BUILDING A WORLD OF DIFFERENCE

The Modeller I want to be?

Challenges facing the urban drainage modelling community

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Malaysian Hydroligical Society

JPS AMPANG 18th September 2012

BLACK & VEATCH
Building a world of difference.

By way of introduction - The things I say everyday

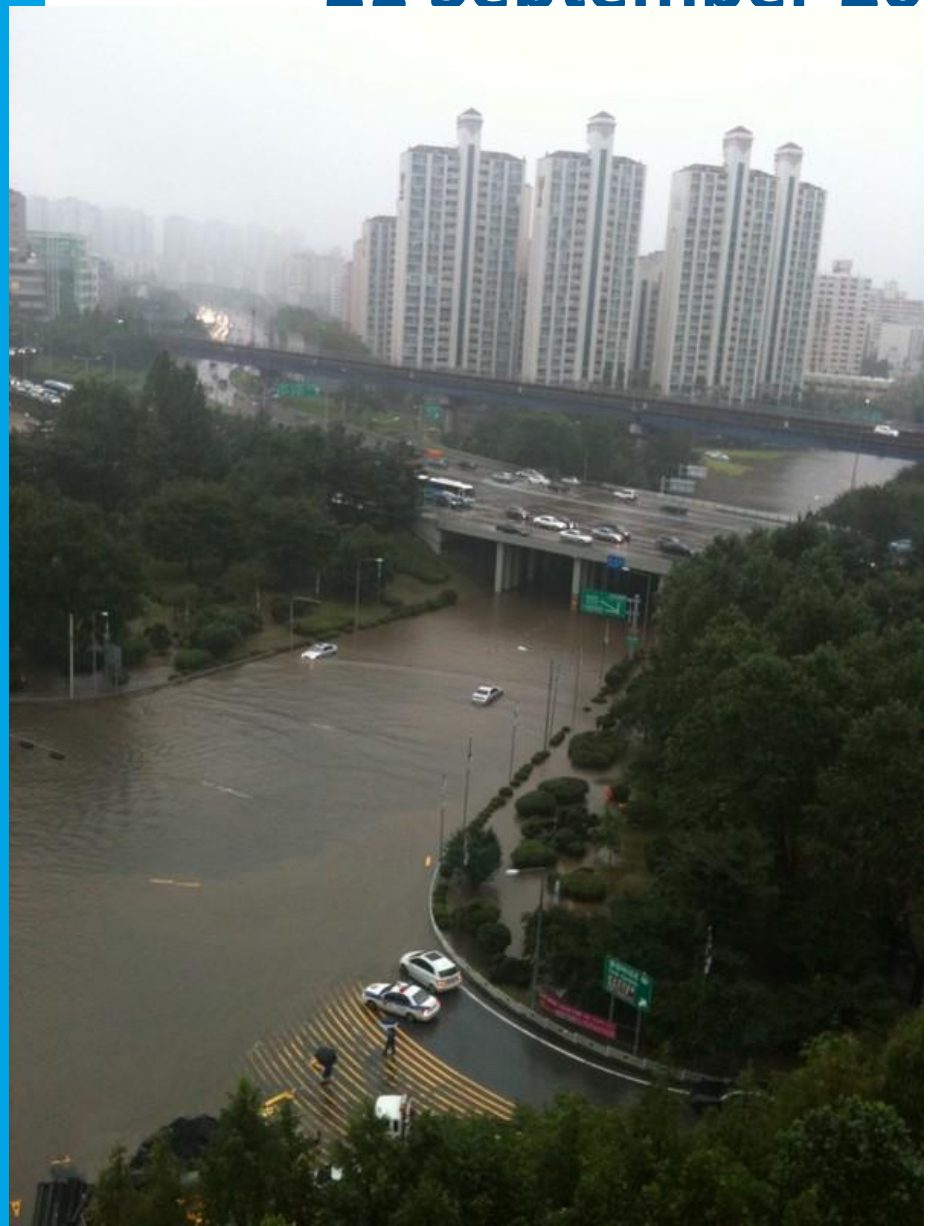
- "All models are wrong … some models are useful" (Semua model salah, tetapi ada yang boled diguna)
- There are no problems only opportunities (Tak ada masalah, semua boleh!)
- Do you know what you need or do you want me to tell you what you need? (Kamu nak saya menulis TOR tak?)
- Let me get back to you… (Tungu sekejap, saya akan datang balik!)
- How are you doing? (I'm really asking if you've gone overbudget, delivering late or not done the QA review) (Kamu baik tak? Cukup wang tak?)

2

UK - Tewksbury

21 September 2010 - Seoul

21 September 2010 - Seoul



Bangkok Flooding, July to Nov 2011, www.france24.com

400 dead, millions displaced,
Economic loss – affecting the region
(my new car is more expensive!)

Flooding In Kajang, KL, 3rd December 2011, www.thestar.com.my

Massive traffic jams, loss of millions

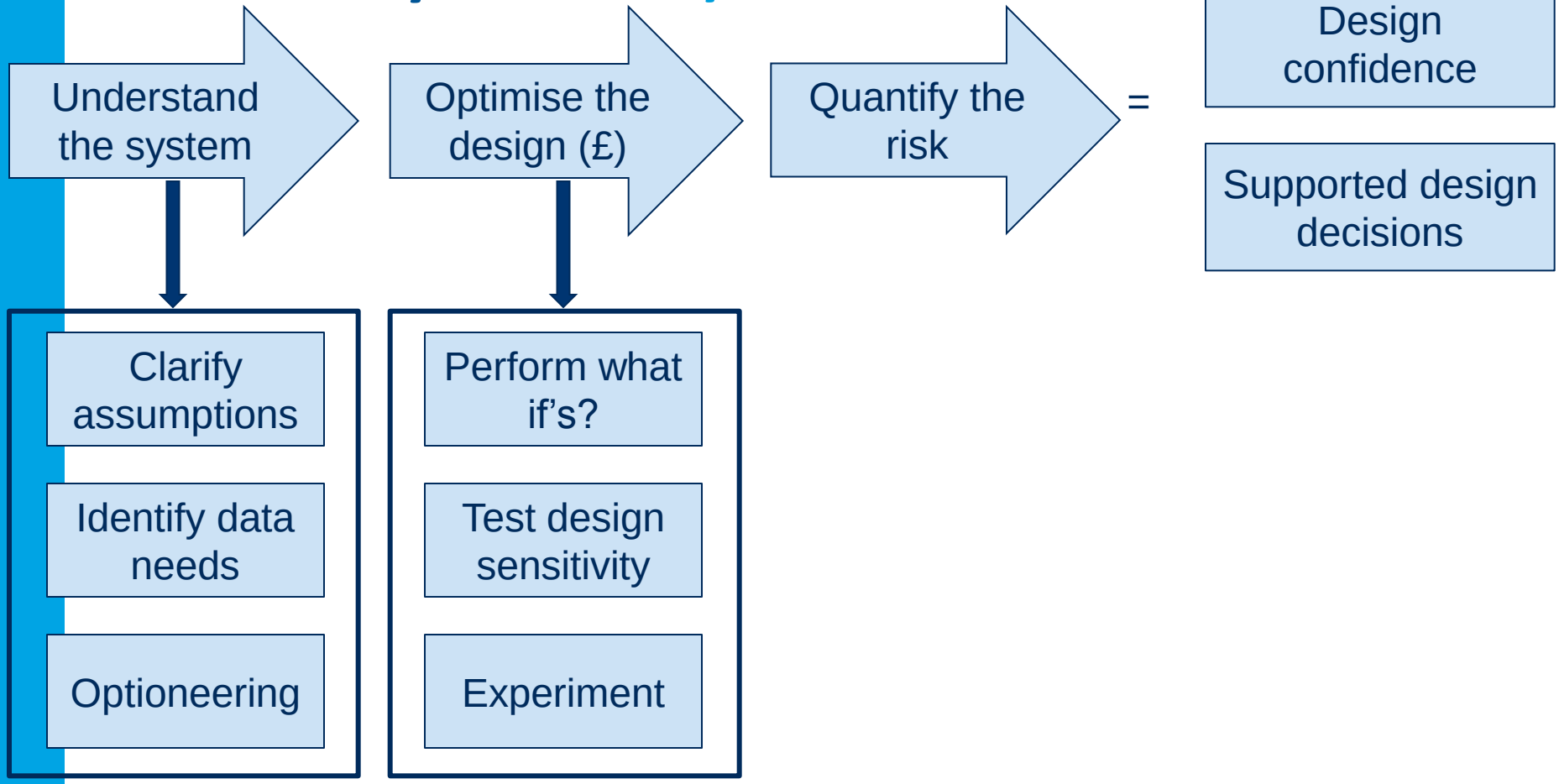
Singapore? Flooding June 2011, www.straitstimes.com

Tangin Mall

Bukit Timah Road

Why Model?

Why Model?



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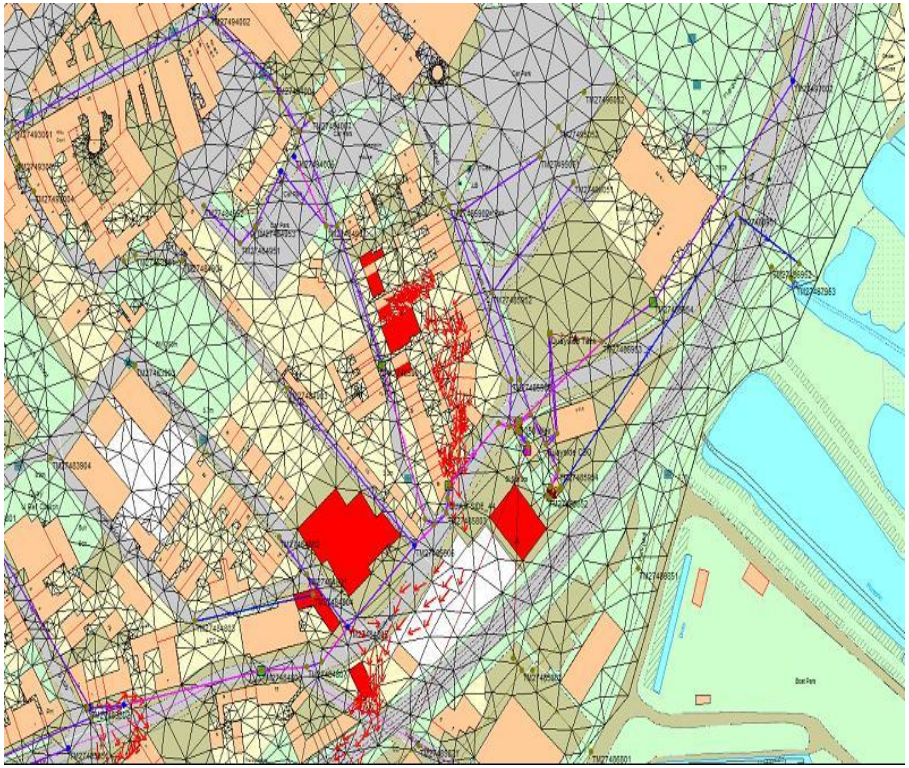
Network Modelling Capabilities (Flooding)

- Model building and verification
  - GIS
  - Data collection surveys
  - Verification
- Root cause analysis support
  - Understand mechanism
- 2D overland flood routing



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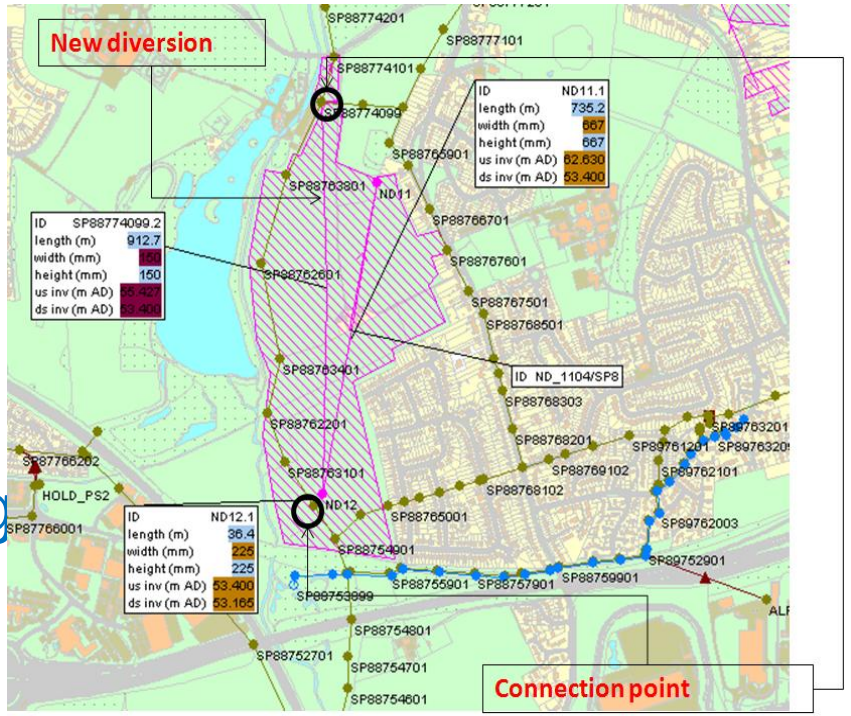
Network Modelling Capabilities (Development)

- Developer impact
- Water Cycle Study support
- Strategic studies
- River impact on system
- Integrated catchment modelling
- Flooding impact
- WQ impact



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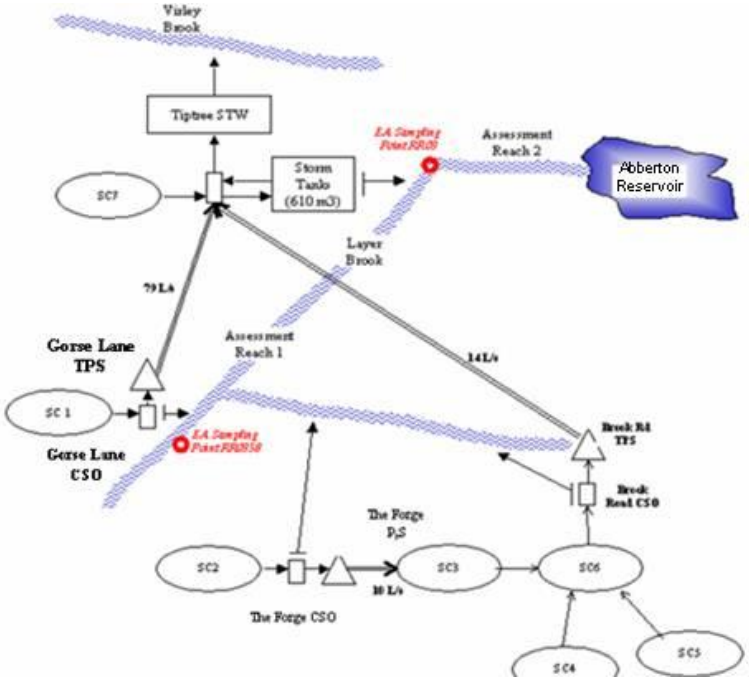
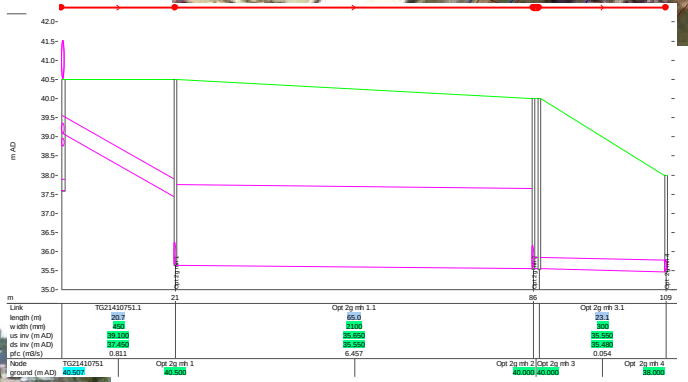
Network Modelling Capabilities (Environmental)

- CSO spill volume and frequency analysis
- Overflow Consenting – CSOs and STWs
- Urban Pollution Managements (UPMs) – Integrated modelling
- Treatment Plant refurbishments (Storm Tanks)
- Protection of Environment & maximising use of assets



Network Modelling Capabilities (Solution Development)

- Develop solutions (Engineers)
- No detriment approach
- Internal 1 in 30
- External 1 in 20
- Highway 1 in 10
- UPM -spill frequency



