Loxwood Flood Alleviation Options Appraisals:

Overview of Hydraulic Modelling

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Progress and Aims

Progress to date

- Topographic survey of watercourse
- Hydraulic model build
- Baseline modelling
- 1 in 20 and 1 in 100 events
- Initial mitigation optioneering modelling (20yr & 100yr)

What's next

- Model changes (if requested)
- Refine optioneering models (if necessary)
- Model preferred scheme
- Model full set of rainfall events
- Complete study

Flood Forum input to move the study forward

- Are there any comments on the baseline and option models?
- Should any addition detail should be included into the model?
- Are there any preferences regarding which options to include in preferred scheme?

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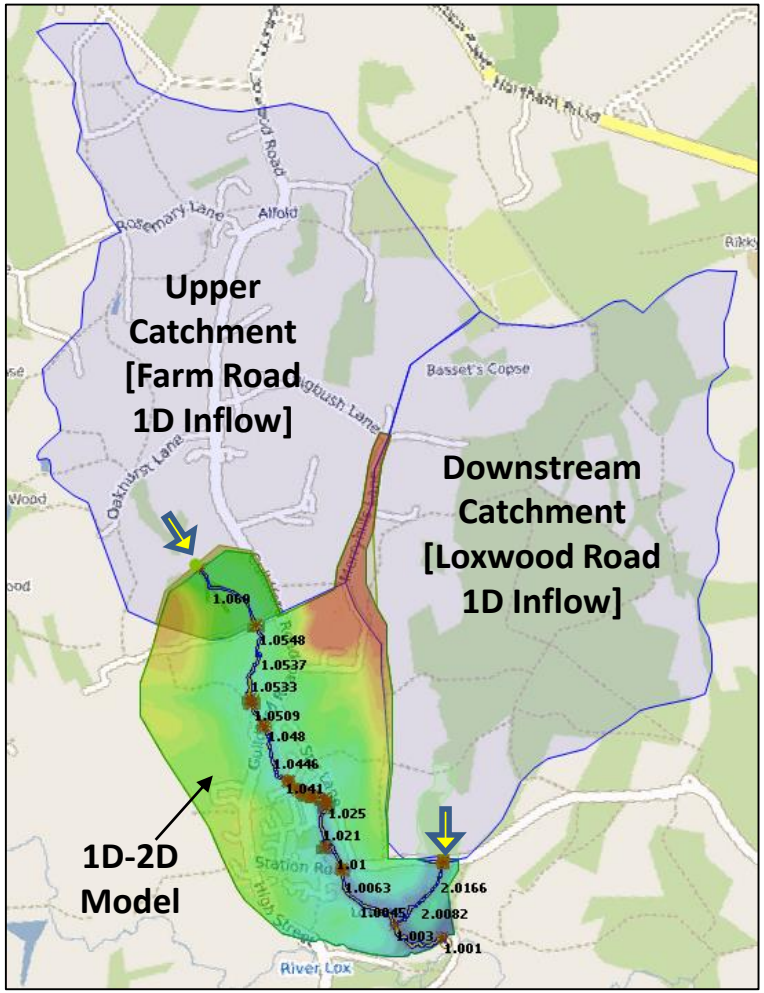
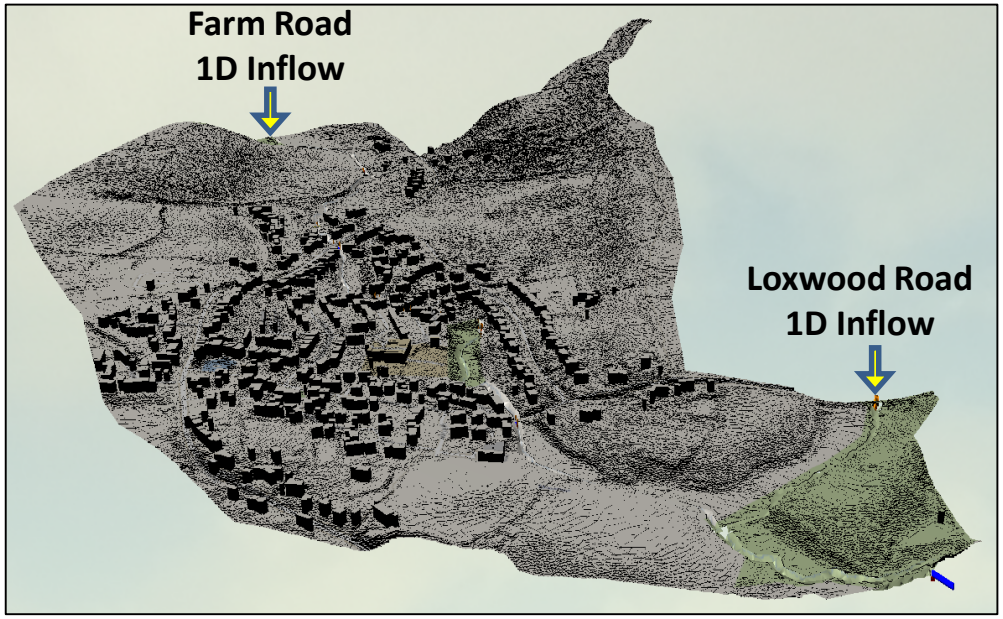
Hydraulic Model Overview





