Modelling Group
WATER NEW ZEALAND

# Modelling Symposium

## REGENERATION OF CHRISTCHURCH STORMWATER MODELLING

# AVON CITYWIDE 2.0 DELIVERED

Presented by
Tim Preston

*(Wellington 16/3/2023)*

GHD

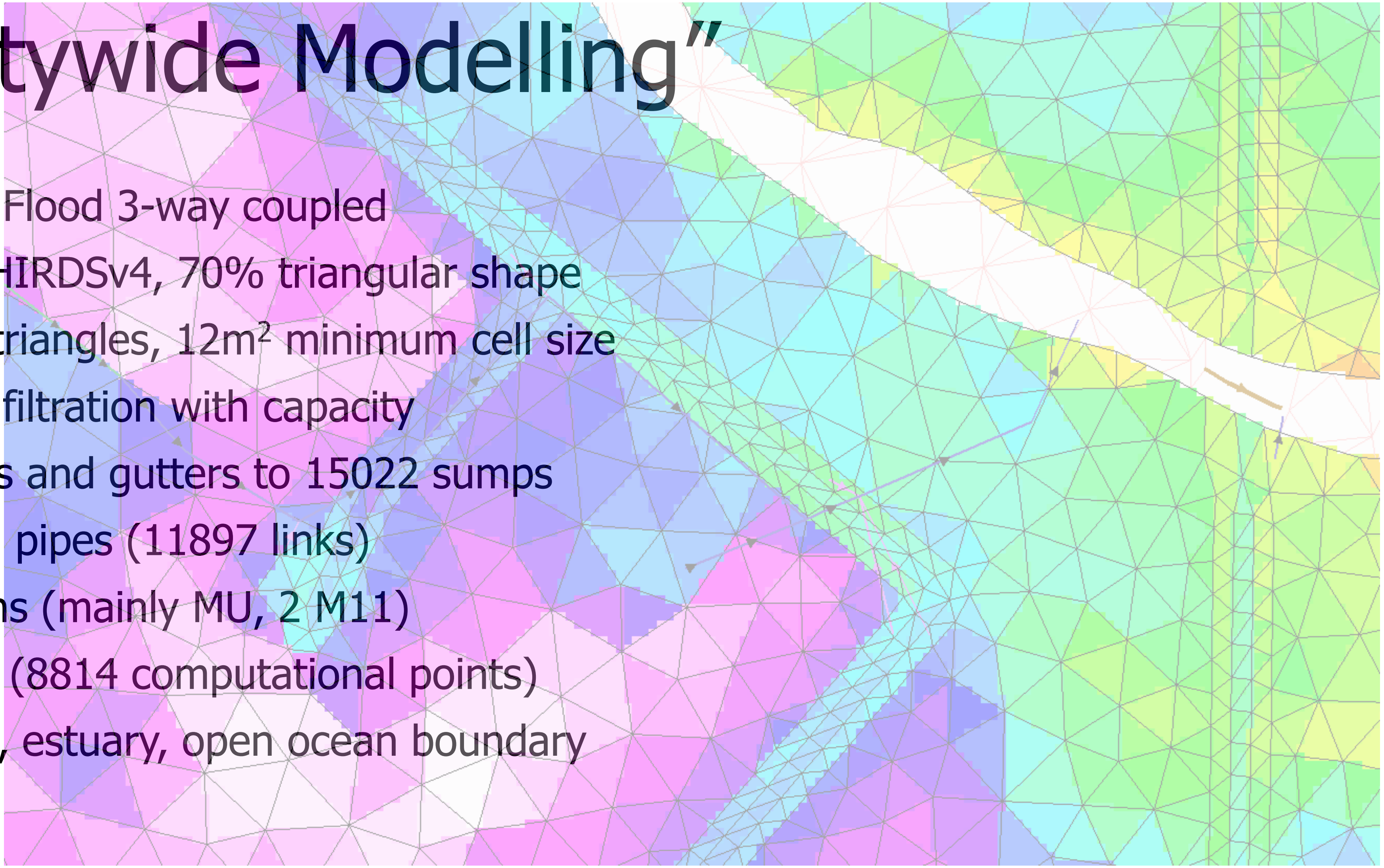
water
NEW ZEALAND
The New Zealand Water & Wastes Association Waiora Aotearoa

