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Regeneration of Christchurch stormwater modelling

Avon Citywide 2.0 Delivered

Stormwater Conference 23-25 May 2023

Presentation contents

- Christchurch challenges
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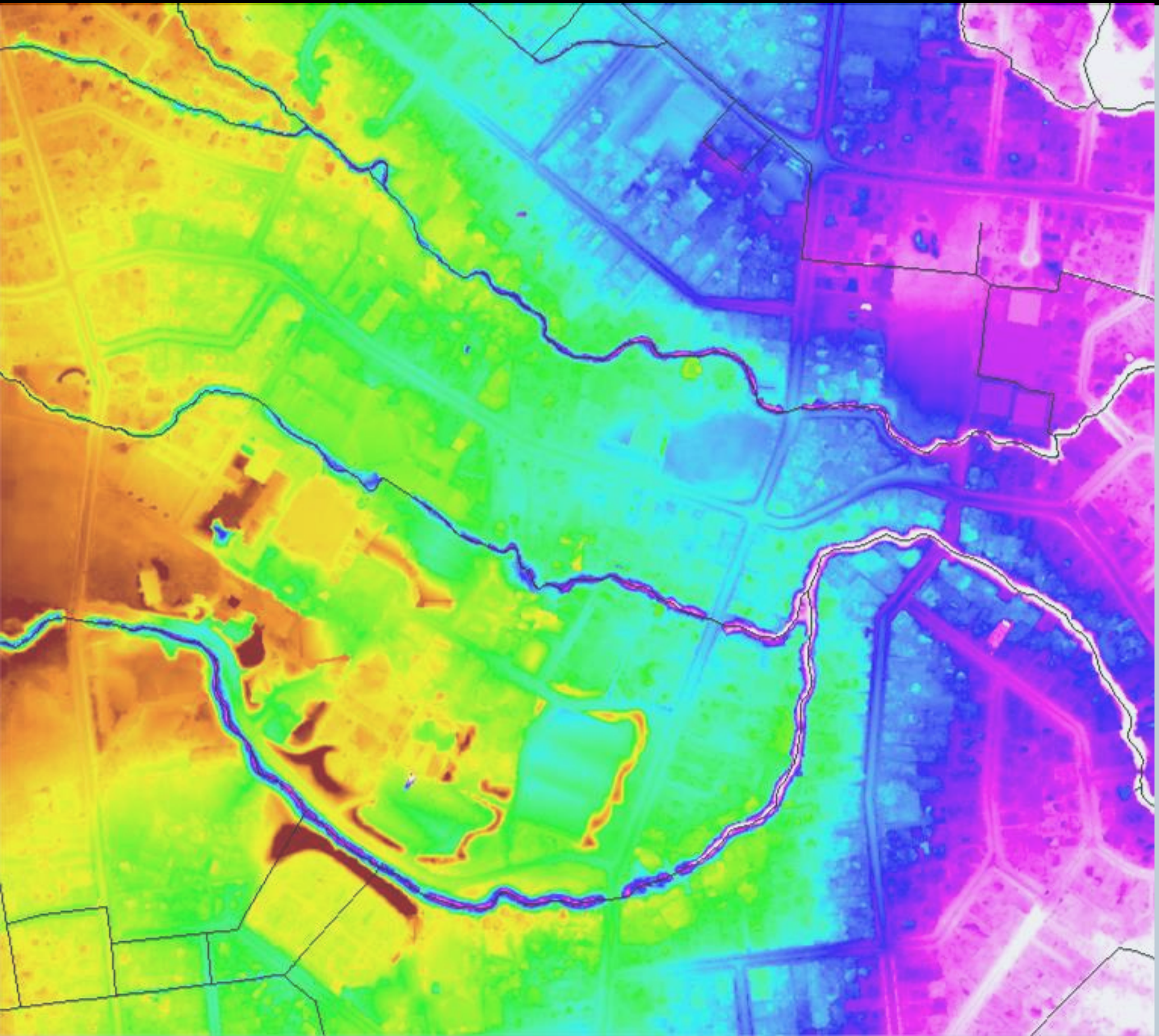
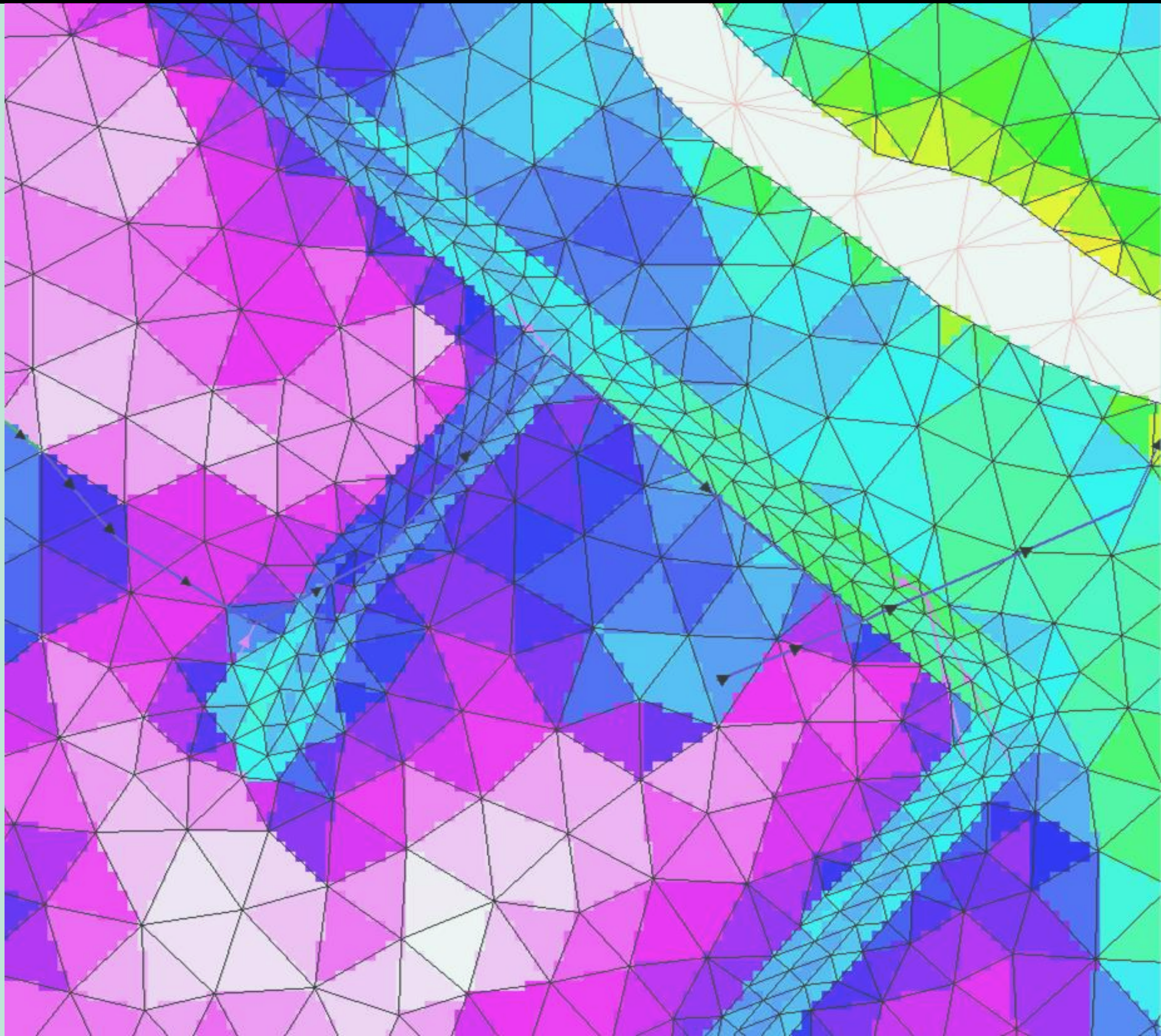
Christchurch challenges