- 1D Upper catchment inflows
  - Upstream of Farm Road
  - Upstream of Lowwood Road
- 1D-2D Model of watercourse through Loxwood village and lower reach to canal

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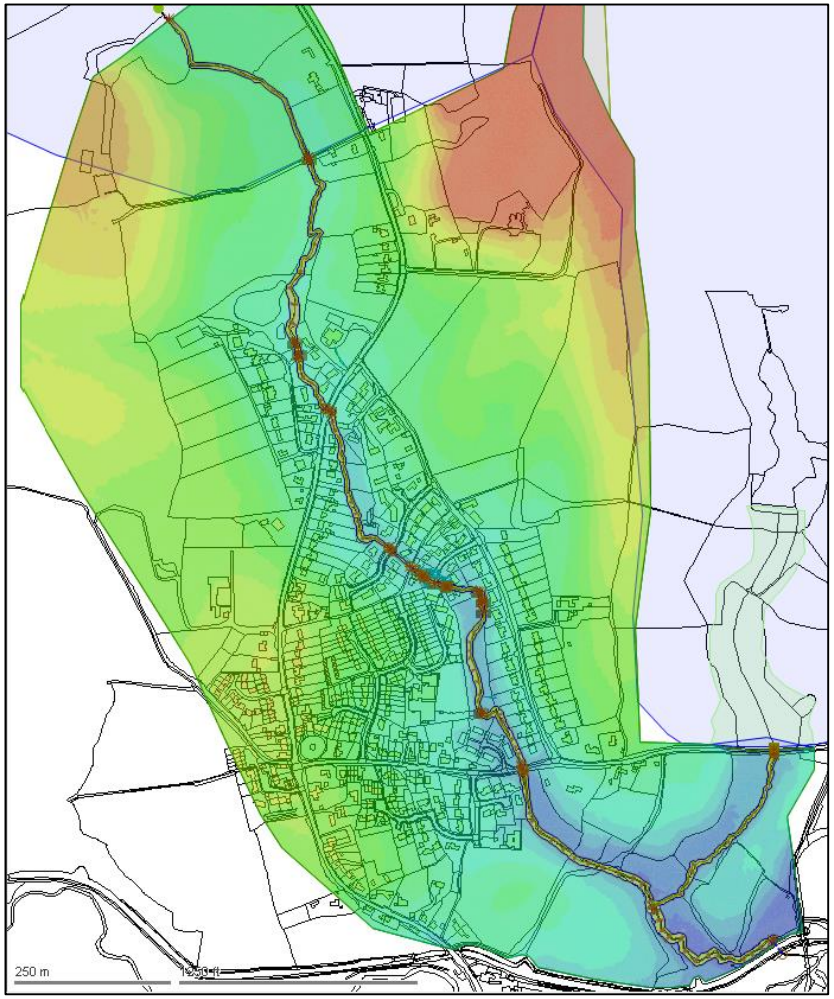
1D-2D Model Discussion



What is included in the model

- Watercourse fully modelled in 1D
- 2D model refined for various surfaces
- Buildings raised
- Pond Close and Oak Grove detailed walls included in 2D
- Rainfall directly onto the 2D model
- Infiltration and excess rainfall runoff calculated across the 2D model