# Introduction

- What does Chch Citywide modelling look like?
- Updates and enhancements V2.0
- Model runs and large scale
- Post processing deliverables
- Lessons learned
- Finding faults
- Future ideas
- Conclusions and acknowledgements
- Questions

# Avon "Citywide Modelling"

- DHIv2020 Mike Flood 3-way coupled
- Rain on mesh, HIRDSv4, 70% triangular shape
- 139 km$^2$, 1.8M triangles, 12m$^2$ minimum cell size
- M21 constant infiltration with capacity
- Road centrelines and gutters to 15022 sumps
- 358km of urban pipes (11897 links)
- 13 pump stations (mainly MU, 2 M11)
- 156km of rivers (8814 computational points)
- Tidal stopbanks, estuary, open ocean boundary



# Updates and enhancements

- LiDAR 2018
  - Substantial customisations for road surfaces and other key features like stopbanks and basins
- M21 constant infiltration with capacity
  - Replaced distributed Hortons, const infiltration 75% like final Hortons infiltration, immediate calibration match
- 2020 satellite impervious data
  - Modified (focused) impervious on road surface extents

# Updates – Future Impervious

- Future impervious
  - Calculated in tabular lines ‘per each meshblock’
  - Existing impervious (satellite 10m raster) and zonings
  - Forecast household numbers to 2041 and population to 2068
  - Related zoning types to typical impervious for full development
  - Commercial zoning assumption of linear development to 90% imperv by 2068 (noting most areas are already near 90% imperv anyway)
  - Roads and redzone remain fixed at current impervious
  - All other areas (nominally ‘residential’ but that includes a lot of other zoning),
    - characterise each meshblock as % developed (% brownfields) and
    - characterise the change in impervious for greenfield areas
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  - Result is written as a factored adjustment to existing raster level impervious detail

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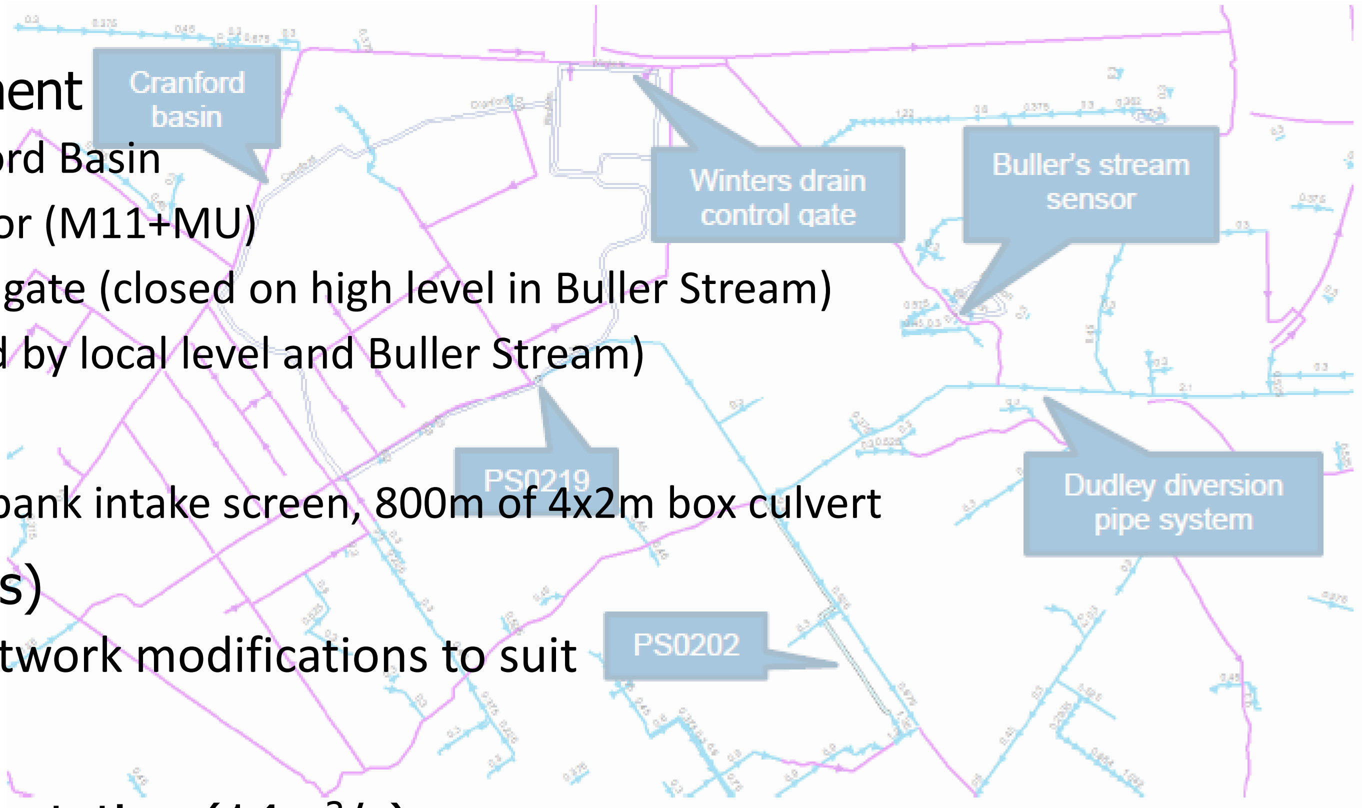
# Updates - Infrastructure