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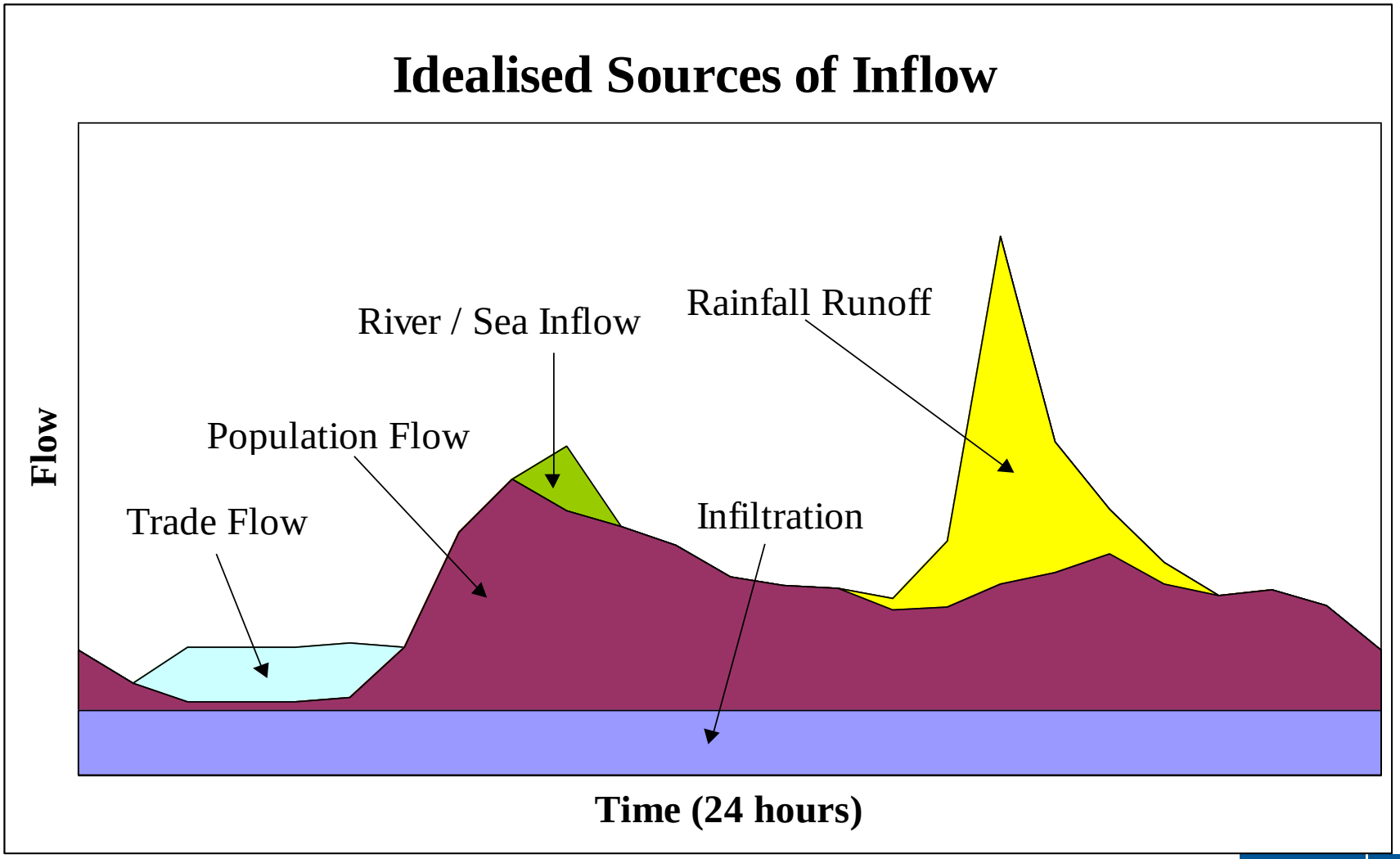
Software Used

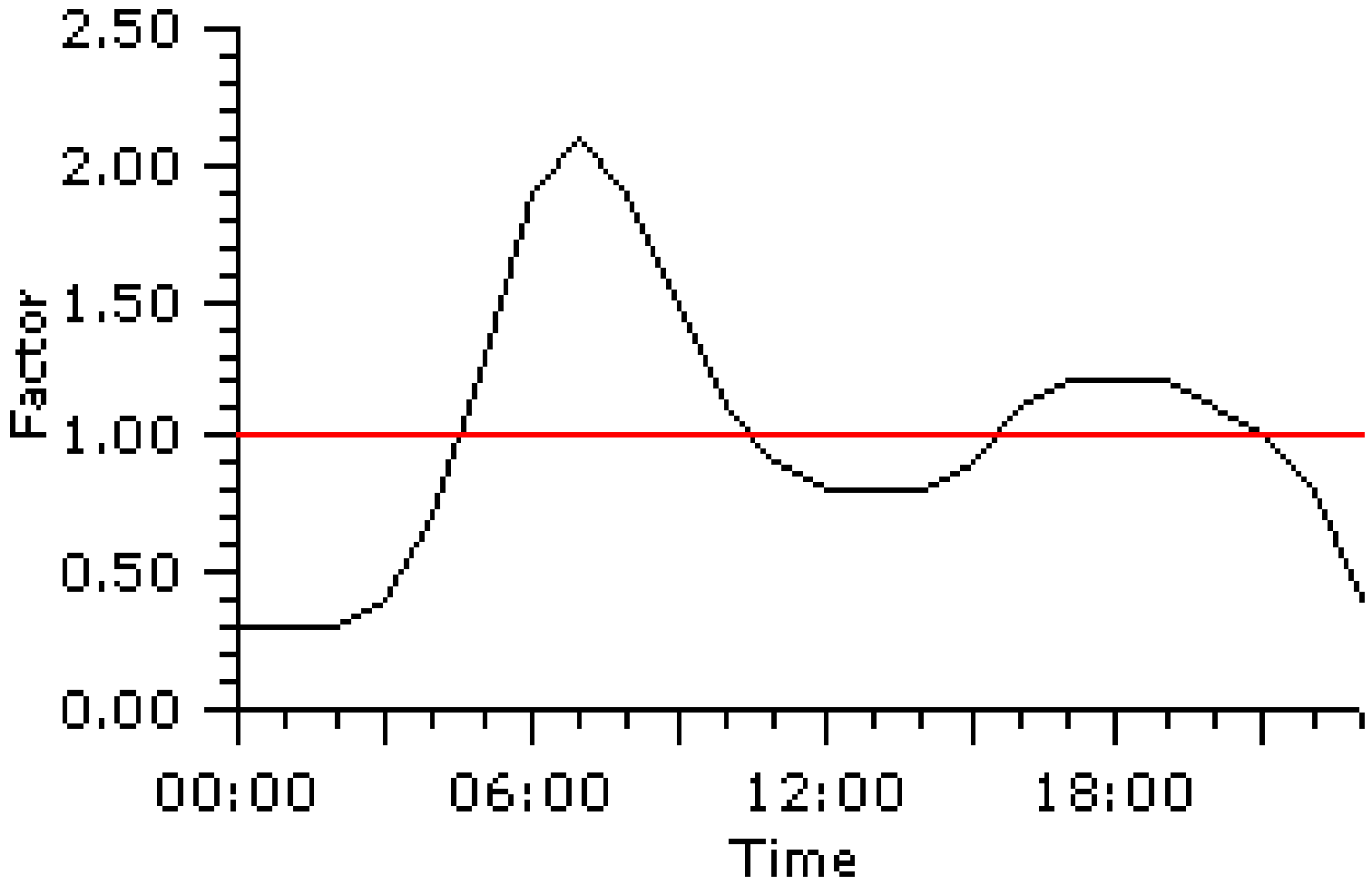
- Old days WASP, Walrus, SWMM, Hydroworks now it is Info works and the latest is ICM
- Within Info works- Infoworks CS, Infoworks RS
- In-house water quality - SIMCON
- GIS Info
- CAD

Surveys

What flows and how to model



Domestic - Waste Water Profile



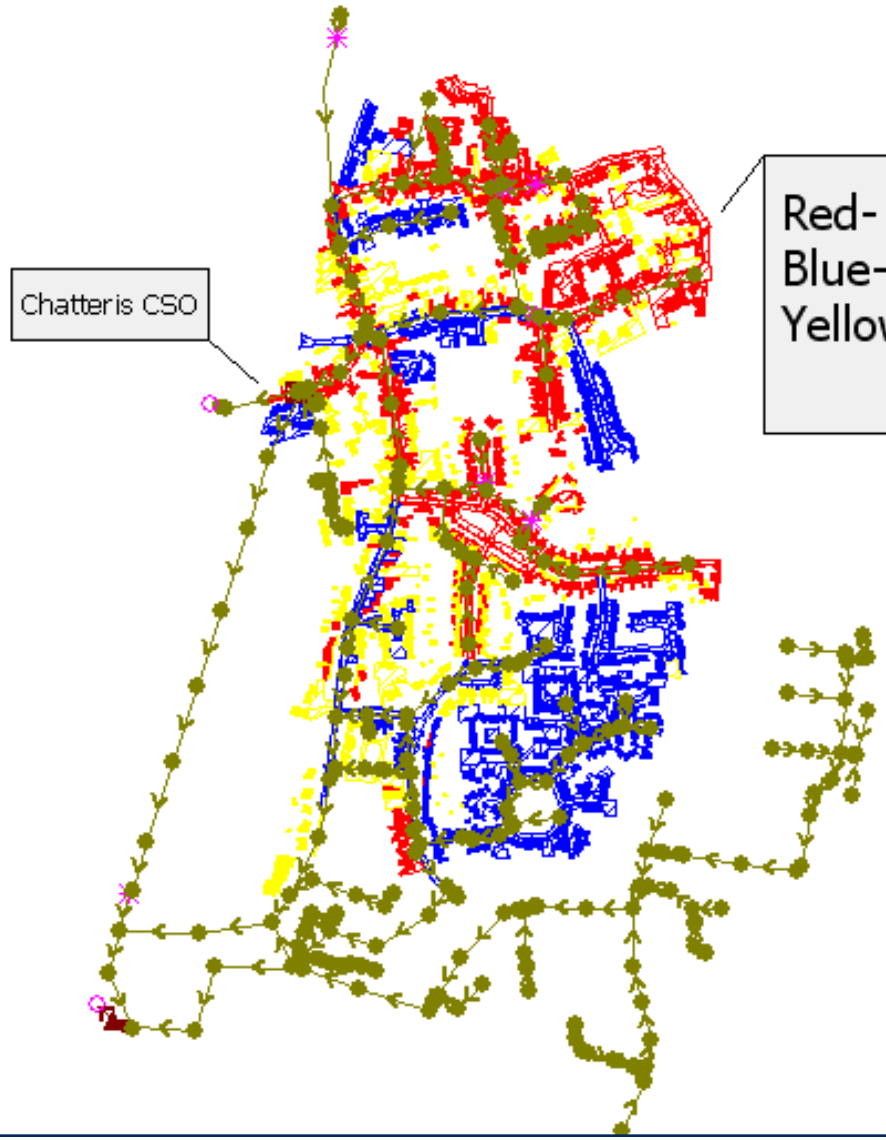
Rainfall

Impermeable
Fast Response
Minutes

Permeable
Slow Response
0 - 4 Hours

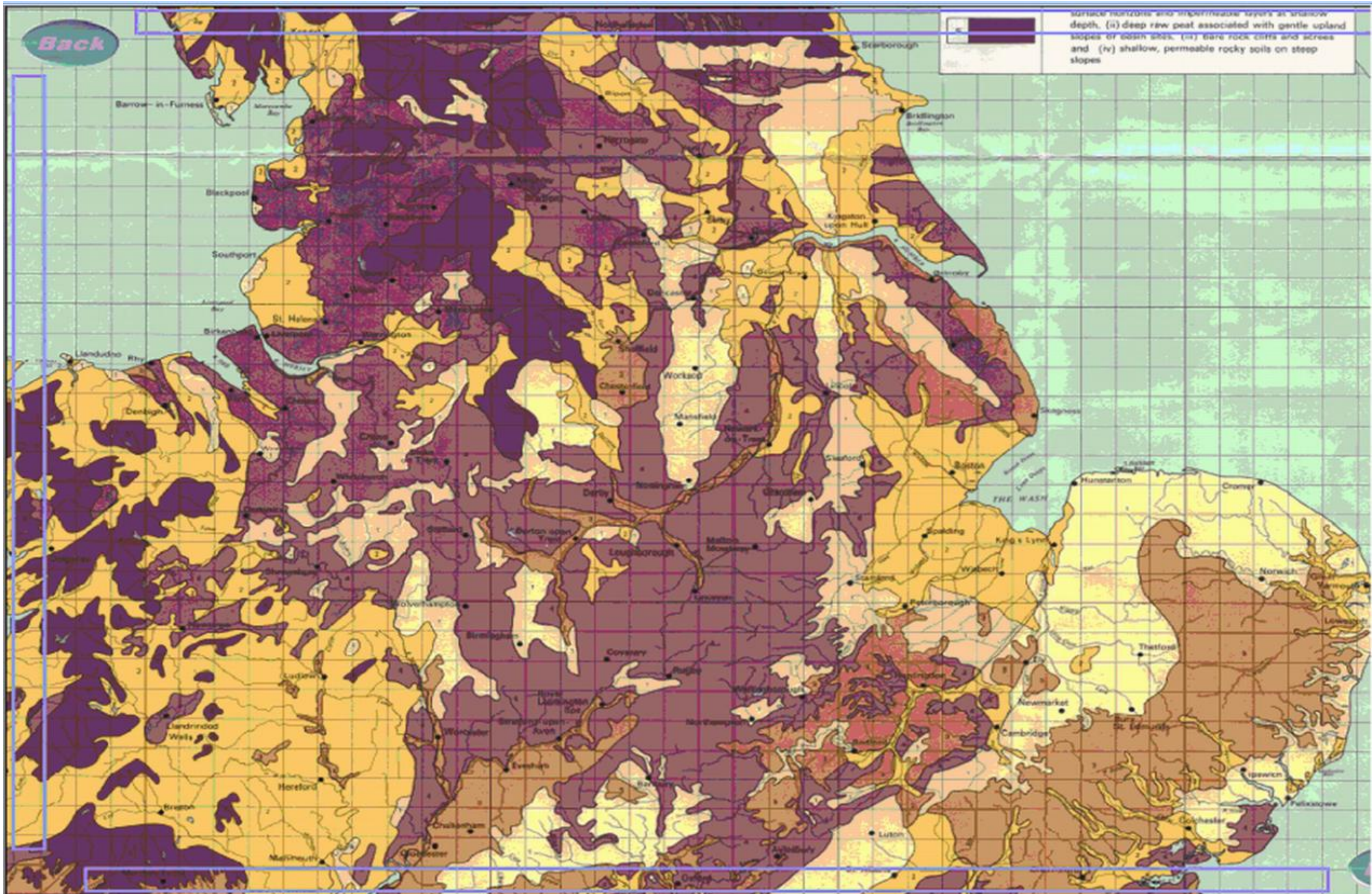
Rainfall Induced Infiltration and Groundwater Infiltration
Days - Weeks