- Flat topography, no catchments
- Reverse topography
- Detail matters
- Coastal estuary
- High sea level sensitivity
- Rainfall durations (not nested)

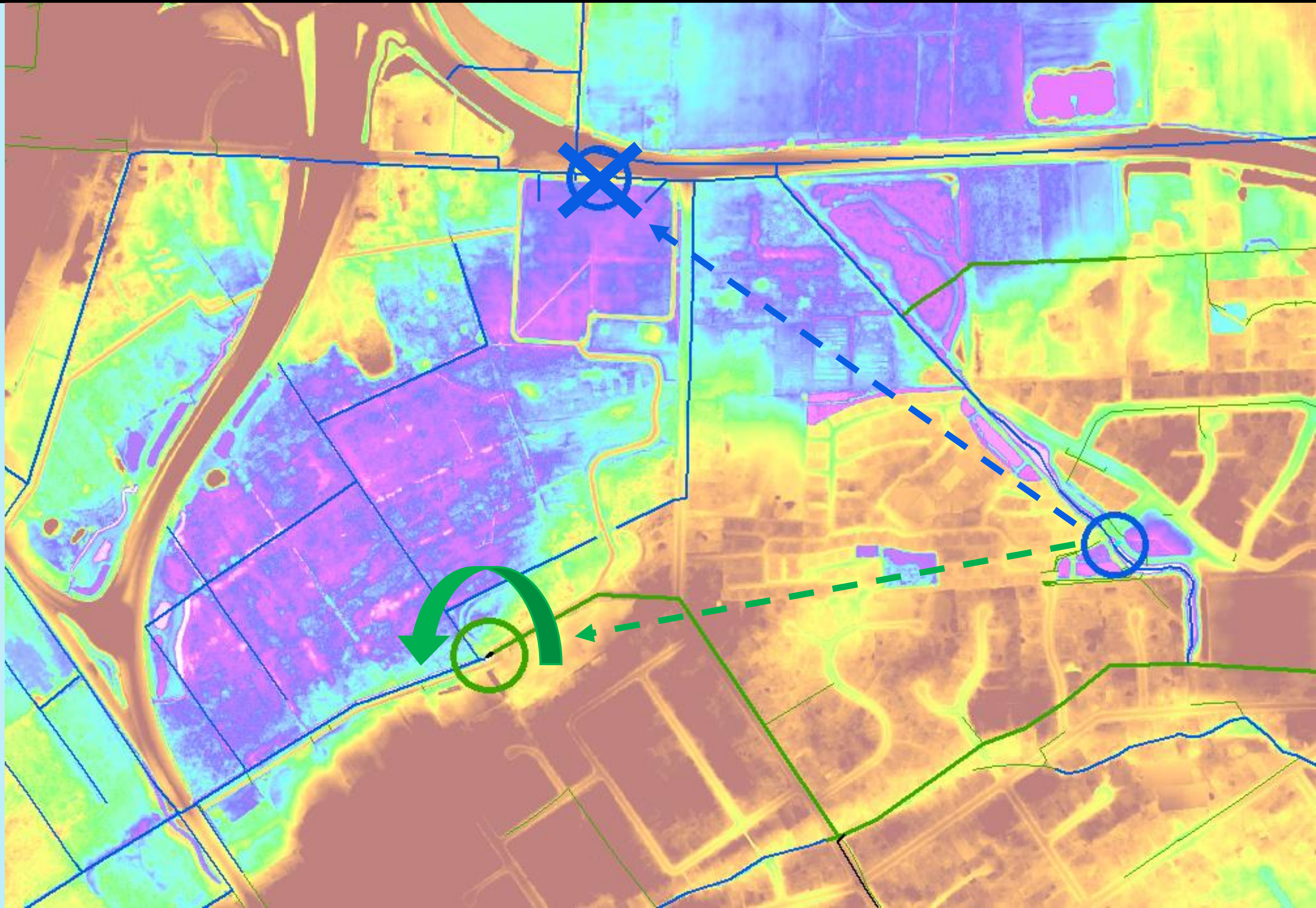
Avon “Citywide Modelling”

