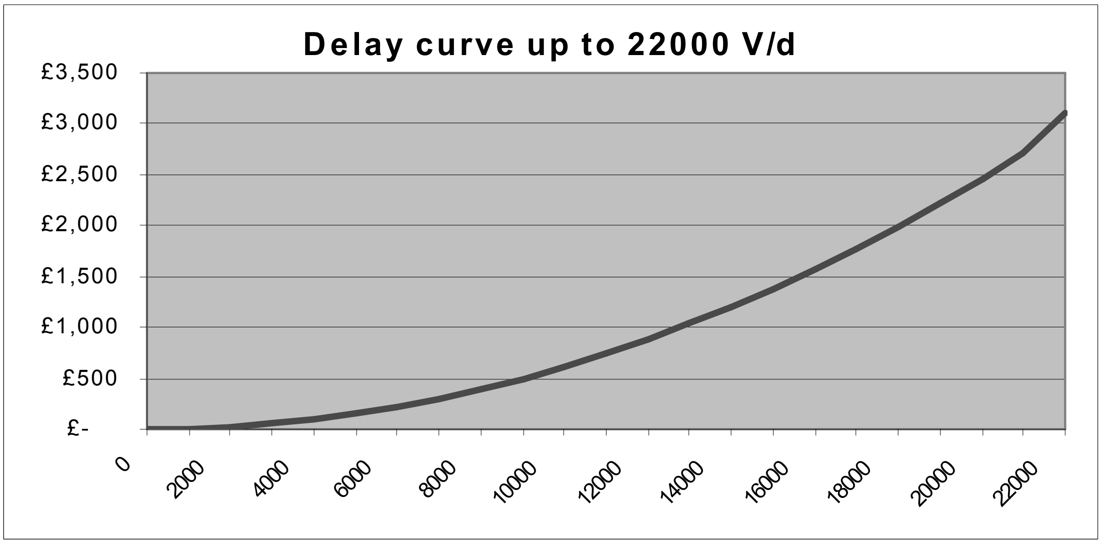
Three approaches

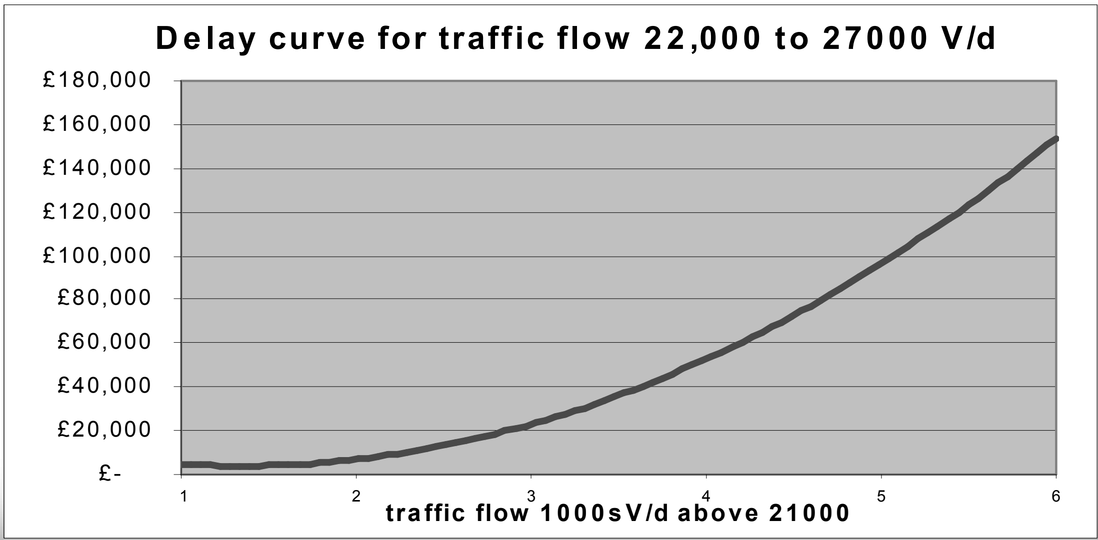
- Traffic volume x best guess at delay
- Hourly traffic volumes in localised delay model
- Quarter hourly traffic volumes in full hig network model

Screening process….



Model is very volume sensitive!





Conclusions….