What is not modelled (but could be)

- Property walls and fences
- Road and roof drainage

Assumptions

- Catchment soil type (loam vs clay)*
- Initial soil moisture content (70%)
- Downstream boundary (Fixed - 100+35%CC)

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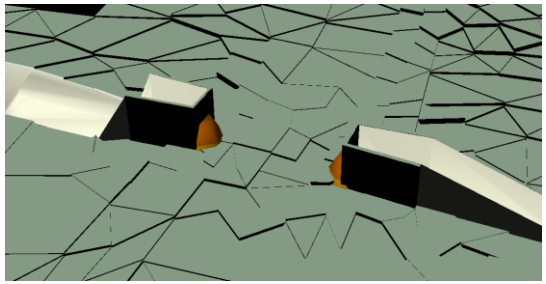
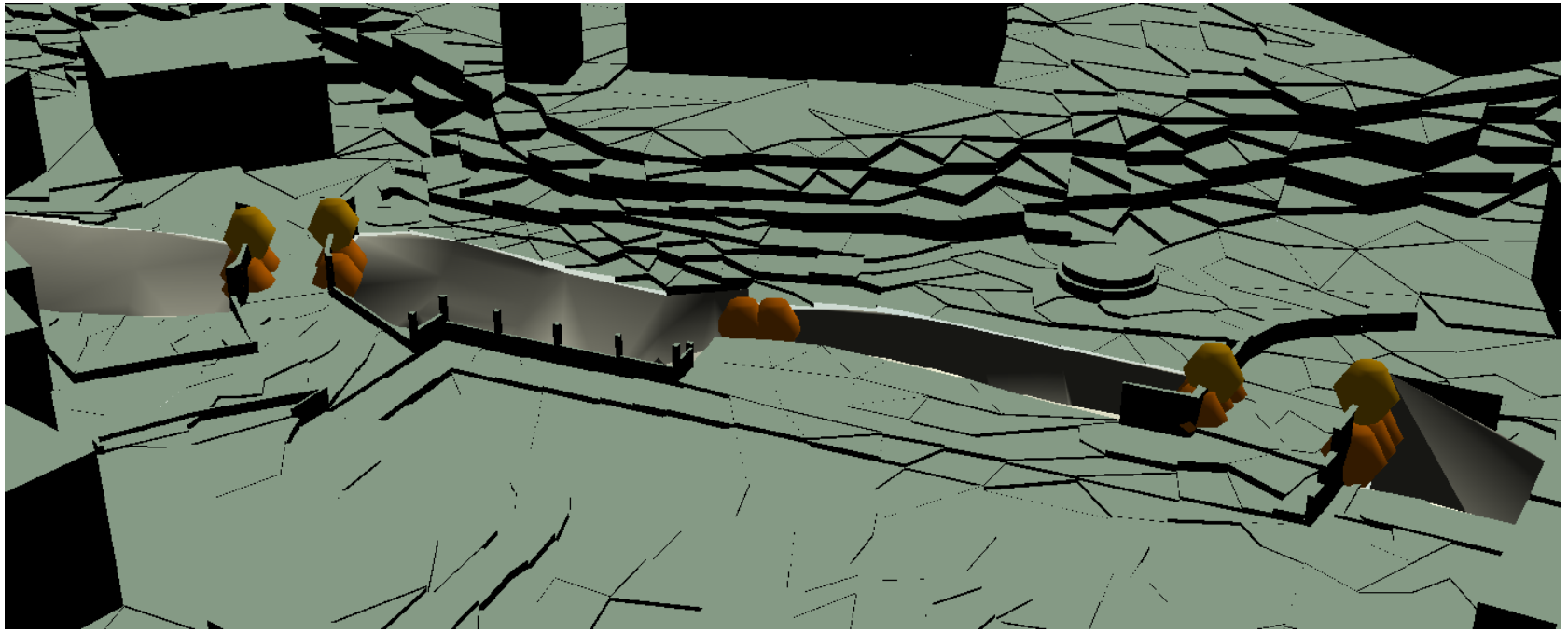
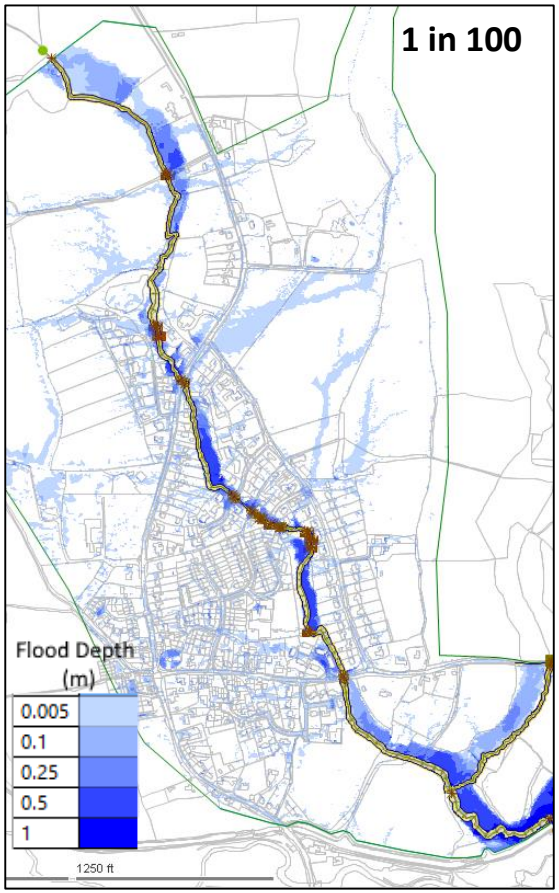
Additional Detail into 2D Model