- 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



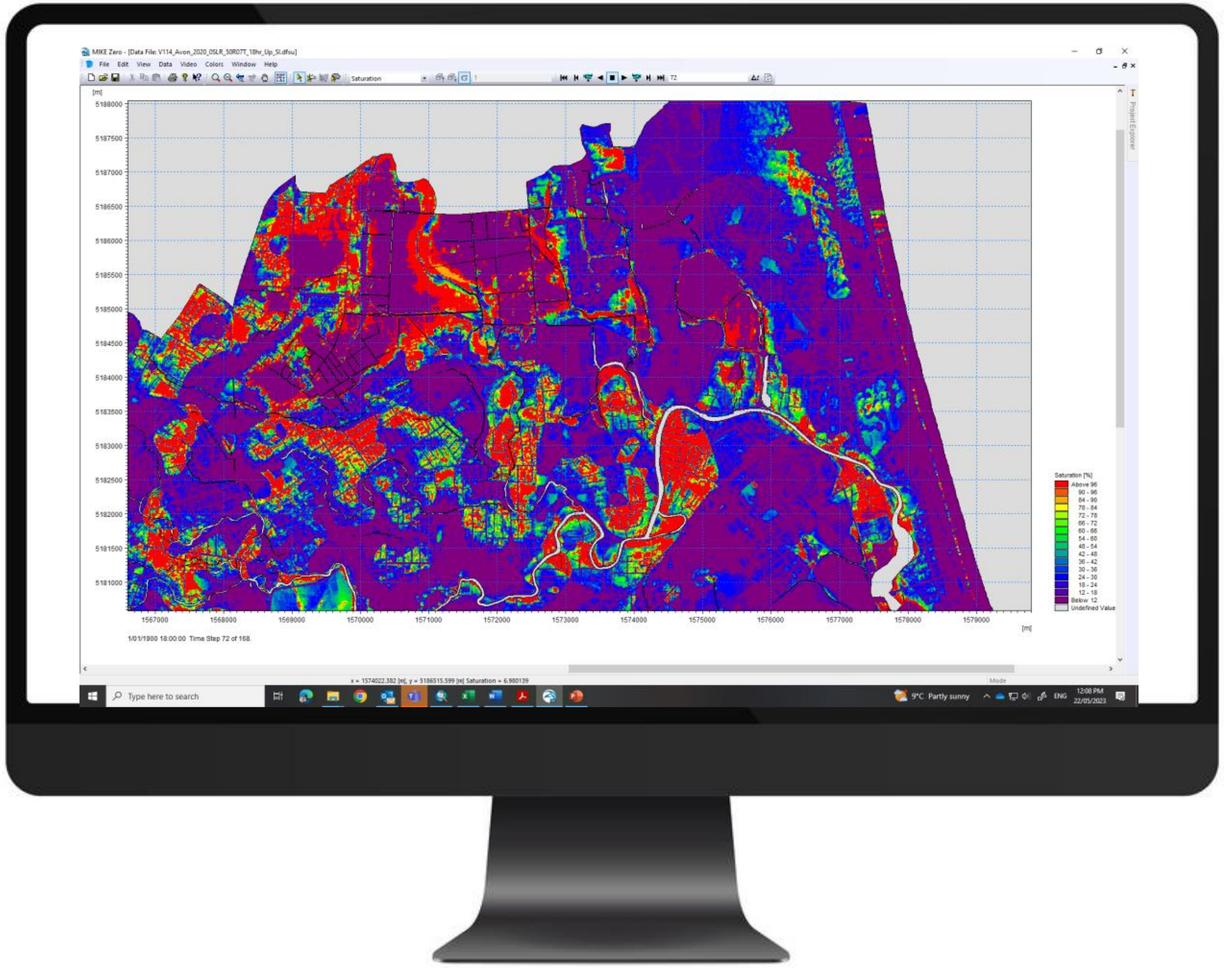
Cranford Basin Active Management

- Winters Basin then new Cranford Basin
- Buller Stream water level sensor (M11)
- M11 Winters active controlled gate (closed on high level in Buller Stream)
- MU Cranford PS219 controlled locally
- MU Cranford PS219 controlled by M11 Buller Stream