Impermeable Area Survey

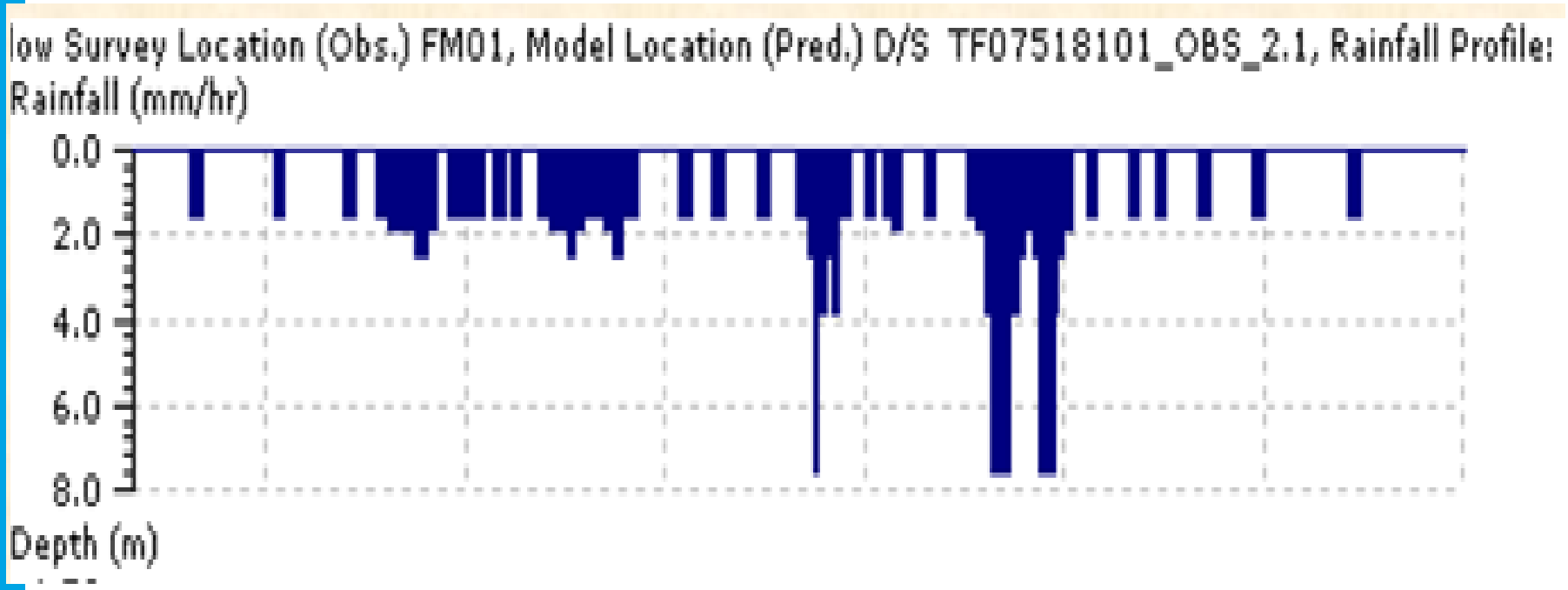


Red- Pitched roof to Foul
Blue- Pitched roof to Surface Water
Yellow-Pitched roof to Soakaway