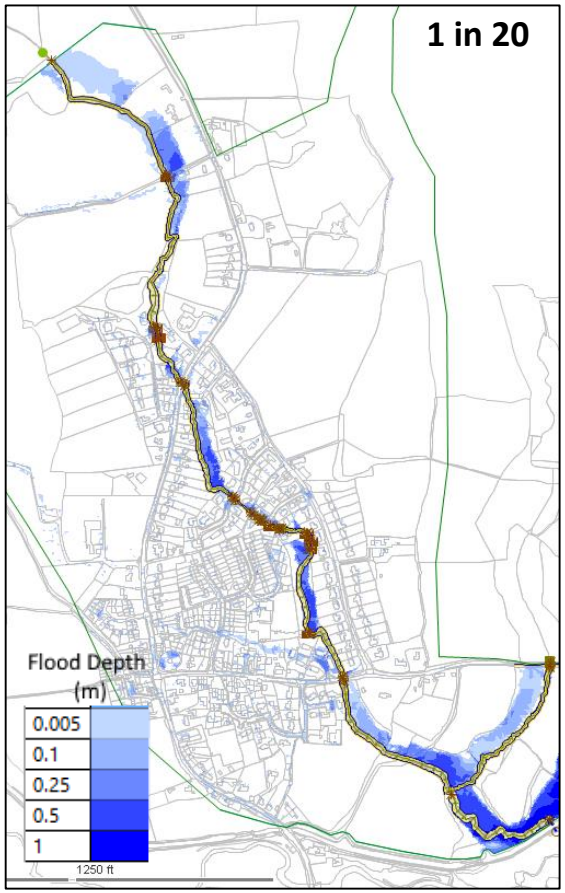


- Pond Close Headwalls
- Detailed representation of Oak Grove road, channel and walls included into model from the topographic survey



Overview of Baseline Results





- Excess surface water flow routes combining with river flows
- Surface water flows may be underestimated for 20yr rainfall event (Modification of soil type / soil moisture?)
- Focus on the 100yr results for options assessments in this presentation