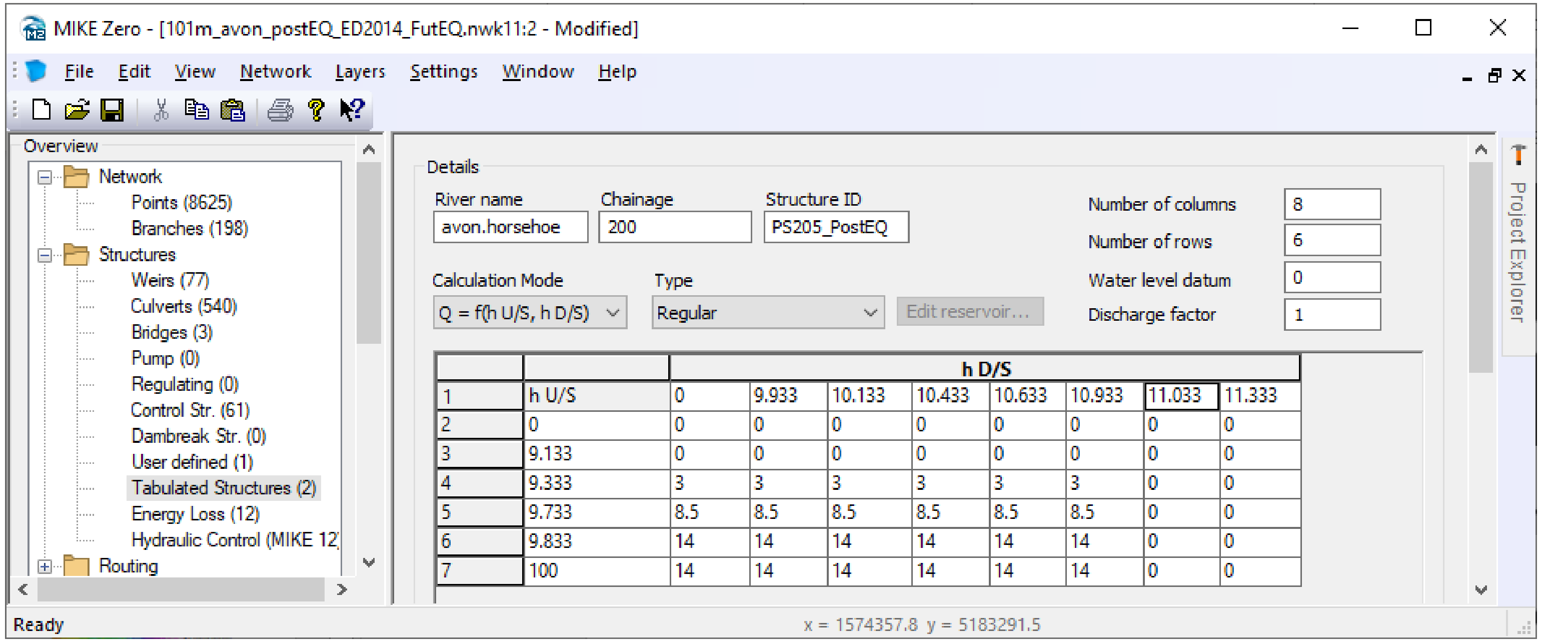


Modelling high groundwater

- Increasing importance with sea level rise
- Incompatible with defacto Horton’s or other methods
- DHI “M21 Constant Infiltration with Capacity”
- 50 yr 18 hrs ED result at end of rainfall V114_Avon_2020_0SLR_50R07T_18hr_Up_SI.dfsu



Horseshoe lake pump station



- 14m3/s Archimedes screw pumps
- Extended for king tide capacity
- Non-linear relationship with tailwater level
- Does not conform with Q-H or Q-deltaH
- M11 network - tabulated structure approach