- Cranford Basin Active Management
  - Winters Basin then new Cranford Basin
  - Buller Stream water level sensor (M11+MU)
  - M11 Winters active controlled gate (closed on high level in Buller Stream)
  - MU Cranford PS219 (controlled by local level and Buller Stream)
- Lower Dudley Diversion
  - Stream realignment and right bank intake screen, 800m of 4x2m box culvert
- New Tay St pump station (2m$^3$/s)
  - And associated drainage network modifications to suit
- Stopbank - Asbuilt top levels
- Upgraded Horseshoe lake pump station (14m$^3$/s)
  - Screw extension for king tide capacity



# Mod

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| Batch | Run Scenarios | Project Scenario Parameters | | | | | | | | Dominant Rain/Tide ARI | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Rainfall/Tide Pairing | Storm durations | Development | Ground water %th | Sea Level Rise | Rainfall Climate Change | Stopbank | FutureEQ | 10ARI | 50ARI | 200ARI | 500ARI |
| 1 | 2020 | | Odd | 2020 | $85^{th}$ | + 0.00m | 0% | Down | noEQ | Yes | Yes | Yes* | n/a |
| 2 | 2020 | | Odd | 2020 | $85^{th}$ | + 0.00m | 0% | Up | noEQ | Yes* | Yes* | Yes | n/a |
| 3 | 2030+ | | Odd | 2030 | $85^{th}$ | + 0.19m | Jacob | Down | noEQ | Yes | Yes | Yes | n/a |
| 4 | 2030+ | | Odd | 2030 | $85^{th}$ | + 0.19m | Jacob | Up | noEQ | Yes | Yes | Yes | n/a |
| 5 | 2060+ | | Odd | 2068 | $85^{th}$ | + 0.45m | Jacob | Down | noEQ | Yes | Yes | Yes | n/a |
| 6 | 2060+ | | Odd | 2068 | $85^{th}$ | + 0.45m | Jacob | Up | noEQ | Yes* | Yes* | Yes | n/a |
| 7 | 2100+ | Joint Probability | Odd | 2068 | $85^{th}$ | + 1.06m | Jacob | Down | noEQ | Yes | Yes | Yes | n/a |
| 8 | 2150+ | | Odd | 2068 | $85^{th}$ | + 1.88m | Jacob | Down | noEQ | Yes | Yes | Yes | n/a |
| 9 | 2150++ | | Odd | 2068 | $85^{th}$ | + 2.40m | Jacob | Down | noEQ | Yes | Yes | Yes | n/a |
| 10 | 2060+ | | Odd | 2068 | $85^{th}$ | + 0.45m | Jacob | Up | FutureEQ | Yes | Yes | Yes | n/a |
| 11 | 2060+ | | Odd | 2068 | $85^{th}$ | + 0.45m | Jacob | Down | FutureEQ | Yes | Yes | Yes | n/a |
| 12 | 2100+ | | Odd | 2068 | $85^{th}$ | + 1.06m | Jacob | Down | FutureEQ | Yes | Yes | Yes | n/a |
| 13 | Sensitivity test (2100+) | | Odd | 2068 | $85^{th}$ | + 1.06m | Jacob | Down | noEQ | Yes | Yes | Yes | n/a |
| 14 | DistrictPlan Future | | Even | 2068 | $85^{th}$ | +1.00m | 16% | Down | noEQ | n/a | n/a | Yes* | n/a |
| 15 | DistrictPlan Current | 1:10 ratio | Even | 2020 | $50^{th}$ | + 0.00m | 0% | Down | noEQ | n/a | n/a | n/a | Yes* |
| 16 | DistrictPlan Future | | Even | 2068 | $85^{th}$ | +0.50m | Jacob | Down | noEQ | n/a | n/a | n/a | Yes* |
| 17 | DistrictPlan Future | | Even | 2068 | $85^{th}$ | +1.00m | Jacob | Down | noEQ | n/a | n/a | n/a | Yes* |