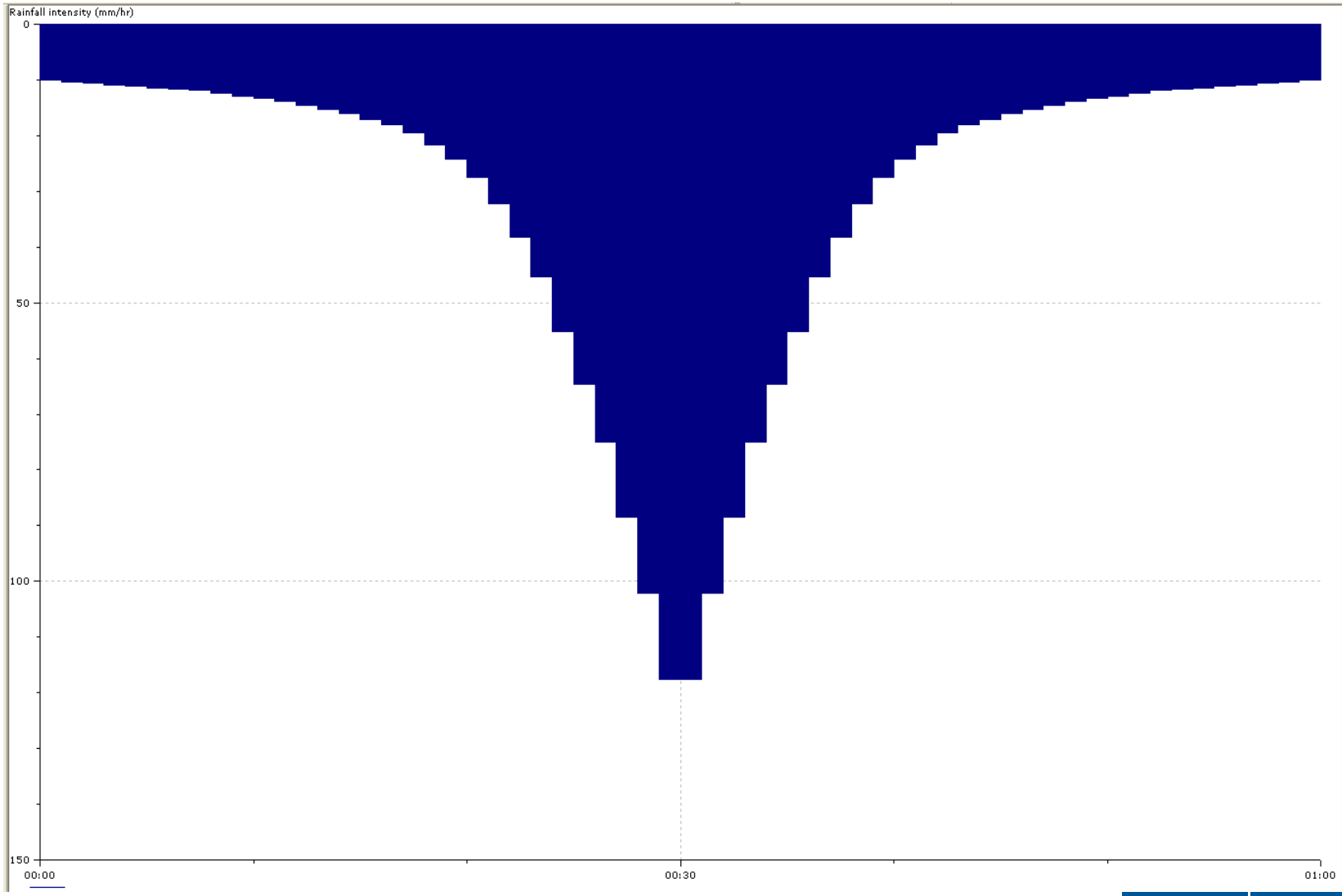
Soil type (WRAP) maps



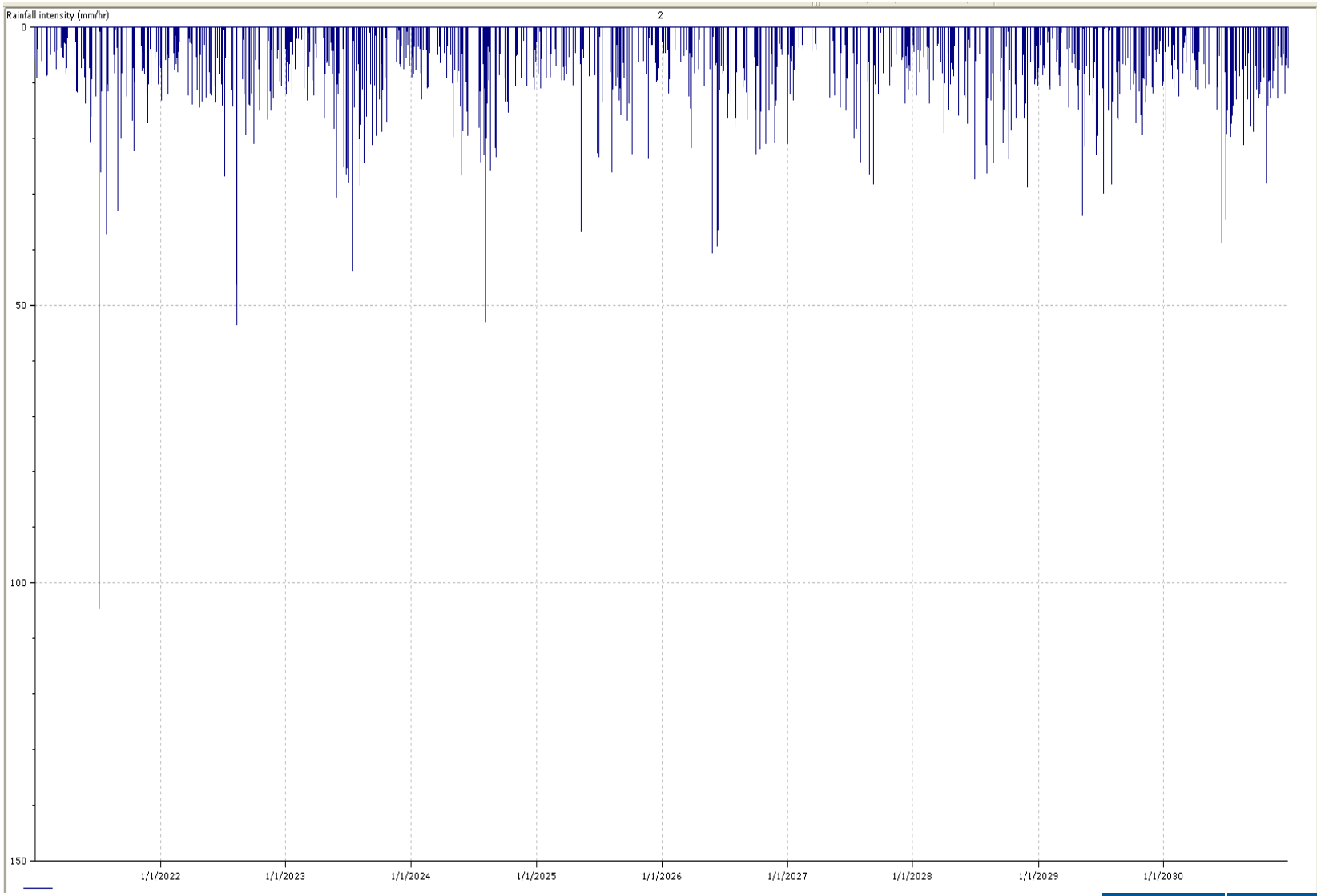
Observed Storm



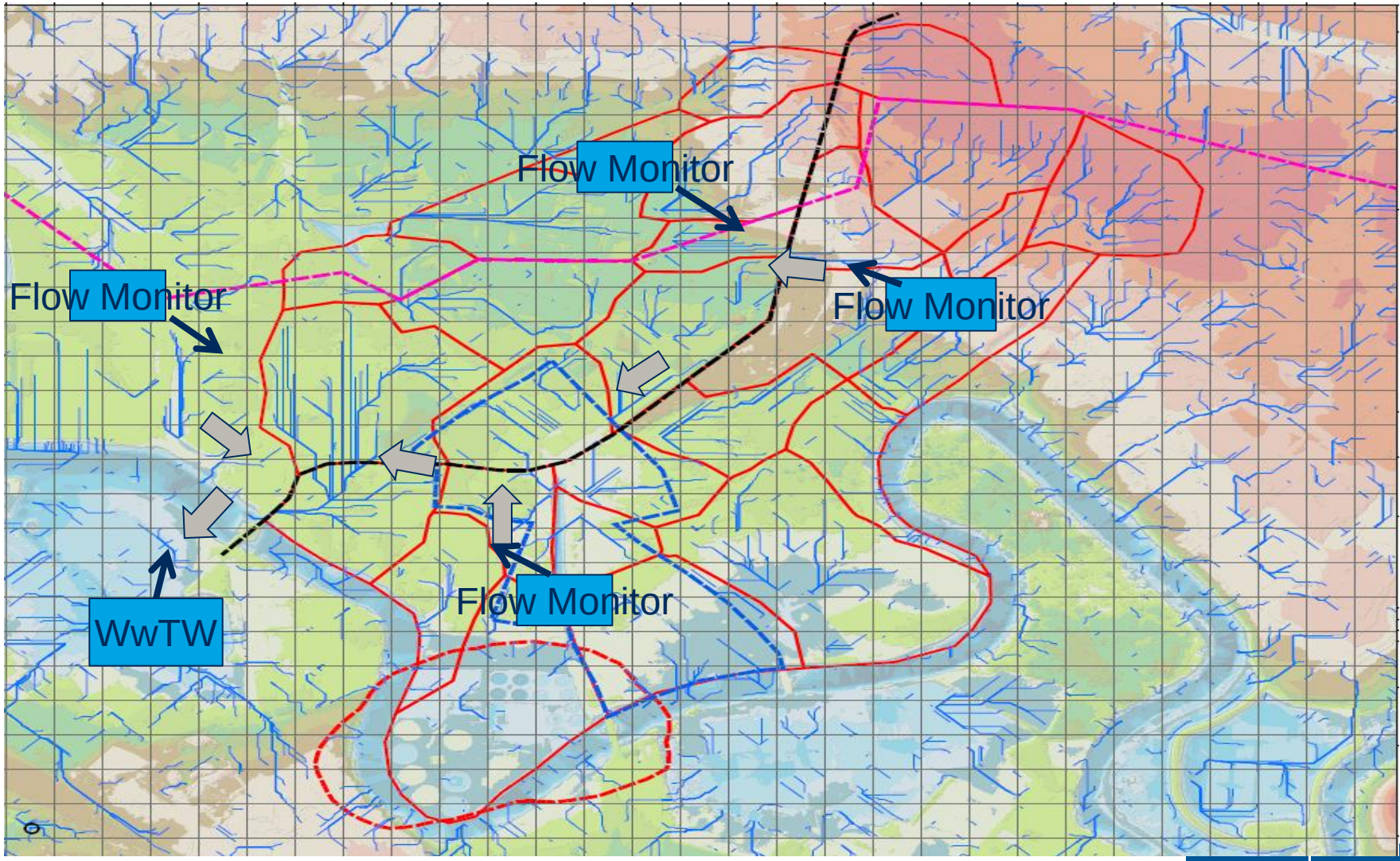
Design Rainfall 5-year 60mins



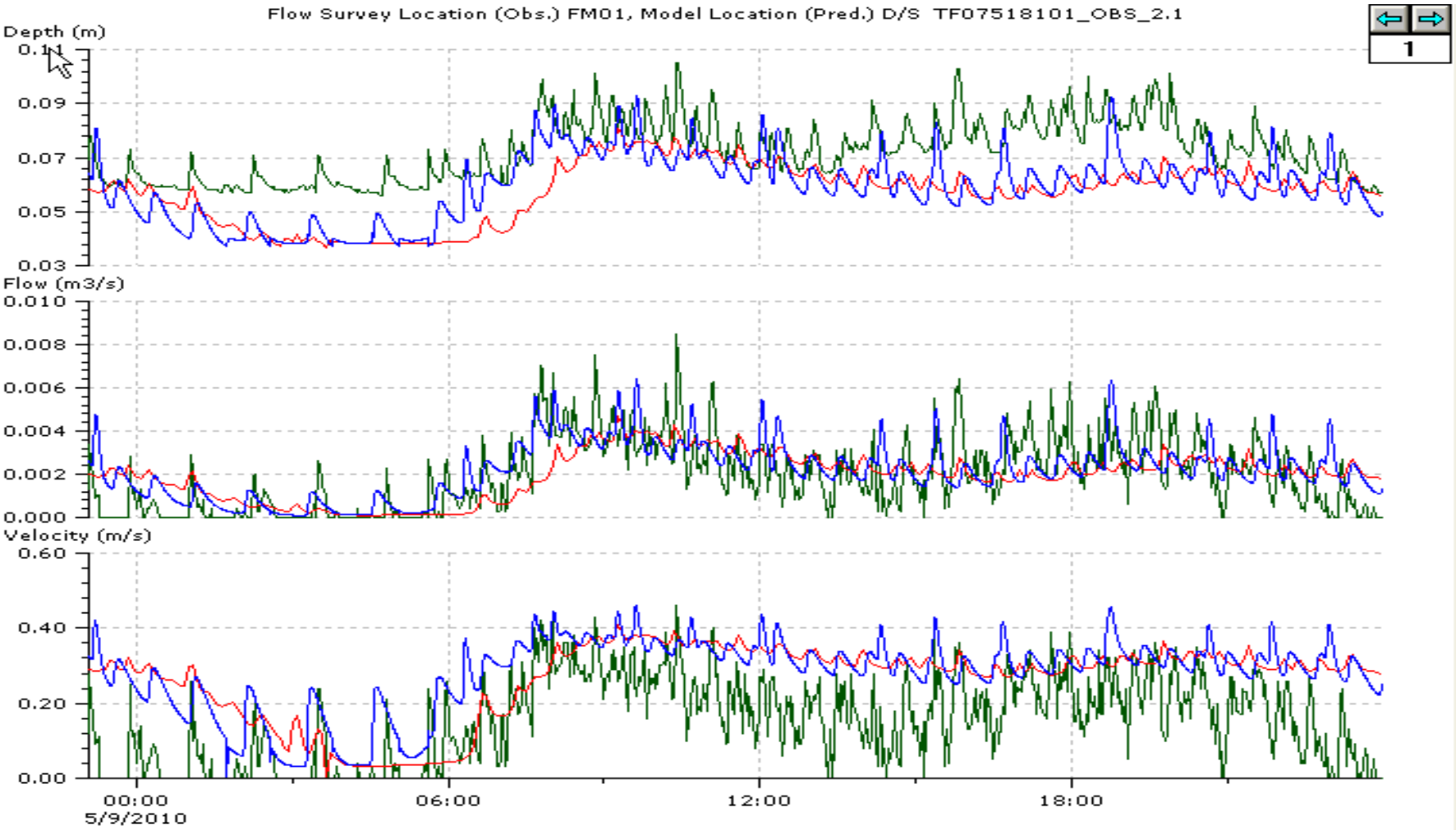
Time Series Rainfall



Short(?)-term Flow survey

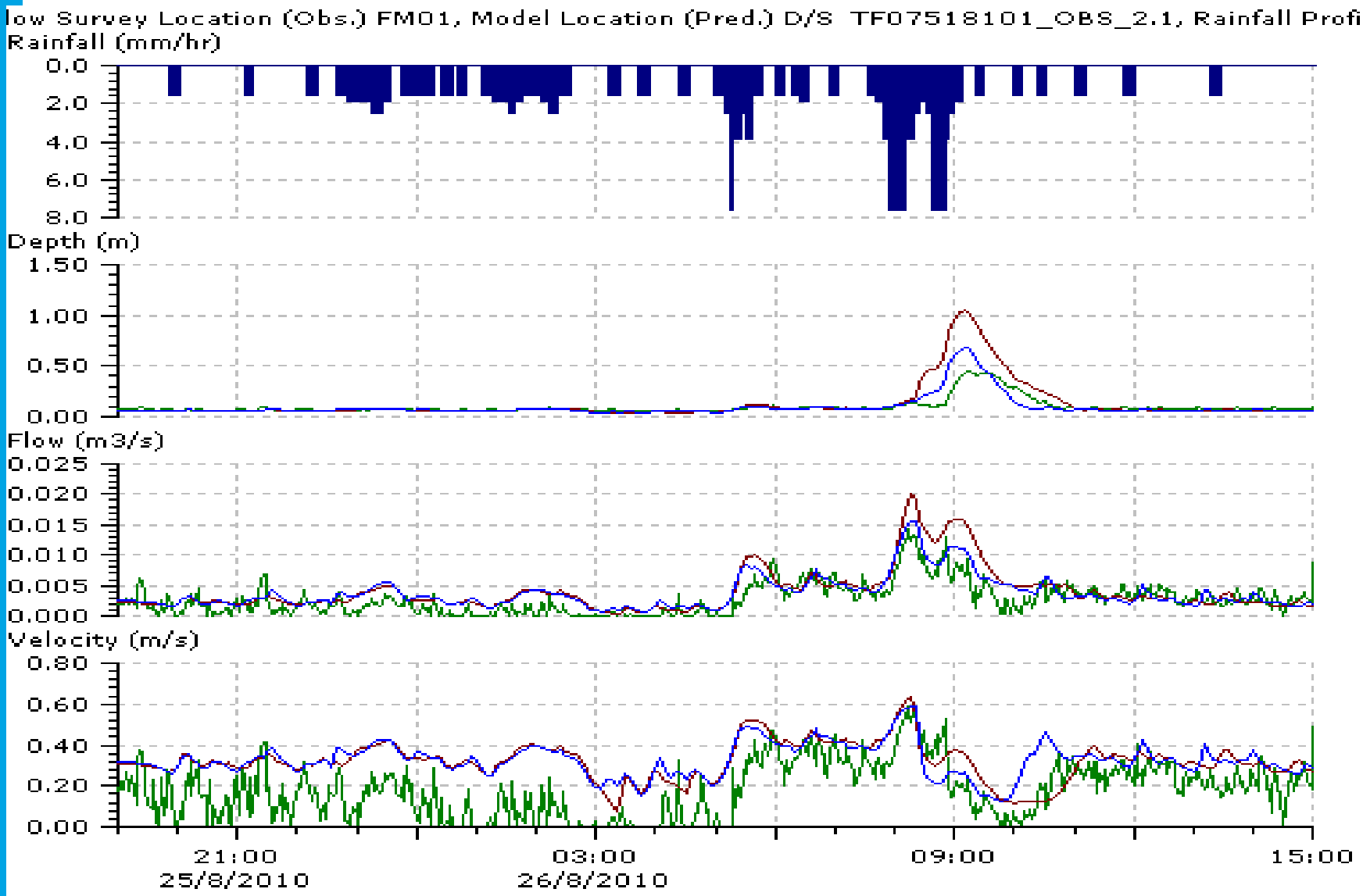


Dry Weather Flow Verification



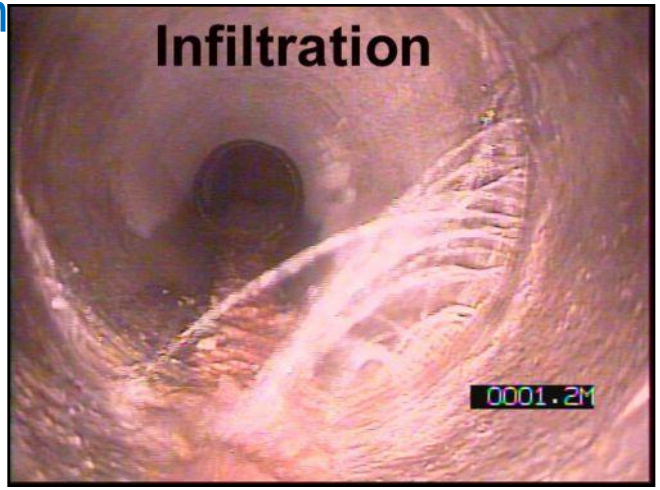
	Depth (m)		Flow (m3/s)			Velocity (m/s)	
	Min	Max	Min	Max	Volume (m3)	Min	Max
Obs.	0.056	0.105	0.000	0.009	176.035	0.000	0.460
...p, initial model>DWF	0.037	0.081	0.000	0.005	175.476	0.000	0.407
... wkend back1h>DWF	0.037	0.093	0.000	0.006	196.459	0.000	0.460

Storm Verification



Data Quality

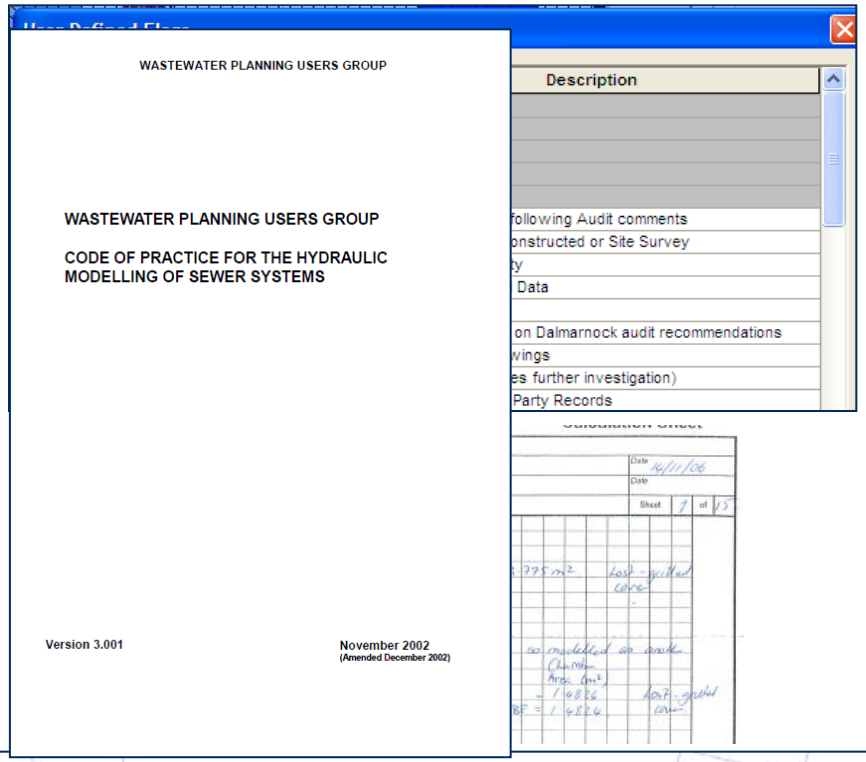
- **Sewer records**
- **GIS**
- **External data**
- **Previous models**
  - Previous reports
  - Contractor supplied – manhole / ancillary surveys / CCTV
  - Flow data – short term / long term / CSO loggers
  - Telemetry

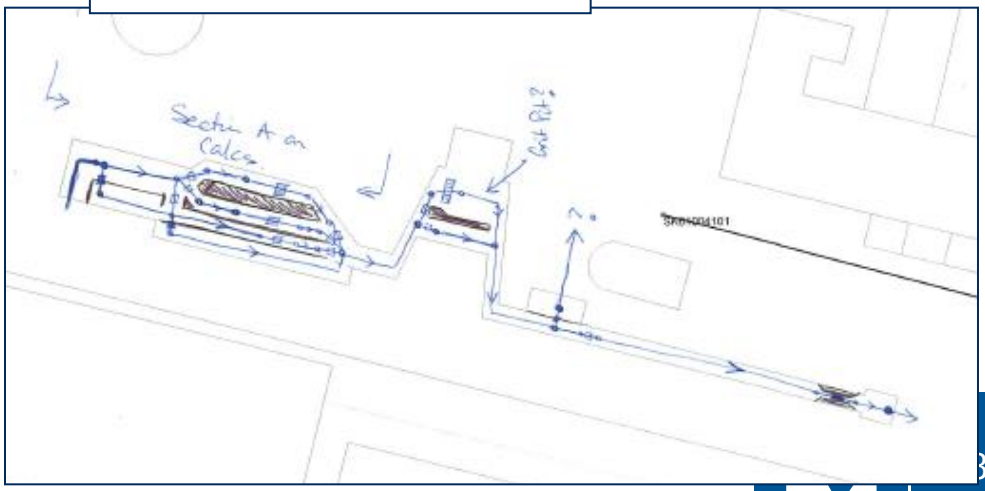


Documentation

- **Model build techniques**
  - guidance available
- **Best practice**
- **Specifications**

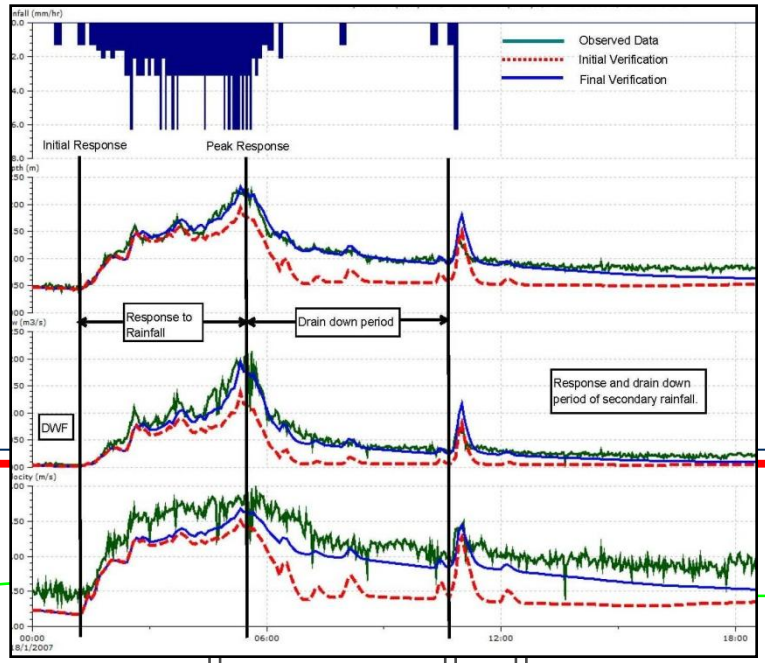
- Model build checklists
- Calculation tracking / model flagging
- 5% survey checks