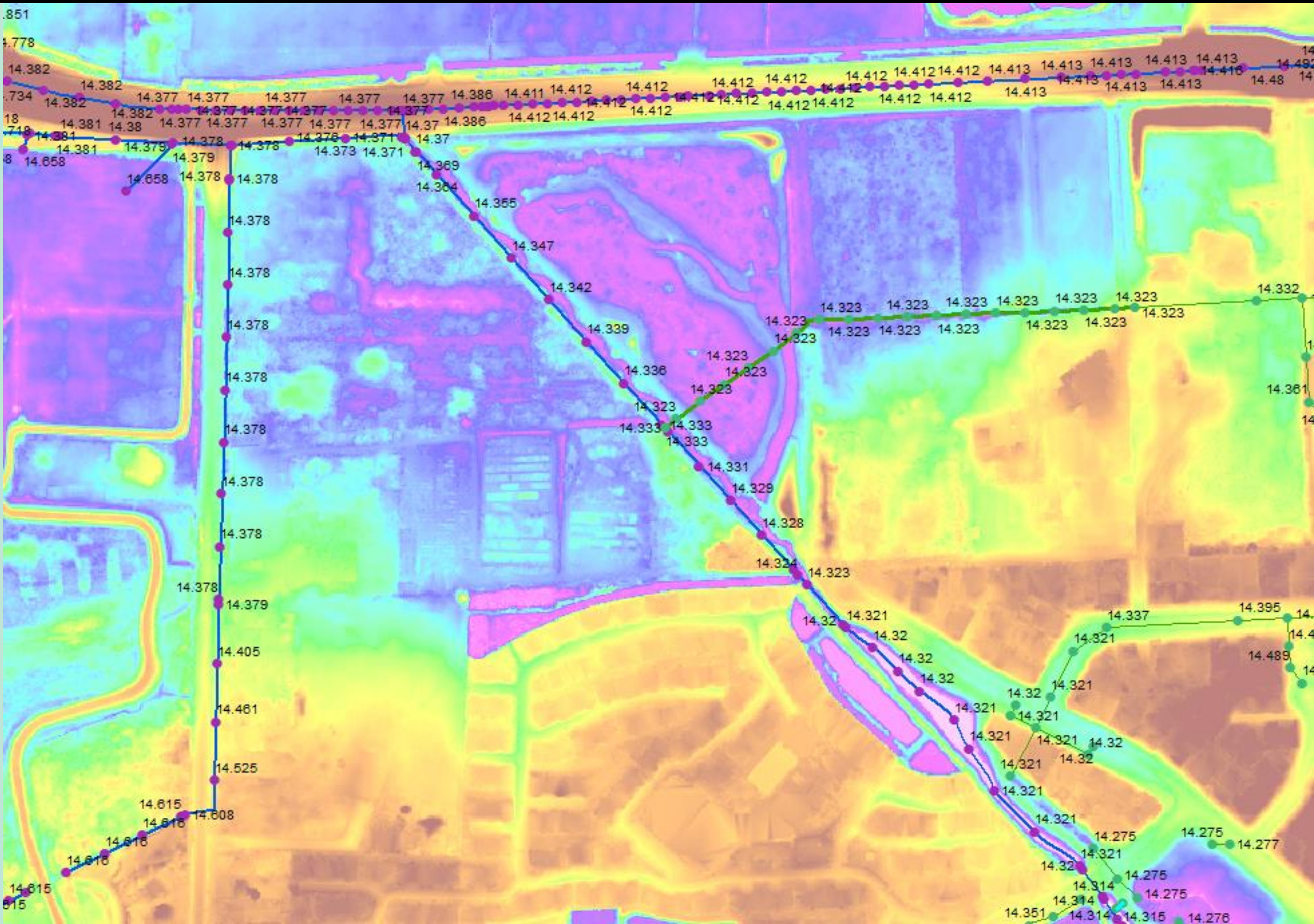
Model Runs

- 17 Scenarios
  - Future conditions
  - Various other specifics
- 4 ARIs
  - 10, 50, 200, 500yr ARI
- 43 combos (ARI scenario)
- 4-6 Rain event durations for each combination
- 210 Total model runs
  - 600 Gb digital deliverables

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	Joint Probability	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+		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	1:10 ratio	Even	2068	85^{th}	+1.00m	16%	Down	noEQ	n/a	n/a	Yes*	n/a
15	DistrictPlan Current		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*

1D points tool

- Max water levels from MU+M11 across multiple results
- Max of run, max of batch and critical duration
- Geometries from PRF and RES11 files
- Output CSV ready for SHP
- Log file records inputs and outputs
- Open-source and published on Github