# Run management

- Five dedicated computers
  - Typical HP Z640, 64Gb, 2x GeForce GTX 980 Ti GPUs
- XLS tabulated run parameters (210 lines)
- PY Python scripted generation of model setups
- BAT Prediction of computational efforts, load balancing to batching
  - Most computers ran two parallel jobs, hence eight batches
  - 5,150 hrs; 26 ideal calendar days; plus rework
- VBA Run progress monitoring
  - restart crashed runs
  - rebalance computational loads
- 100% run completion
  - including 56 re-runs to achieve

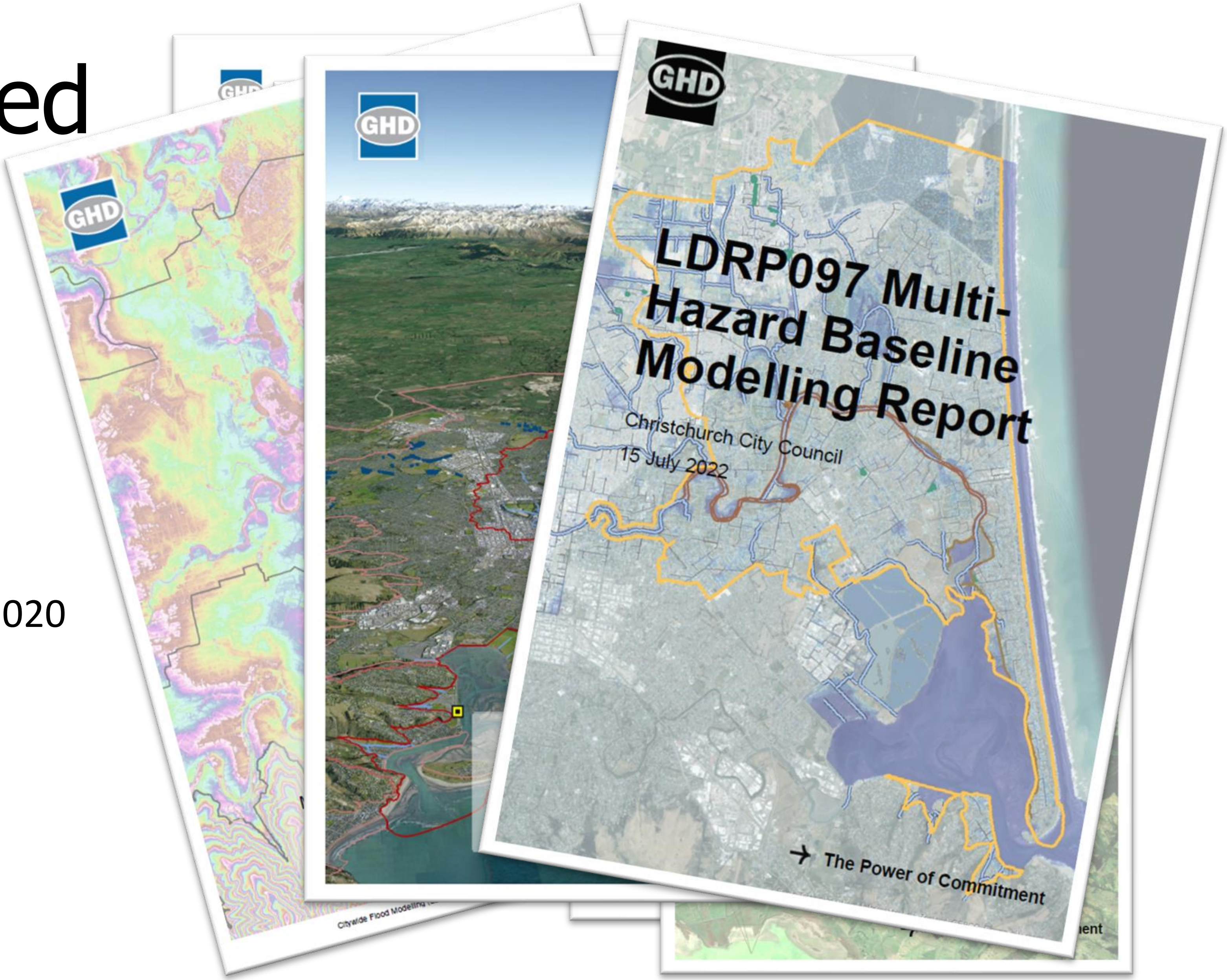
# Post processing deliverables

- Full runtime results
  - M21, M11, MU (600 Gb deliverables)
- Integrated floodplain and river result rasters
  - max of run and max of max