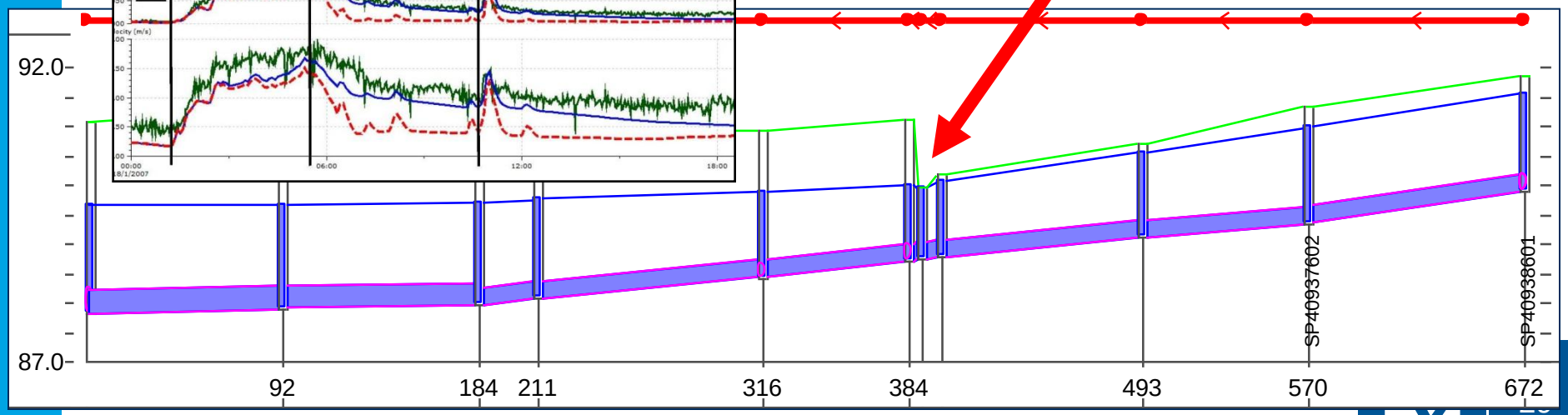




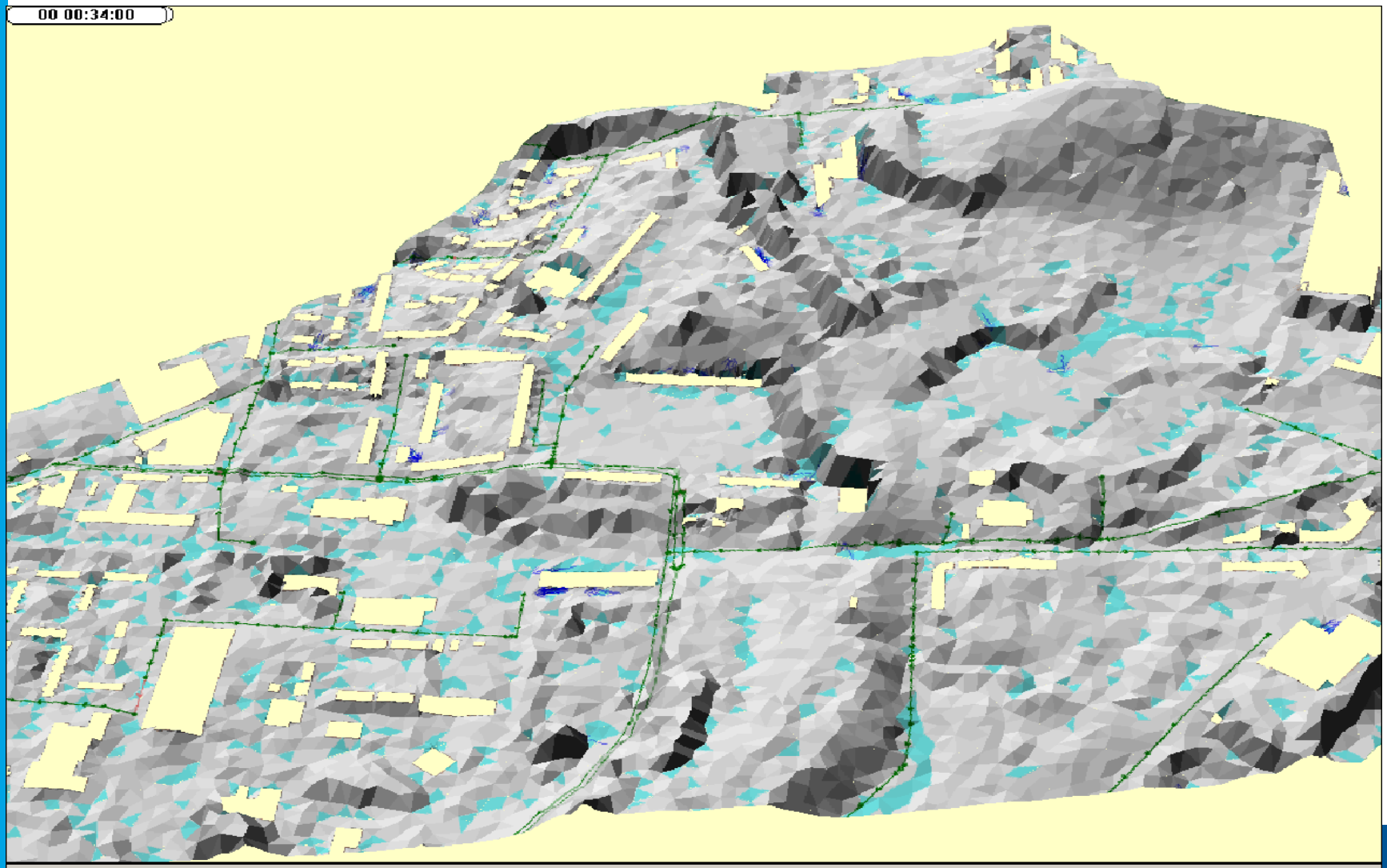
Results

- **Verification - flow data**
  - Historical verification





2D Modelling- Digital Terrain Model



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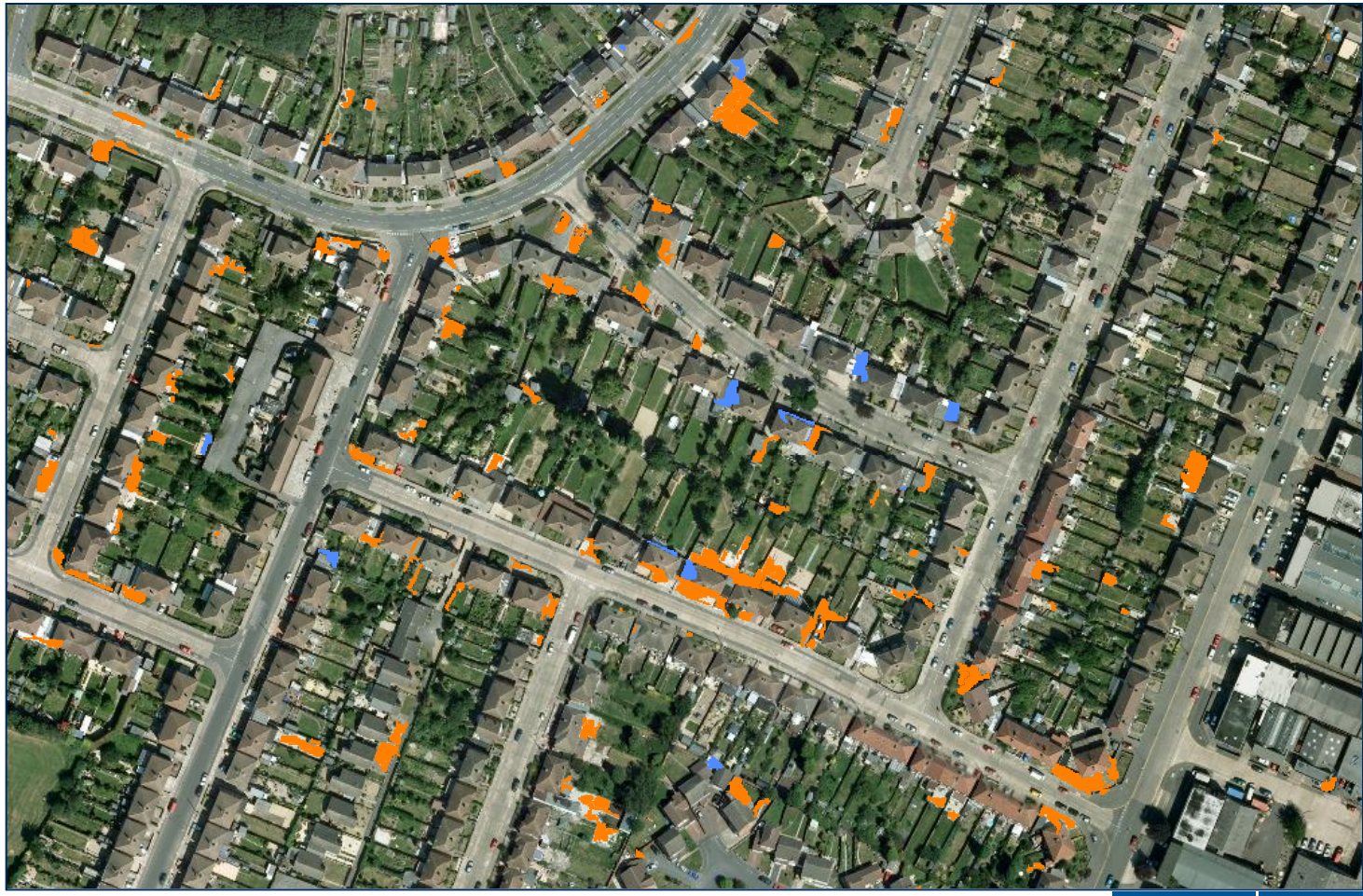
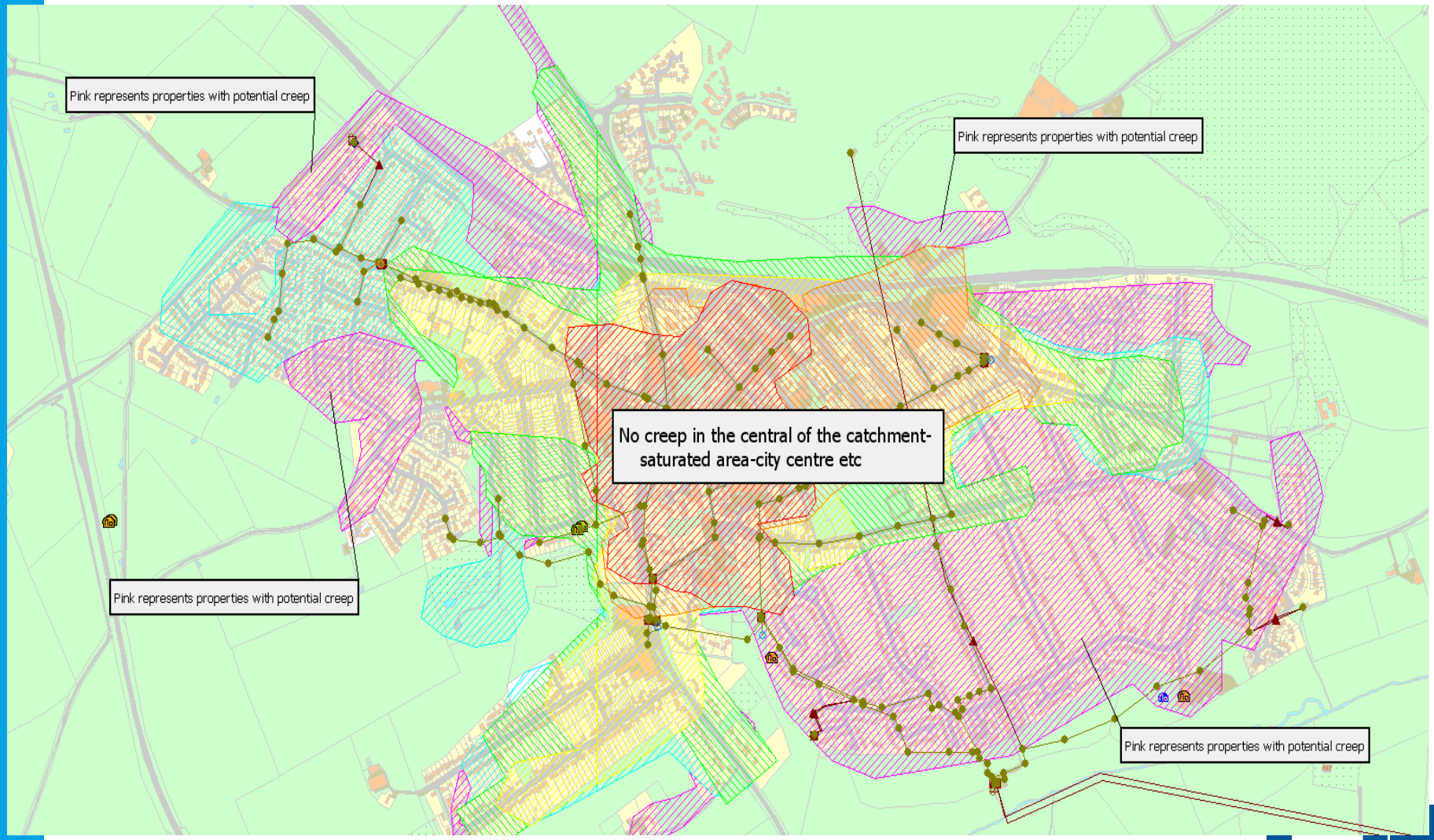
Impermeable area Creep