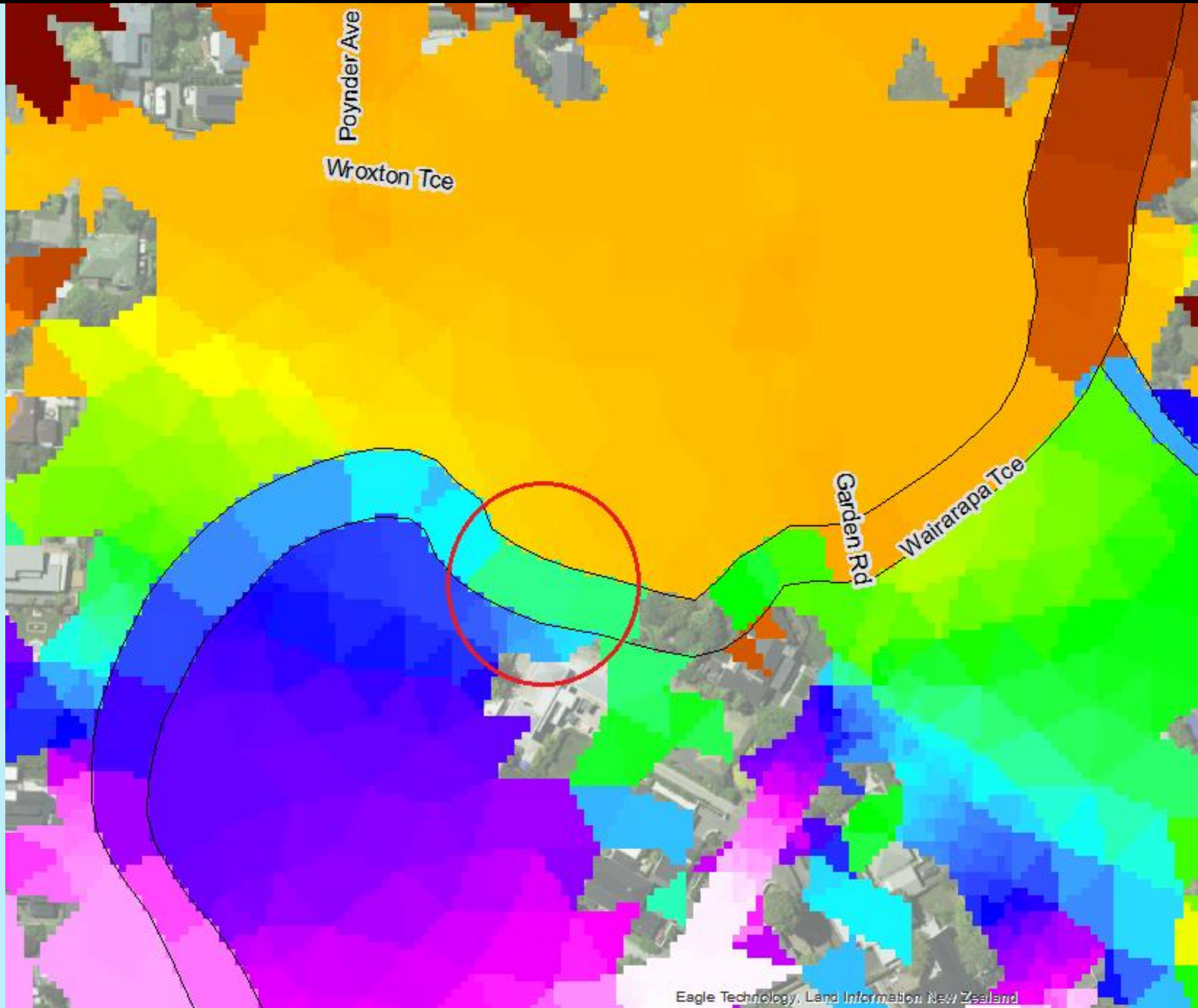


1D points tool

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	S	T
1	node_id	file_type	projection	x	y	invert_level	V114c_Av	V114c_0S	V114_Avor	V114_0SL	V114_Avor	V114_0SL	V114_Avor	V114_0SL	max_of_max_level	max_of_max_depth
2	AVON.Inlet.CCCGIS.49278	prf		1568633	5184102	18.5		18.593		19.514		19.428		18.748	19.514	1.014
3	AVON.AVON 18382.1	res11		1573383	5181334	8.497	11.244		10.987		11.156		11.413		11.498	3.001
4	AVON.Inlet.CCCGIS.289	prf		1578019	5183279	10.155		11.406		11.723		11.789		11.768	11.789	1.634
5	AVON.Wc.avon.rawhiti.249	prf		1577465	5183615	10.49		11.05		11.047		11.419		11.62	11.62	1.13
6	AVON.MOORES 520.0	res11		1570562	5184579	13.09	14.216		14.227		14.246		14.248		14.378	1.288
7	AVON.RHODES12 74.9	res11		1571623	5185905	12.322	13.142		12.904		13.126		13.302		13.365	1.043
8	AVON.Access.CCCGIS.2406	prf		1566505	5183841	24.694		25.514		25.909		25.907		25.899	25.909	1.215
9	AVON.Inlet.CCM.6397	prf		1570873	5179668	13.019		13.884		15.015		15.015		14.731	15.015	1.996
10	AVON.HEWLINGS 644.4	res11		1565805	5182904	24.348	25.11		25.352		25.422		25.435		25.435	1.087
11	AVON.Inlet.CCCGIS.11244	prf		1565385	5180787	23.464		23.97		24.492		25.156		25.154	25.156	1.692
12	AVON.STALBAN 5814.3	res11		1572172	5182051	10.991	12.038		12.064		12.24		12.259		12.259	1.268
13	AVON.SNELLNG 2239.9	res11		1574058	5185305	9.872	11.013		10.904		11.144		11.244		11.244	1.372
14	AVON.Access.CCCGIS.11586	prf		1568665	5180514	16.316		16.591		17.276		17.291		17.343	17.343	1.027
15	AVON.Access.CCCGIS.2214	prf		1566277	5184957	25.665		27.022		27.015		27.155		27.204	27.204	1.539
16	ESTY.CHARLBR1 157.3	res11		1575833	5178875	10.52	11.026		10.848		10.885		10.882		11.026	0.506
17	Avon.Access.CCCGIS.20253	prf		1573259	5186139	10.19		11.832		12.243		12.386		12.351	12.386	2.196
18	AVON.BINGSDR 1029.2	res11		1572014	5182570	11.612	12.398		12.387		12.638		12.93		12.93	1.318
19	AVON.Wc.riccmain2038.5	prf		1568039	5180047	15.32		17.499		17.619		17.893		18.186	18.186	2.866
20	AVON.Outlet.CCCGIS.13748	prf		1566499	5184601	25.028		26.233		26.229		26.362		26.421	26.421	1.393
21	AVON.Access.PAM.9440	prf		1575887	5186429	11.451		12.363		12.691		12.779		12.774	12.779	1.328
22	AVON.Inlet.ARM.21767	prf		1576140	5183087	10.092		10.639		11.37		11.347		11.321	11.37	1.278
23	AVON.AVON 16482.4	res11		1572715	5181356	8.998	11.398		11.148		11.508		11.745		11.768	2.769
24	AVON.Access.CCCGIS.2501	prf		1566617	5180165	20.663		21.899		22.147		22.218		22.227	22.227	1.564
25	AVON.Inlet.CCCGIS.17019	prf		1564388	5182667	29.038		29.57		29.665		29.977		30.01	30.01	0.972