- The simplified models offer the best immediate compromise;
  - Simple to use
  - Data is readily available
  - Tends to under estimate costs in town cen
- Further work with highway network mod needed provide a better long term solut

end

Personal Injury

Example 1

Scope of cost element

- Cost element relates to personal inj
resulting directly from a failure event….
- …from, for example;
  - a sewer collapse or blockage
  - a bursting water main or rising main
- Anticipated that the greatest consequer
of personal injury would occur
locations under a carriageway or spec
location

Personal injury costs

- Annual figures are published for the total valu prevention of road casualties and road accide in Great Britain (Department for Transport, 2(

Injury Severity	£ per incident (June
Fatal	1,312,260
Serious	147,460
Slight	11,370
Average, all casualties	42,850

Personal injury costs (continued)

- These figures are cost-benefit values
- Represent the benefits which would be obtained by prevention of road accident they include:
  - Loss of output due to injury
  - Ambulance and hospital treatment costs
  - Human costs, based on Willingness To Pa (WTP) values

Is personal injury likely ?

- Personal injury costs are very high
- Could potentially 'swamp' the other cost element values
- Introduced a variable (E_o) for each 'pers injury' outcome ('slight', 'serious', 'fatal')
- Represents the probability that, onc failure event has occurred, then pers injury will result

Example: 'Low consequence' rising main

Consequence grade personal injury	Type and location of rising main	Probability of injury arising f failure event, Eo (%)		
		Slight injury	Serious injury	F
2	< 300 mm diameter, normal pressure, erodable soil	0.07	0.01	

So personal injury consequential cost:
(£11,370 x 0.0007) + (£147,460 x 0.0001) +
(£1,312,260 x 0.0) = £22.71*

* This can be factored by likelihood of people being in
of event

Rising main consequential factors

- Factors which influence the severity of a
  rising mains failure event include:
  - Diameter of rising main (>=300 / <300 mm
  - Pumping pressure (>1 bar / <=1 bar)
  - Surface type (carriageway / non-carriagew
  - Soil type (erodable / non-erodable)
  - Cover depth (<=1.2 m / >1.2 m)
  - Special locations (e.g. hospital, basement,

Summary for personal injury

- Personal injury from asset failure is expected a rare occurrence
- Always include this cost element in the OCC to it's sensitive nature
- Have introduced a term E_o which represents t probability that should a failure event occur th personal injury will result
- Incorporating E_o stops the personal injury consequential cost from 'swamping' the other element values
- Personal injury cost models developed for risi mains, sewers and water mains

Application of the OCC

Introduction

- Cost models developed for OCC were applie
limited number of case studies (pipelines)
- Objectives:
  - To demonstrate how effectively they could be app
  - Assess the data requirements of each cost model
  - Preliminary assessment of the relative importance each cost element.