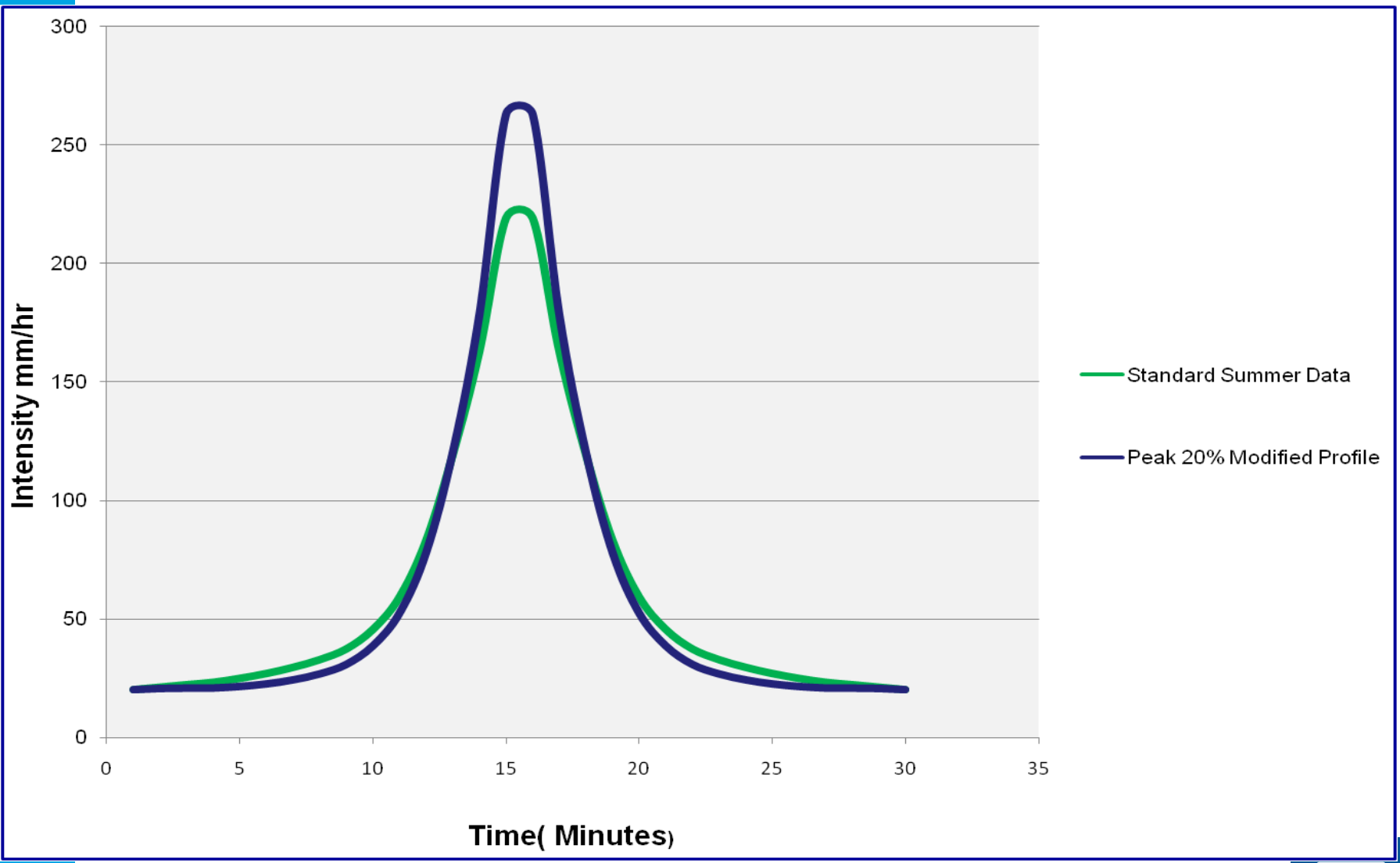
Buildings **Paved Areas**



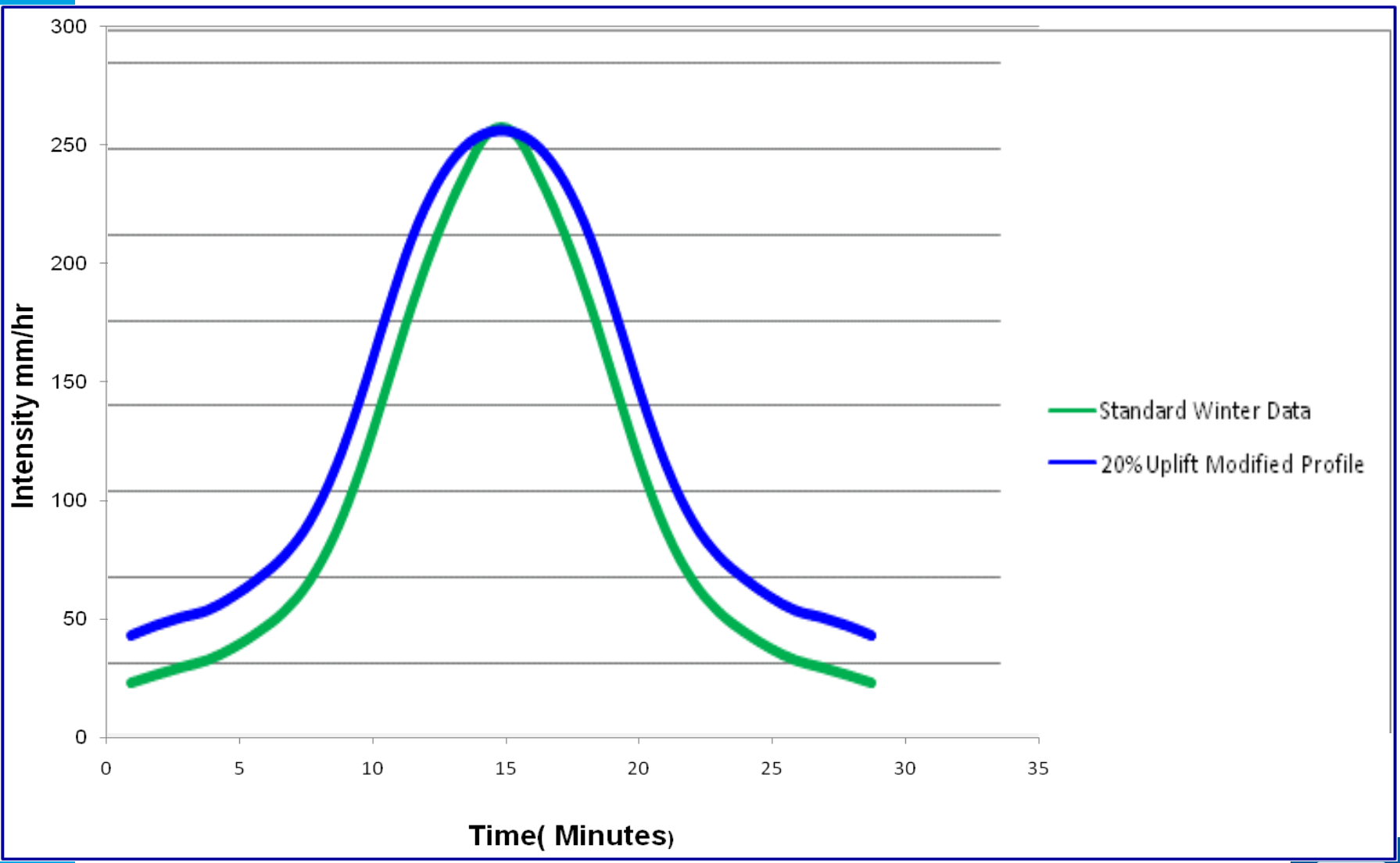
New methodology using epoch layers



Climate Change Summer Profile



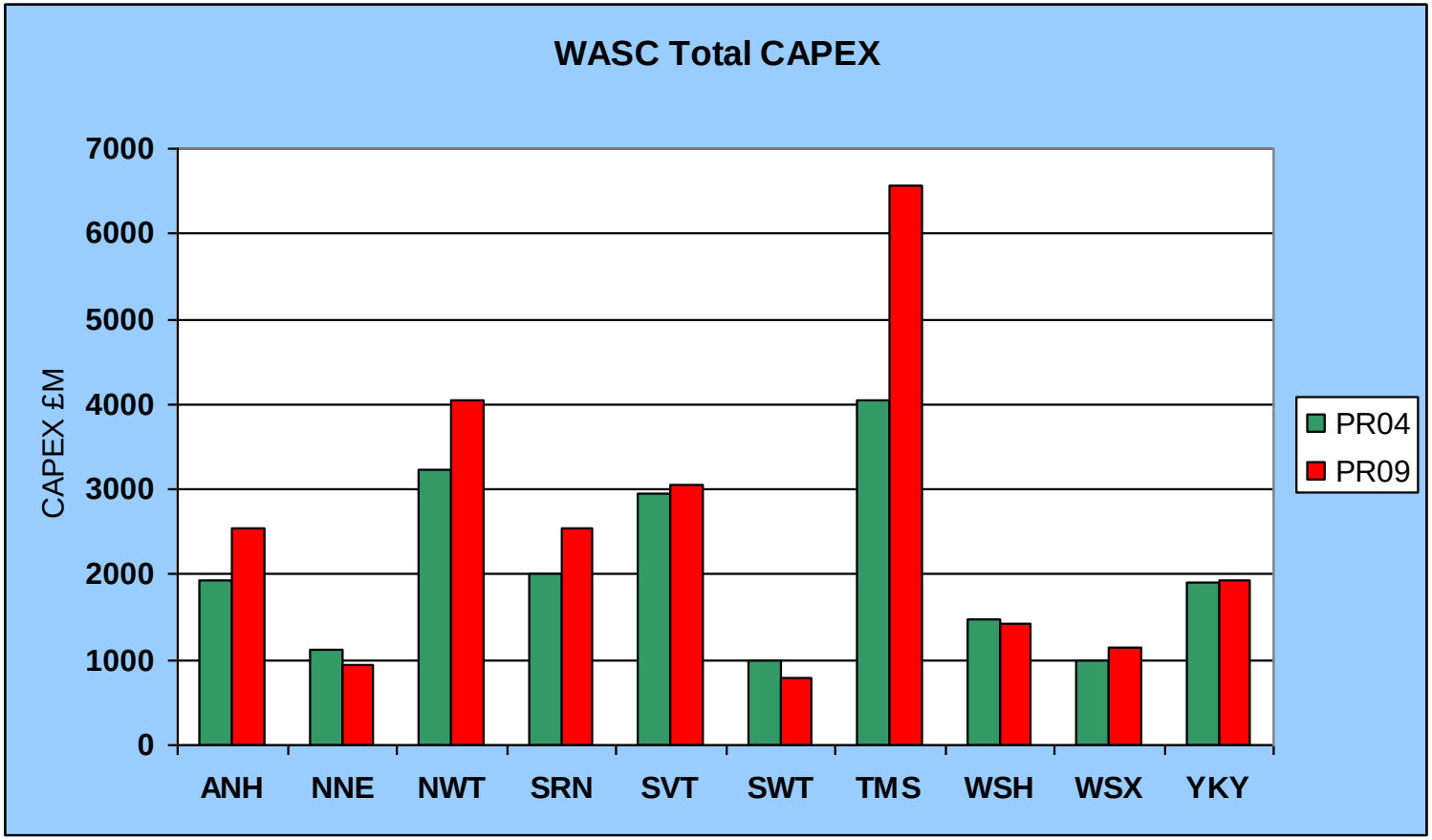
Climate Change Winter Profile



Outline

- **After a long introduction..!**
- **UK industry**
  - AMP4 and AMP5
  - Example projects
  - Evolving Partnerships - Alliances
  - Specific Challenges
- **Future?**
- **The Impact of research & Innovation**
- **... What about the rest of the world?**

Draft Business Plans – WASC CAPEX



PR04 Final determination CAPEX £20.7 billion

PR09 Draft Business Plan CAPEX£25.0 billion (+20%)

Modelling to help AW out of a tough spot

Letchworth MP wades in on sewage flooding problem

By Nick Gill
Wednesday, February 23, 2011
1:31 PM

Norton Common after flooding last August

Recommend 0 Tweet 1

+1 Recommend this on Google

AN ONGOING flooding problem which has caused sewage to spill on to a Letchworth GC nature reserve has been labelled as "unacceptab

Comments | Email | Print | Got a story?

North East Herts MP Oliver Heald, who represents Letchworth GC, has spoken out against the "unpleasant situation" residents face every time there is heavy rainfall at Norton Common because it results in a local sewer backing up.

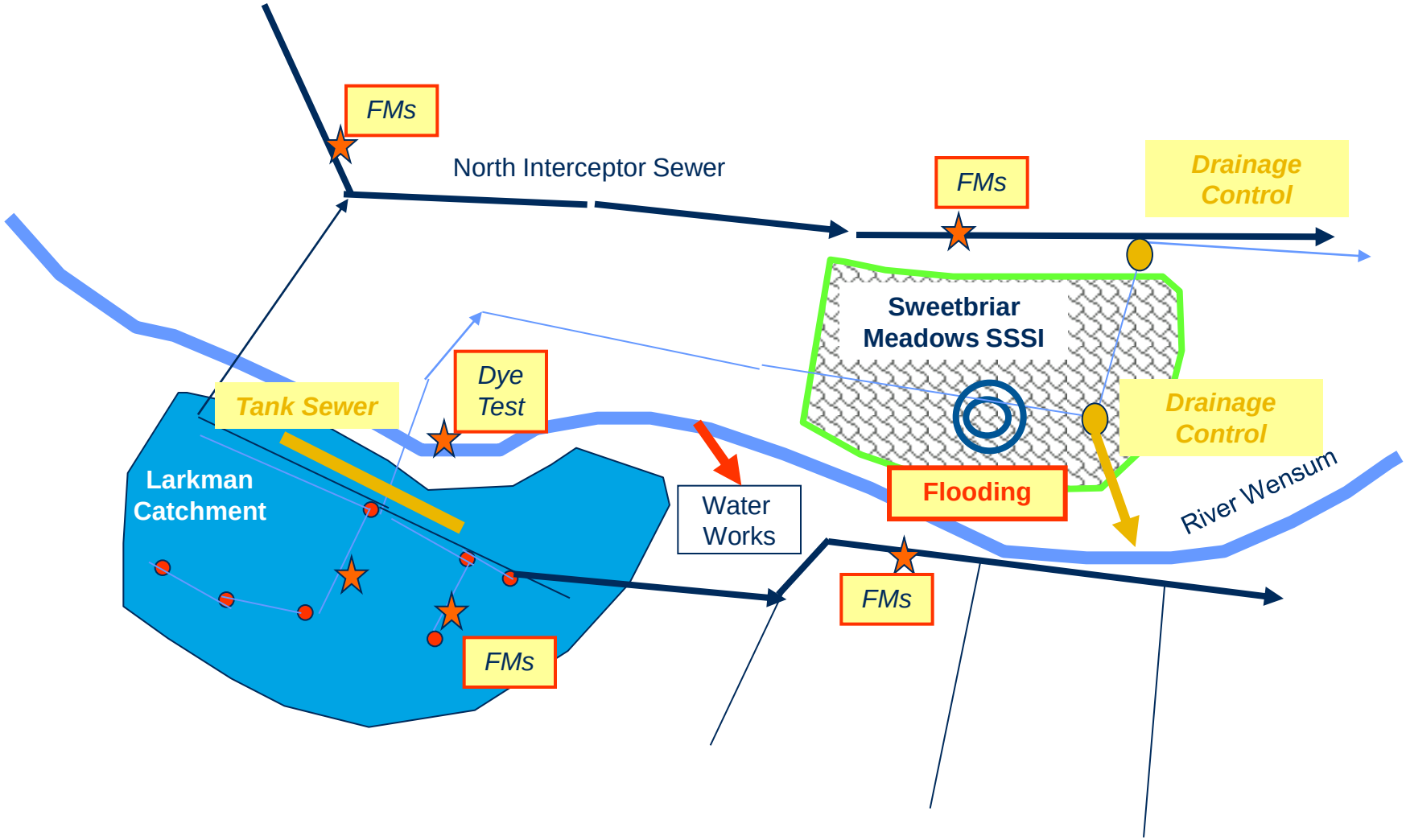
MP Oliver
like this'

The flooding, which was raised to Mr Heald by the Friends of Norton Common and has occurred on several occasions in the last five years, has been investigated by North Herts District Council (NHDC) who have reported the matter to Ang
Agency, but to no avail.

Letchworth Flooding and UPM analysis

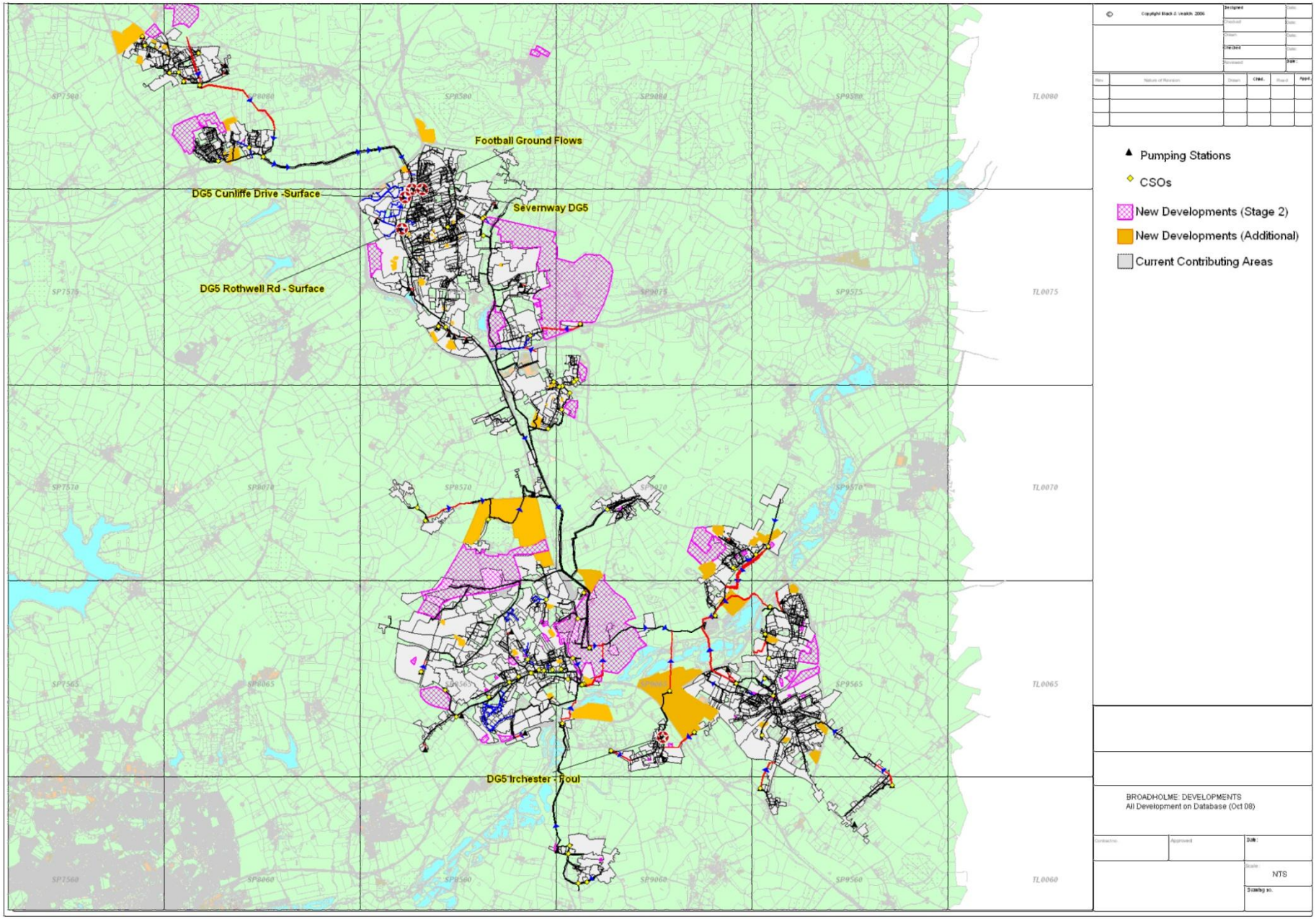
Graham,
Can you ensure all involved are thanked for their contribution to this , its really appreciated.
I gather from my contact at North Herts DC that a residents "open forum" meeting last week was very positive about us (AWS) this is a million miles from where we were.
Tim T was great in getting the "flood wall" put up so quickly.
Just to show how this all joins **up Peter is at the House of Commons today talking about water resources, Oliver Heald (Letchworth MP) is in the audience!**

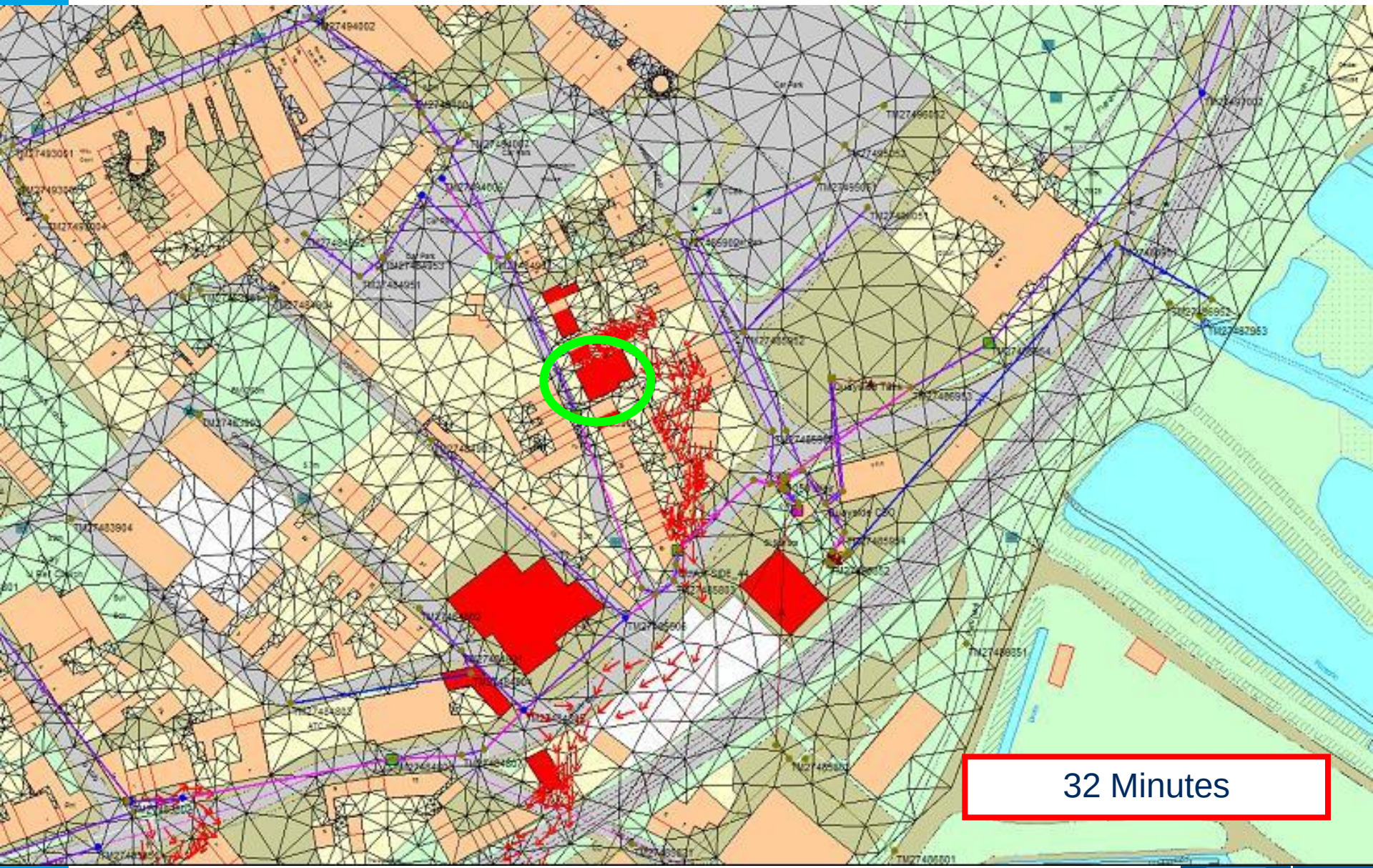
With best regards Simon Love


FMs
North Interceptor Sewer
FMs
Drainage Control
Sweetbriar Meadows SSSI
Tank Sewer
Dye Test
Drainage Control
Larkman Catchment
Water Works
Flooding
River Wensum
FMs
FMs