  - depth, level and critical duration
- 1D points max of run and max of max, depth, level and critical duration
  - MU+M11 computational points
  - max of run and max of max, depth, level and critical duration
  - 43 GIS point datasets for each of the scenario batches
- M21 stability oscillations summary
  - 43 GIS polygon datasets for each of the scenario batches

# Reports generated

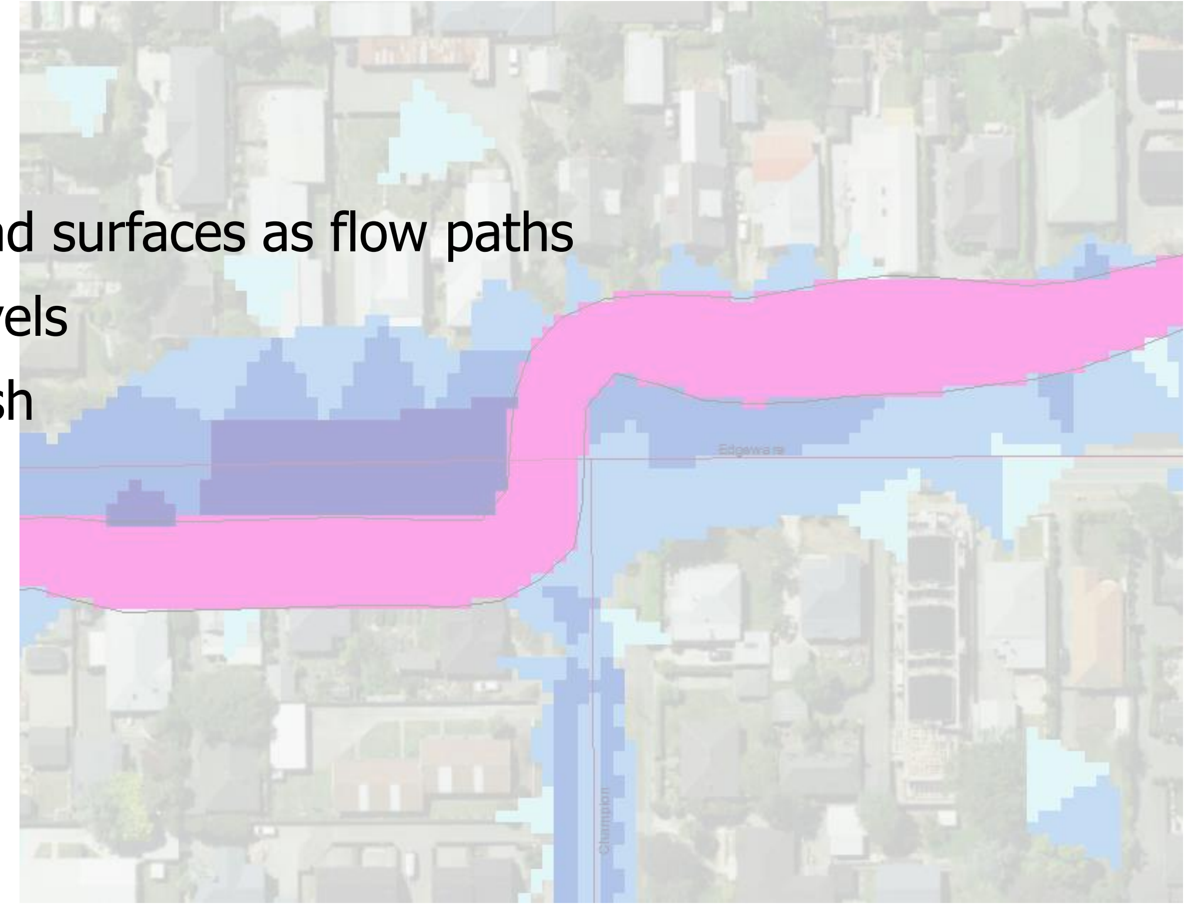
- Mass balance error corrections and validation
- Stormwater Infrastructure Change Analysis
- RORB Integrated Model Build Report
- LDRP097 Multihazard baseline modelling
- Avon model sensitivity to rainfall and groundwater level
- Vadose soil moisture and groundwater sensitivity