Lessons learned – lateral flows

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

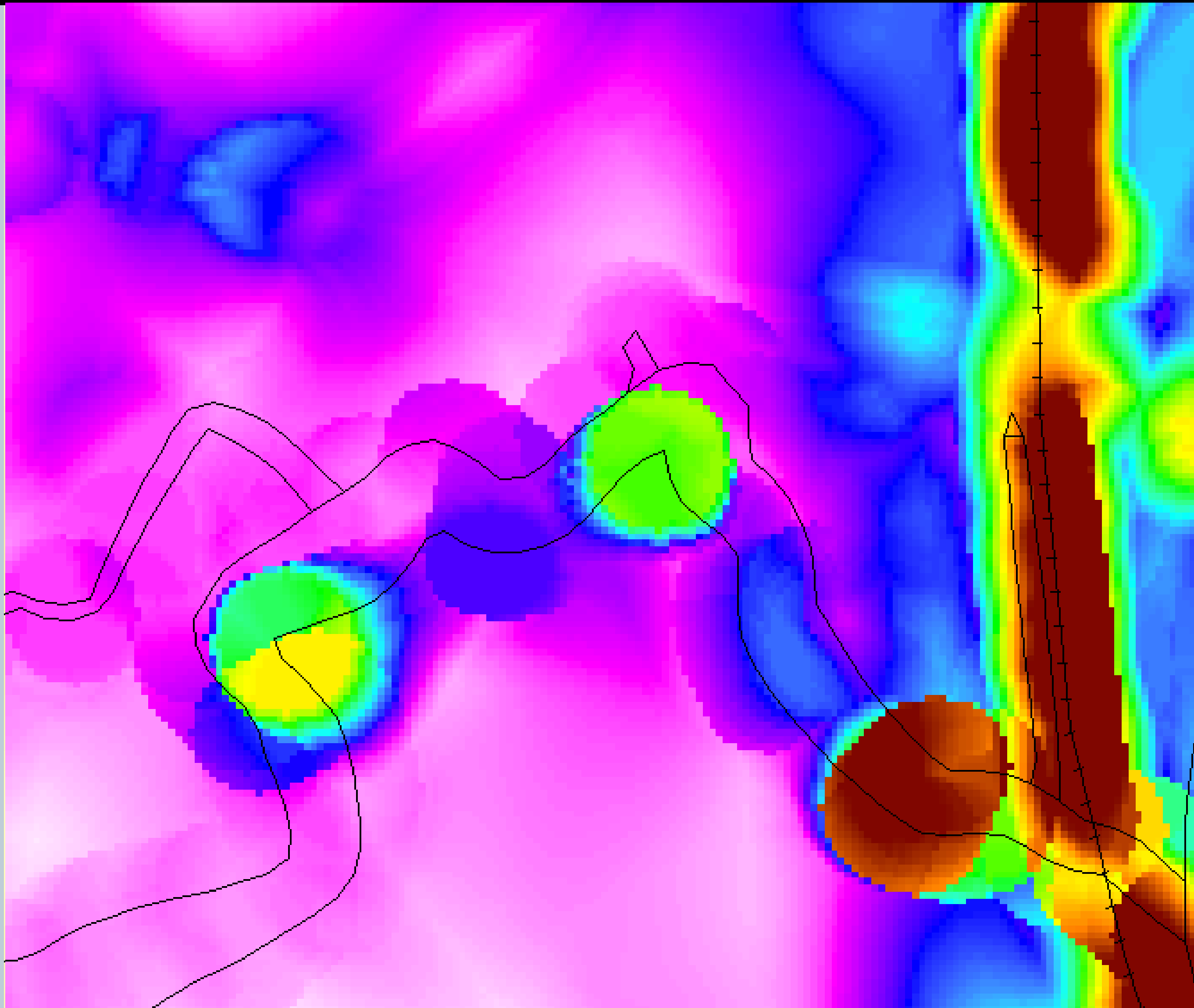


Lessons learned - blockouts

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

Fault finding – high slopes

- Harakeke Street North
- 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)
- Data minus trend (flat anomalies from trend)
- Search radius, max minus min



Conclusions Acknowledgements

- Big detail, big data
- Plan, do, observe, learn
- Still learning how to observe better
- Pay attention to water levels between floodplain and rivers in conjunction with the depth tolerance parameter
- Continuity of road surfaces in the floodplain model was more important to results than we anticipated
- Open source programming can enhance our ability to process large model result sets into more useful summary forms

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

✱ Thank You

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