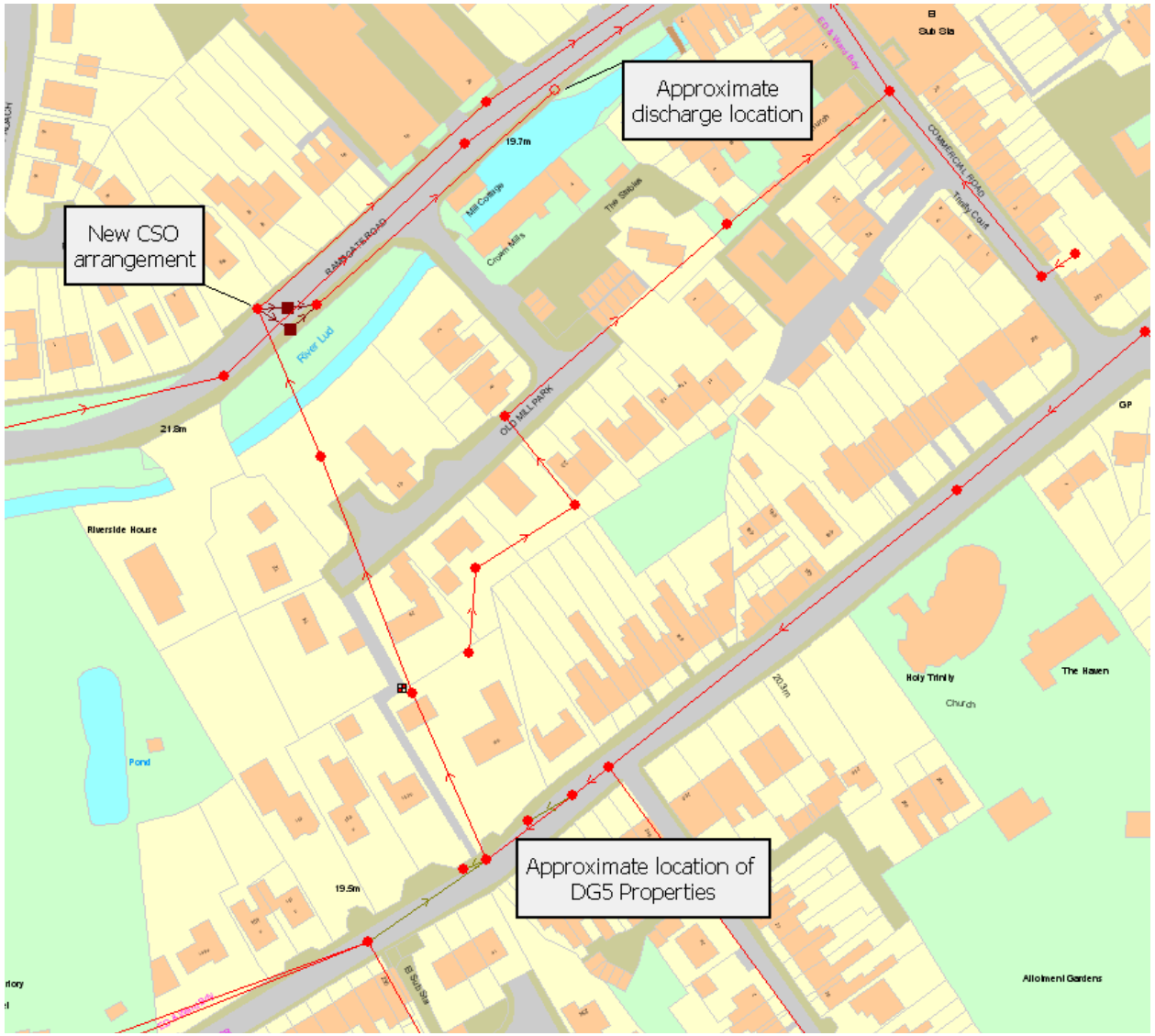
Environmental Outcome…..

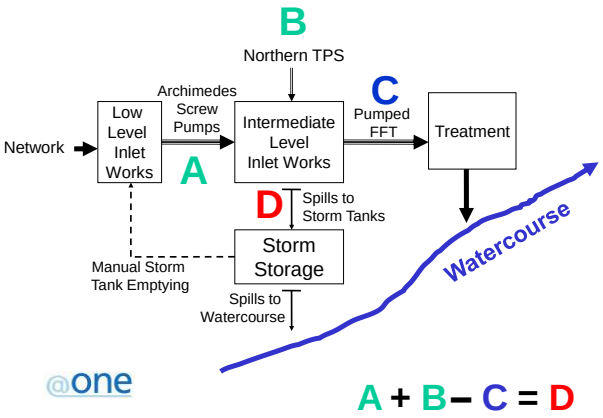
SSSI – Recovering


Football Ground Flows
DG5 Cunliffe Drive -Surface
Severnway DG5
DG5 Rothwell Rd - Surface
DG5 Irchester - Foul
Pumping Stations
CSOs
New Developments (Stage 2)
New Developments (Additional)
Current Contributing Areas
BROADHOLME: DEVELOPMENTS
All Development on Database (Oct 08)
NTS

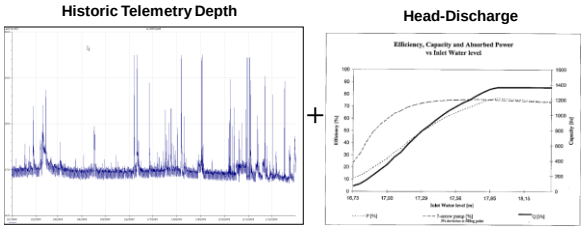

32 Minutes

Louth – new CSO to solve DG5 flooding





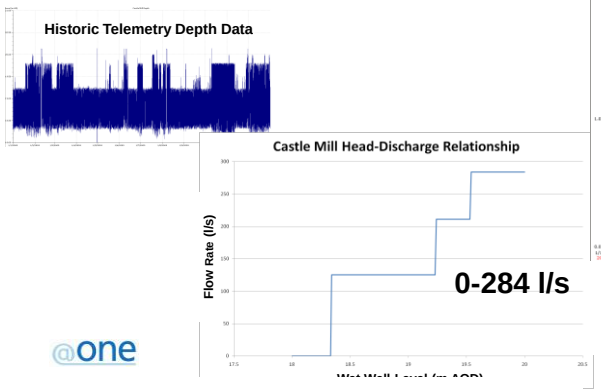
A: Inflows From Low Level Inlet (archimedes screws)



0-1350 l/s

@one

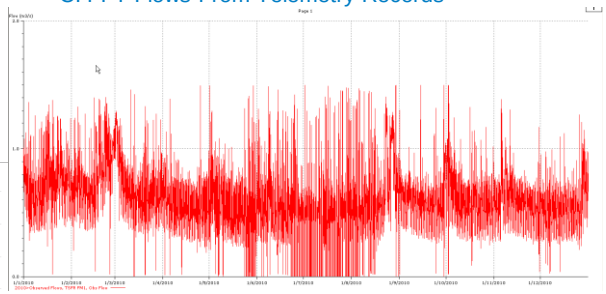
B: Inflows From Northern TPS



0-284 l/s

@one

C: FFT Flows From Telemetry Records



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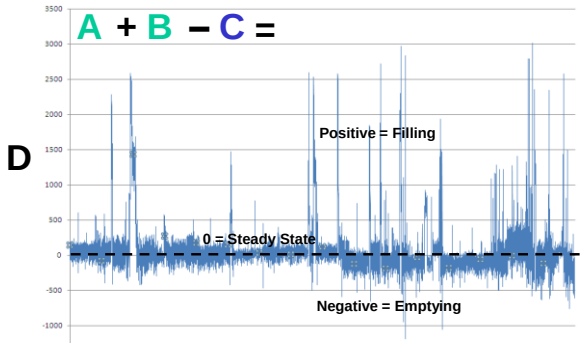
D: Rate of Filling/Emptying in Intermediate System



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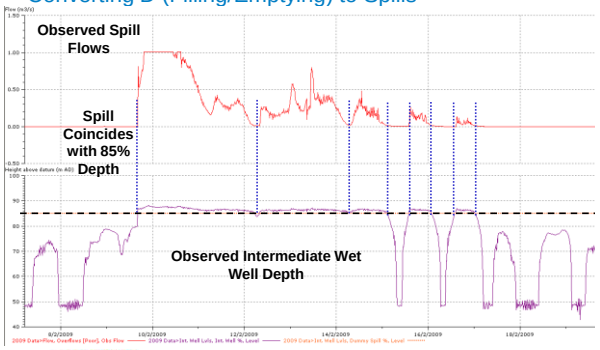
Converting D (Filling/Emptying) to Spills



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The Anglian Water Alliance AMP4/AMP5

£730M AMP4

£1000M AMP5 – Capital Spend half of AW

£245M WWI AMP4

£190M WWI + **£290WWNI AMP5**

Section101A, DG5s/Flooding, CSOs, Sewer Rehab, New Developments, STW compliance

Modelling: Process, CFD, Odour, **Network, UPM/CSO**

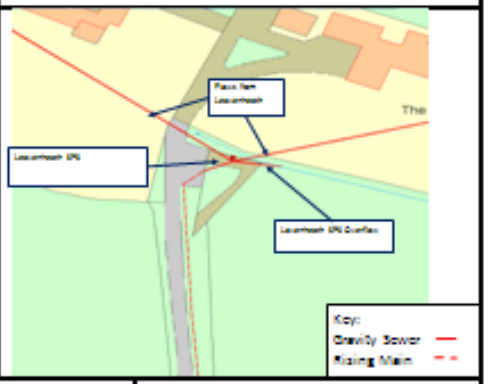
EO Compilaince UPM Scoping Dashboard

anglianwater

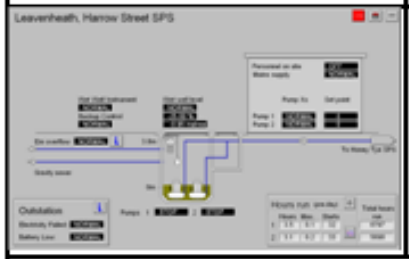
Leavenheath - Harrow Street

Background Information

STW and Outfall Location Plan



SCADA Telemetry Extract

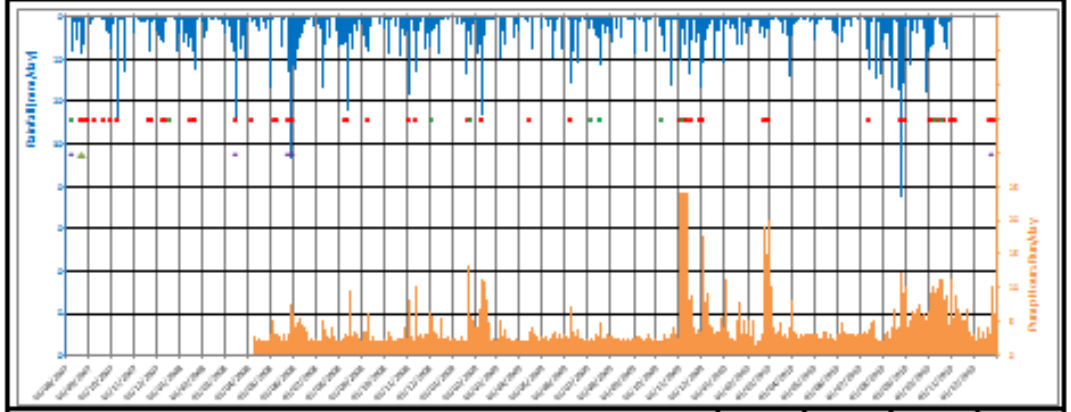


Graph Key

- Rainfall
- Pump1 Hours Run
- EO Spills Unconsented
- EO Spills Consented
- CAT 4
- CAT3

Graph Notes

Rainfall / Pump Hours Run / EO Spills / CAT Incidents



River Analysis

AW Specific Challenges

- FWF directive - none!
- UWWTD (there will be sites that cross PE thresholds (e.g. 2K & 10K) and will therefore require a greater level of treatment (P removal for example)) - 12 schemes
- Groundwater Directive (investigations may be required into the impact of WW discharges on groundwater) - still waiting
- Shellfish Waters Directive - limited
- New Bathing Water Directive (the industry will need to consider what level of investment it wants to make. As a minimum it should look to meet the new 'sufficient' standard for bathing waters)- limited number of schemes but now difficult ones remain
- WFD (at this stage it looks as though the industry will be co-ordinating AMP5 investigations into potential improvements during AMP6) – a few schemes

AW Specific Challenges

- Habitats Directive/SSSI – higher priority in AMP5 (SIMCAT analysis)
- Flooding (more DG5s!) – easy ones solved – now onto the difficult ones…..
- PITT review recommendations – more integration with surface water & also inherited private sewers
- Integrated Urban Drainage – IUD pilot project recommendations of better integrated working
- Climate Change resilience – Key assets against flooding, designing for exceedance, sensitivity testing
- Energy/Carbon – AW commitment to reduce carbon on capital schemes
- CSOs – very few
- SUDS – 6 pilot schemes
- Commercial Efficiencies – year on year increase 25% by year 5

Future Challenges

- **Water Regulation, Legislation and the Periodic Review**
  - De-regulation?
  - Water White Paper – summer 2011
  - New legislation – 2012
  - PR14 (already started)
  - Energy generation and ecosystem services methodologies
- **(Michael) Pitt, (Anna)Walker and (Martin) Cave reviews**
  - Pitt (2008) – Independent review of 2007 flooding; breaking down barriers; integrated solution
  - Walker (2009) – Charging of households water & sewerage
  - Cave (2009) – Competition and Innovation in Water Markets; separation, mergers, new markets & need for innovation

Future Challenges

- **Climate change, Carbon and the Water Sector**
  - AMP5 – Implicit requirement to integrate climate change into flooding solutions; formation of climate Change steering groups
  - Need to deliver Adaptation Report – all Water companies
  - Mitigation and adaption strategies
  - Link to cost, carbon, energy
- **Natural environment white paper**
  - 'Greenest' ever government?
  - National Ecosystem Assessment for the UK
  - SAGIS - WFD

Future Challenges

- **Water Resource Management Plans**
  - First round completed
  - International benchmark for Water resource planning
  - Still many challenges to overcome
- **Water Infrastructure and Distribution Networks**
  - Impact of Austerity
  - Current impact of drought in parts of UK – leakage becoming an issue again

Future Challenges

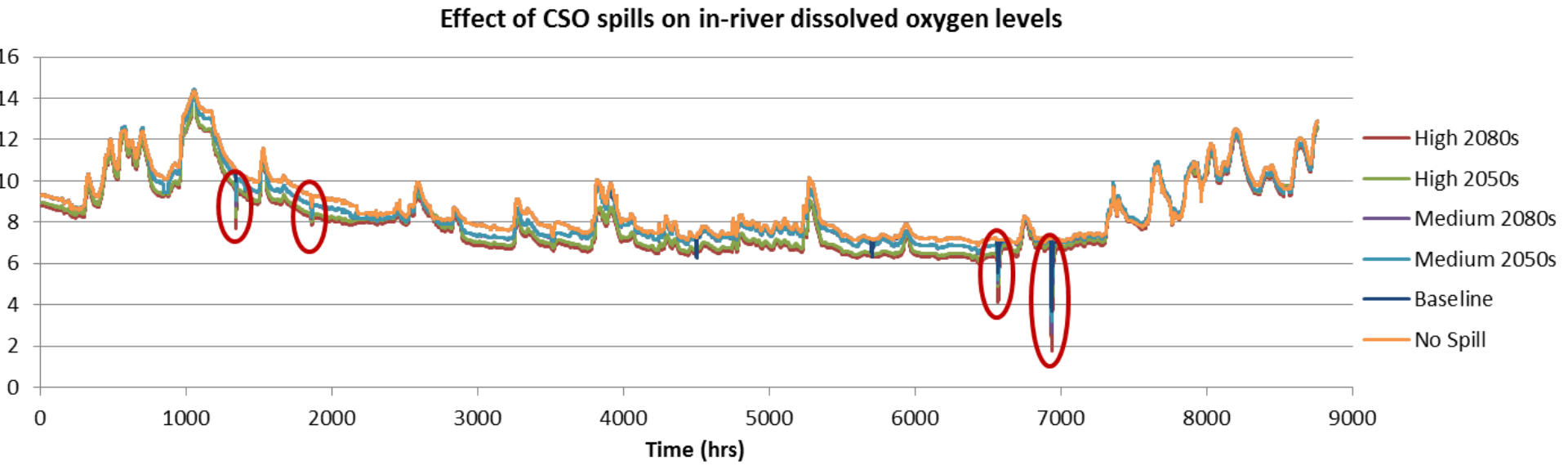
- **Opportunities for Venture Capital Investment in high value asset development in the UK Water Industry**
  - "There a wide range of new and developing technologies which offer significant efficiencies and green outcomes for the water and waste sectors including phosphorus recovery systems, enhanced primary treatment systems, microbial fuel cells, thermophilic digestion, multistage digestion, multistage digestion linked with VFA fermentation to produce high value chemicals, and low cost algal biodiesel. The recent referral to the OFT by Ofwat of the use of regulated assets for non regulated business is key to this."