- Citywide Model Schematisation 2020 Update Report
- Avon Model Status Report
- LDRP097 Multi Hazard Baseline Modelling



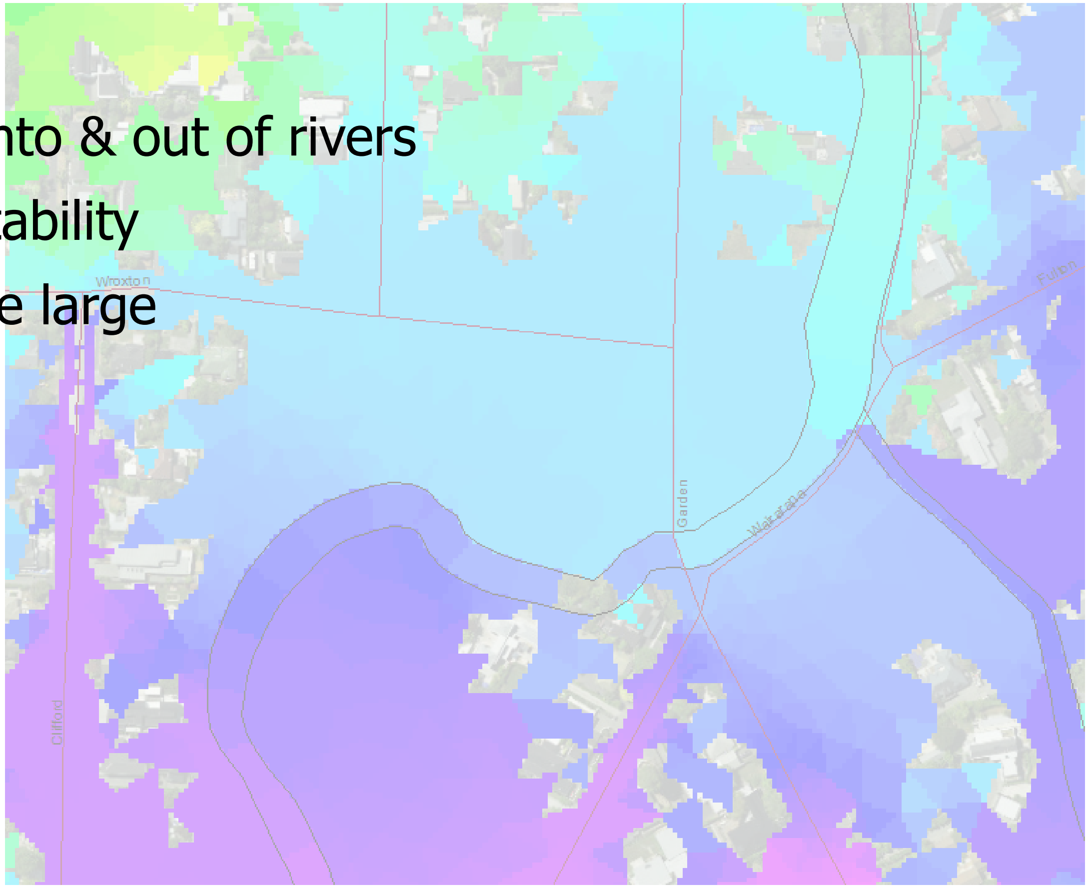
# Lessons learned - Blockouts

- Continuous blockouts for short culverts
- Good generally but these ‘blocked’ the road surfaces as flow paths
- Sometimes this was important to flood levels
- Approach now to find and join up the mesh