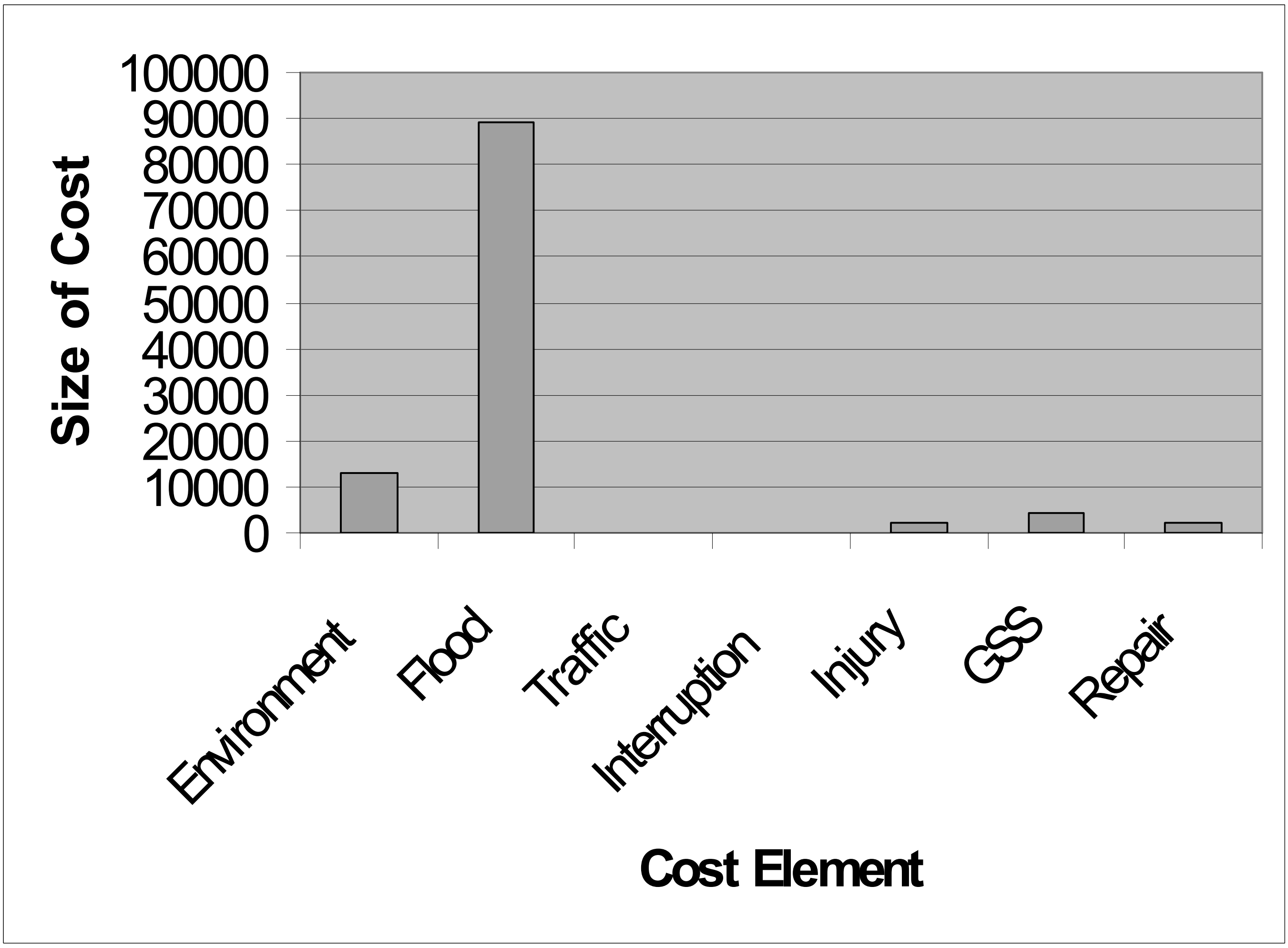
Cost Elements Applied

- Repair costs
- Environmental damage
- Flood damage to properties
- Traffic disruption
- Personal injury
- Interruptions to supply
- GSS payments (sewer flooding event)

Input data

- Physical properties from asset register
- Reasonable estimates for environmenta data, based on local knowledge
- Traffic information supplied by local bor council in 2003

Sewer, large town



Conclusions from case studies

- Main cost of consequence was 'flood damage to properties'
- 'Environmental damage' and 'GSS payments' were the other main contrib

Conclusions (cont.)

- Environmental damage' and 'GSS payments' would l significant if small watercourses, parks and open are present, or if there are a large number of properties i vicinity of the failure event
- The costs of consequence for 'traffic disruption' were minimal as the levels of traffic were below 22,000 ve day. A rise of only 2,000 vehs / day in the large town see this cost increase from £615 to over £700,000
- The cost elements that appear most critical are: **'pot flood damage to properties'**, **'personal injury'** anc **'traffic disruption'** (but only if the daily traffic flow is greater than 22,000)

Critical Appraisal of Case Study

- The sensitivity of the OCC methodology means that could be dominated by one or two cost elements, su ‘personal injury’ or ‘flood damages’
- ‘Personal injury’ is an unlikely outcome, and therefor attempt to include probability of consequence has be included in the model. However, this is not calibrate the current model tends to highlight the ‘potential’ to injury
- The effect of ‘traffic disruption’ takes much greater e when the daily traffic flow reaches 22,000.
- The current flood model needs to be strengthened. A LIDAR method has now been identified

Recommendations

- Further testing of Cost Models and OCC
- Calibrate the models to ensure the right pipelines are classed as critical
- Further investigation of repair costs be undertaken to improve the robustness of the model
- Develop the 'flood damage' and 'injury elements' to t into account (more fully) the probability that once a fa event has occurred the damage will occur
- Incorporate the use of specific tools such as GIS to a in the application of OCC
- Incorporation of failure probability and development t ensure Common Framework compatibility