Investment in water innovation overseas

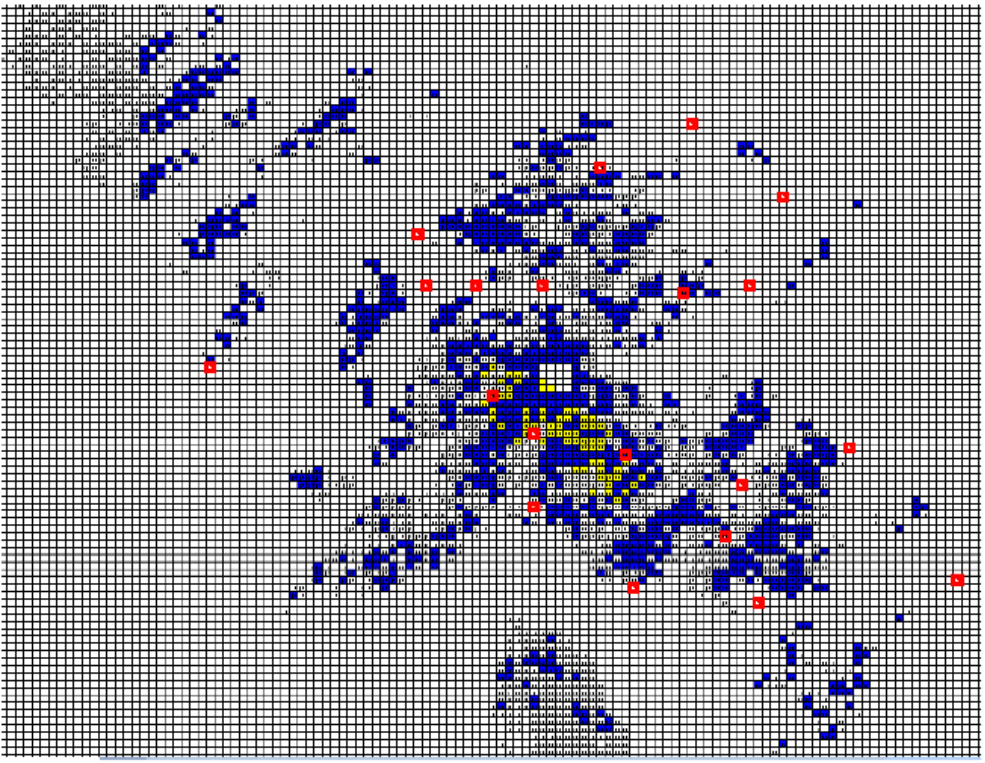
- In 2010, US$257 million went into water-related start-ups, up from a record high of US$140 million in 2009
- China has invested $3 billion in desalination and holds 50 percent of water related patents issued last year
- In Singapore, the government has committed to build a strong ecosystem for the industry with close to S$700 million being channelled for R&D centres ($350 million by government)

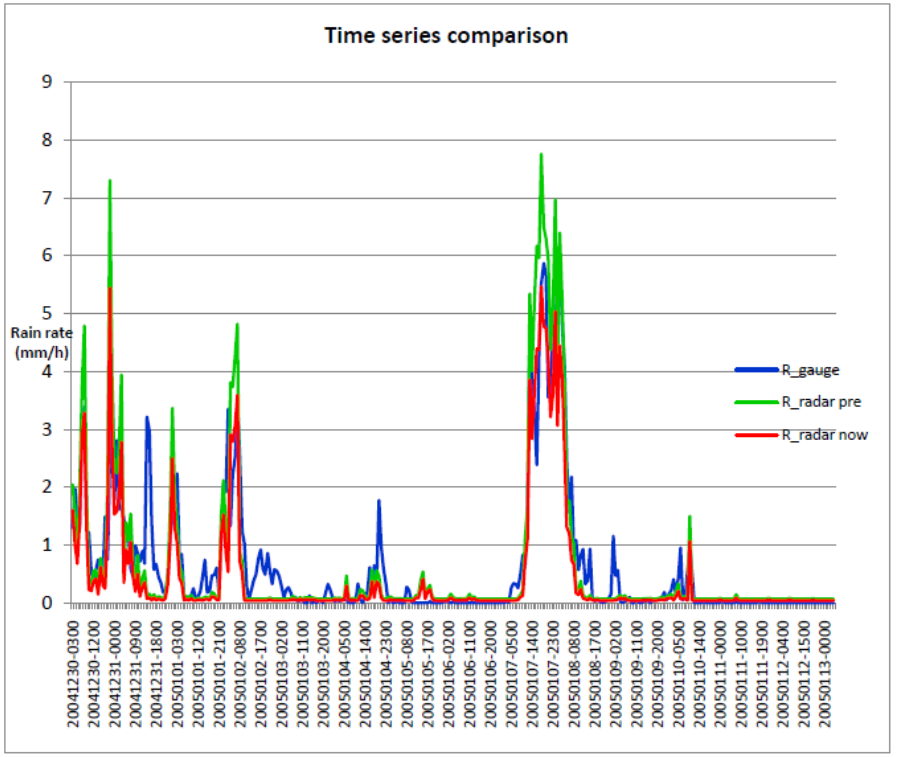
"Carbon: what are the water industry's leaders doing to balance the budget? WWT roundtable talk, B&V 2012"

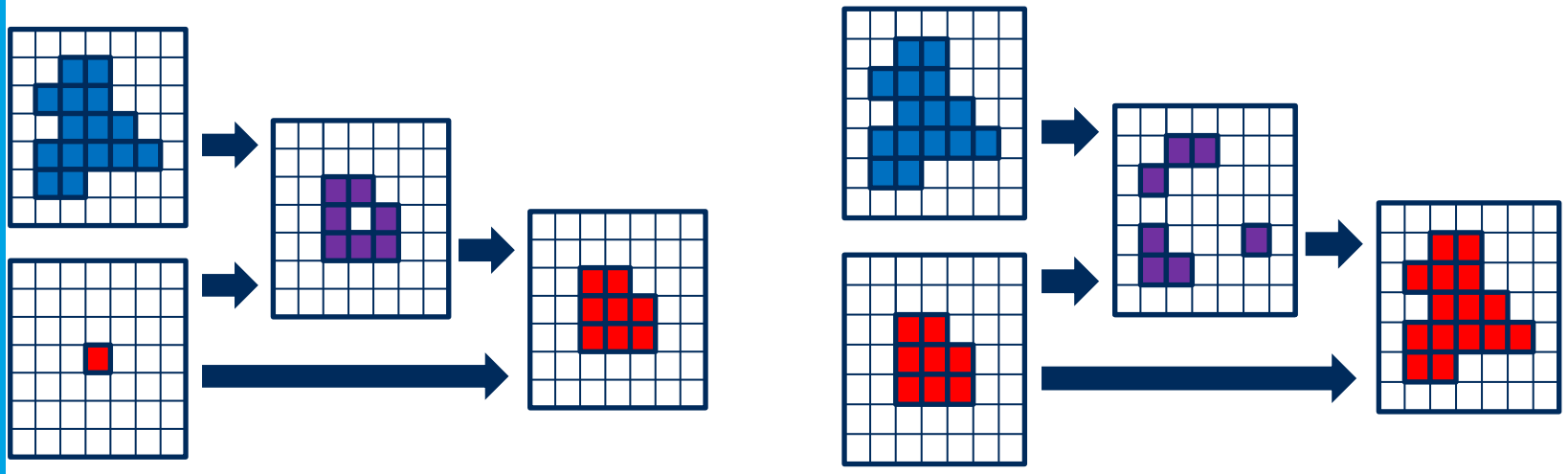
Climate change on urban discharge and impact on river quality



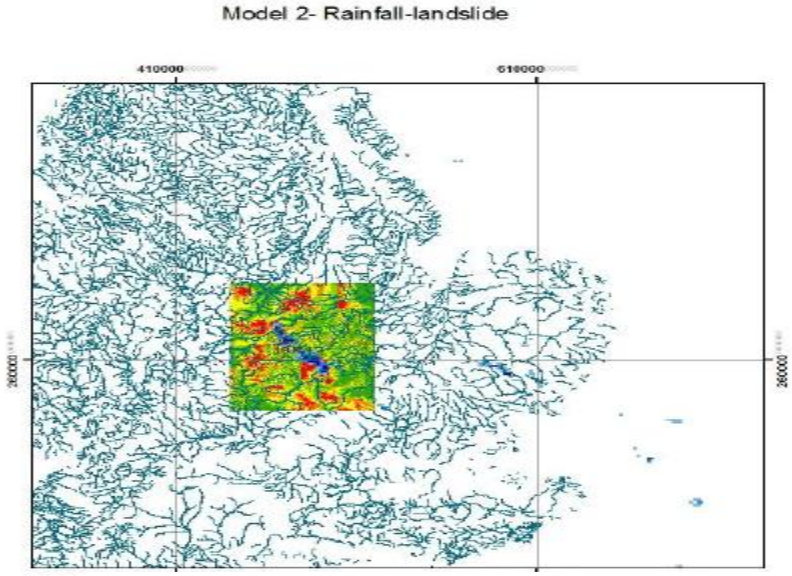
Spatial rainfall

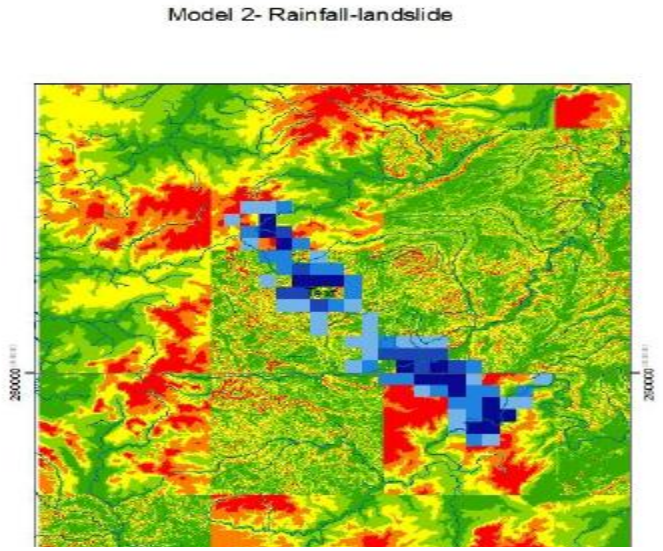






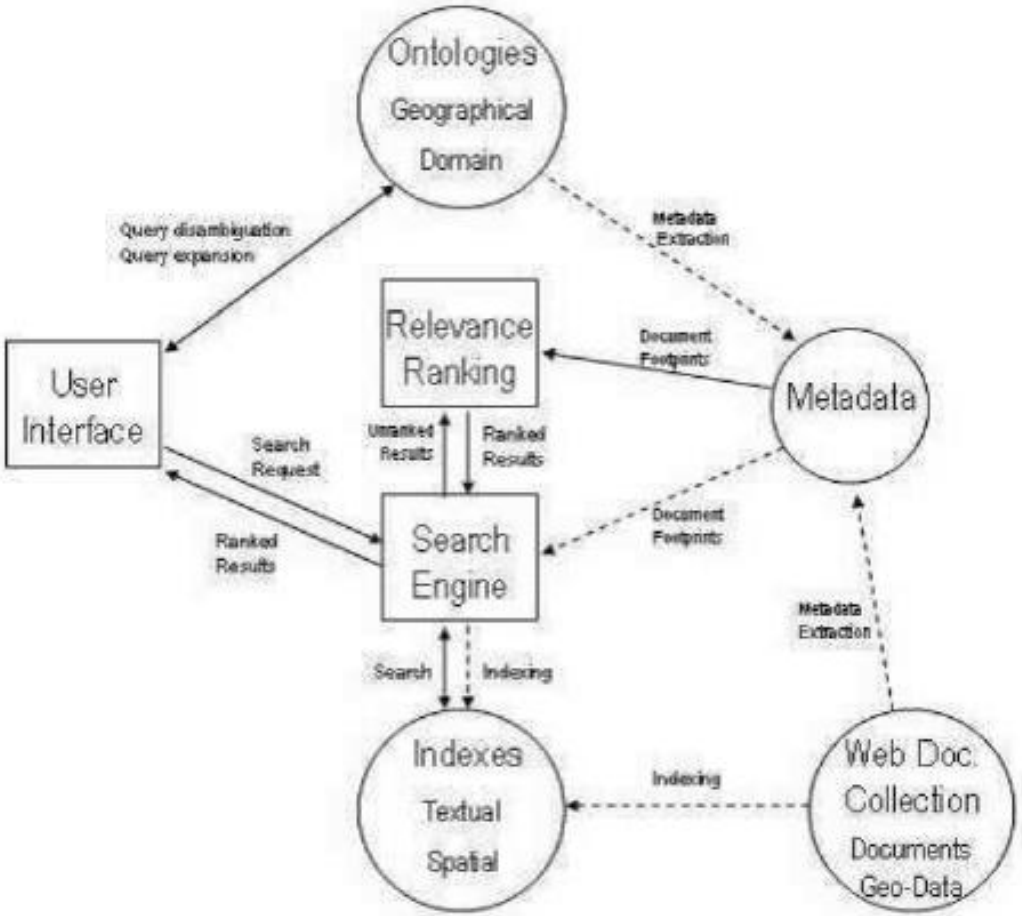
NOWCASTING





SLOPE STABILITY WARNING SYSTEM

Spider bots for environmental data screening



Black Scholes Equation in Urban Drainage

Funding Sufficiency *Funding* *Cost*

$$p = Ke^{-rT}N(-d_2) - S_0N(-d_1)$$

$$d_1 = \frac{\ln(S_0/K) + (r + \sigma^2/2)T}{\sigma\sqrt{T}}$$

$$d2 = \frac{\ln(S_0/K) + (r - \sigma^2/2)T}{\sigma\sqrt{T}} = d_1 - \sigma\sqrt{T}$$

p= Funding Sufficiency
So= Cumulative Cost of Project
K= Cumulative Funding
r= Rate of return of Government Bond
T= One Funding Period
σ= Uncertainty of Flooding Project

Reflections for the individual

- Discovering new challenges
- Renewed enthusiasm
- Rewarded effort
- Deepening relationships
- Transformed knowledge, experience and wisdom

- And ‘The world is your oyster’!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