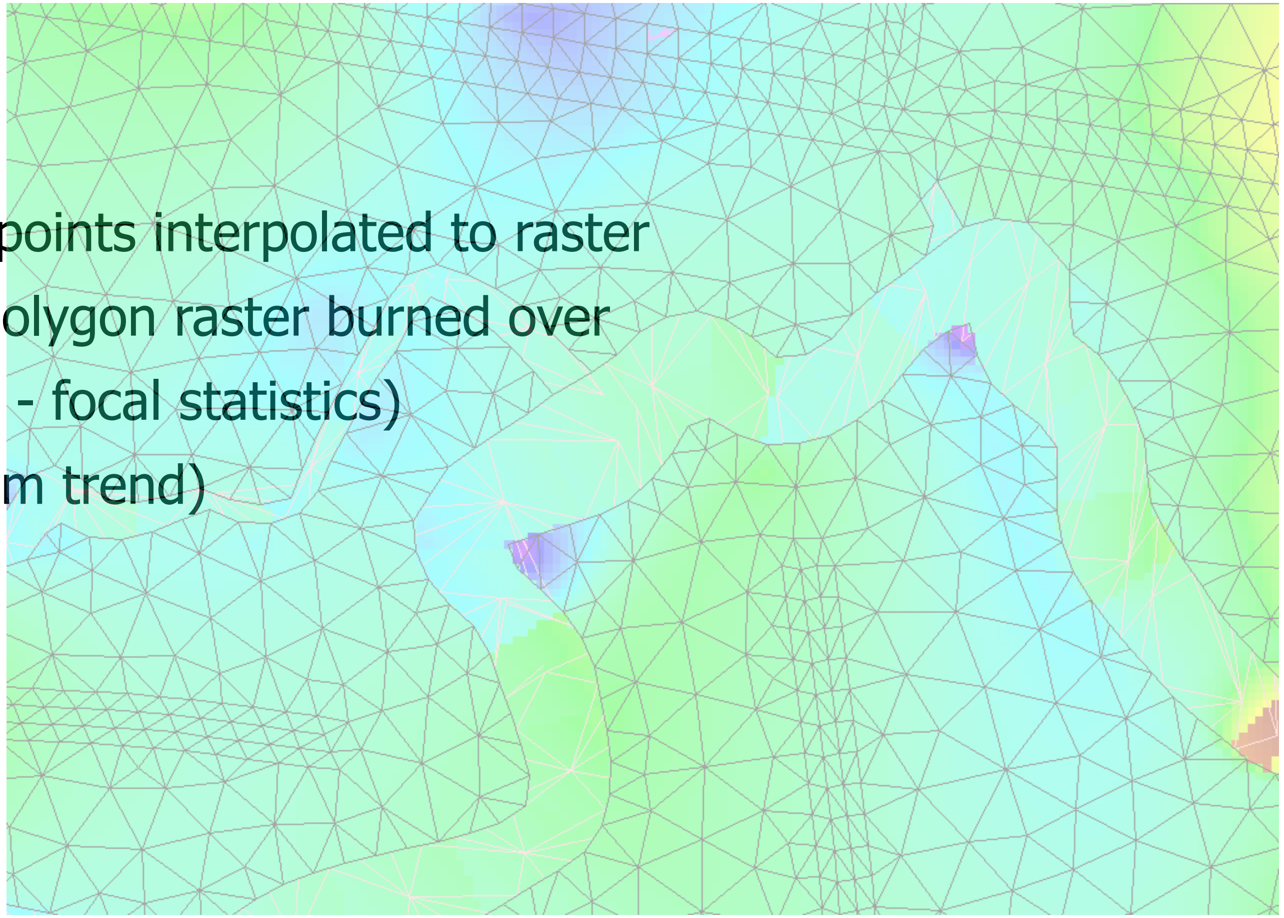
# Lessons – Major lateral flows

- Lateral linked flows connect the floodplain into & out of rivers
- Finite capacity and flow constraints to aid stability
- Unsatisfactory results where lateral flows are large



# Fault finding – high slopes

- Filter floodplain 'noise'
- Floodplain centroid points and river points interpolated to raster
- River points separately to thiessen polygon raster burned over
- Trend levels (100m radius averaging - focal statistics)
- Data minus trend (flat anomalies from trend)
- Search radius, max minus min



# Future ideas

- Bridge the important mesh gaps
- Refinement, automation and integration of fault finding
- Faults summary across large batches to prioritise remediation
- Improved lateral linking performance
- Improved mesh generation to reduce buffer erasure of conflicting features
- Improved railway embankment modelling – top levels, permeable ballast
- Reconsider Rorb for hillside hydrology

# Conclusions Acknowledgements

- Big detail, big data
- Plan, do, observe, learn
- Still learning and learning how to observe better


- Thanks to CCC
  - Helen Beaumont, Kevin McDonald, Jo Golden

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# Thank you!
# Questions? Patai?

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