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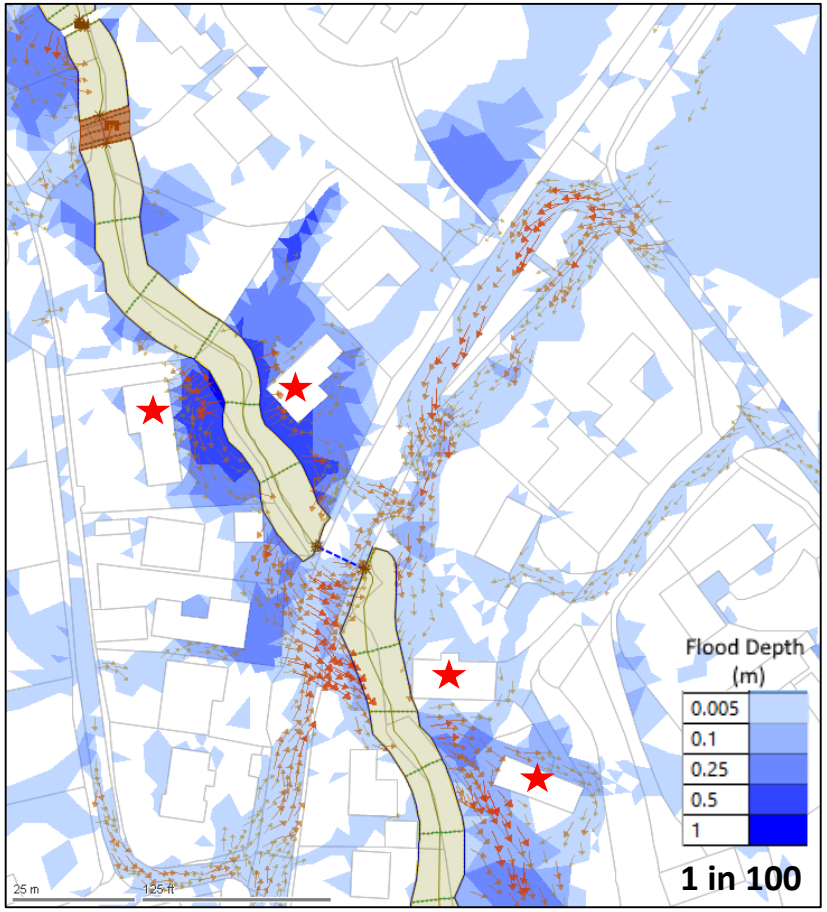
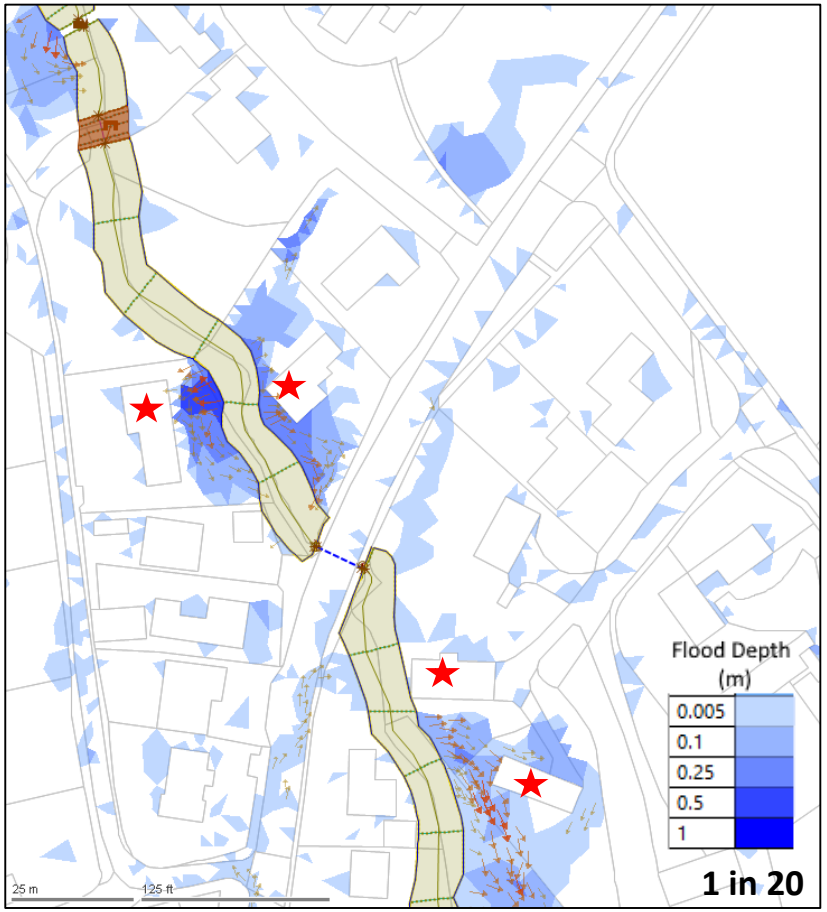
Baseline – Guildford Road





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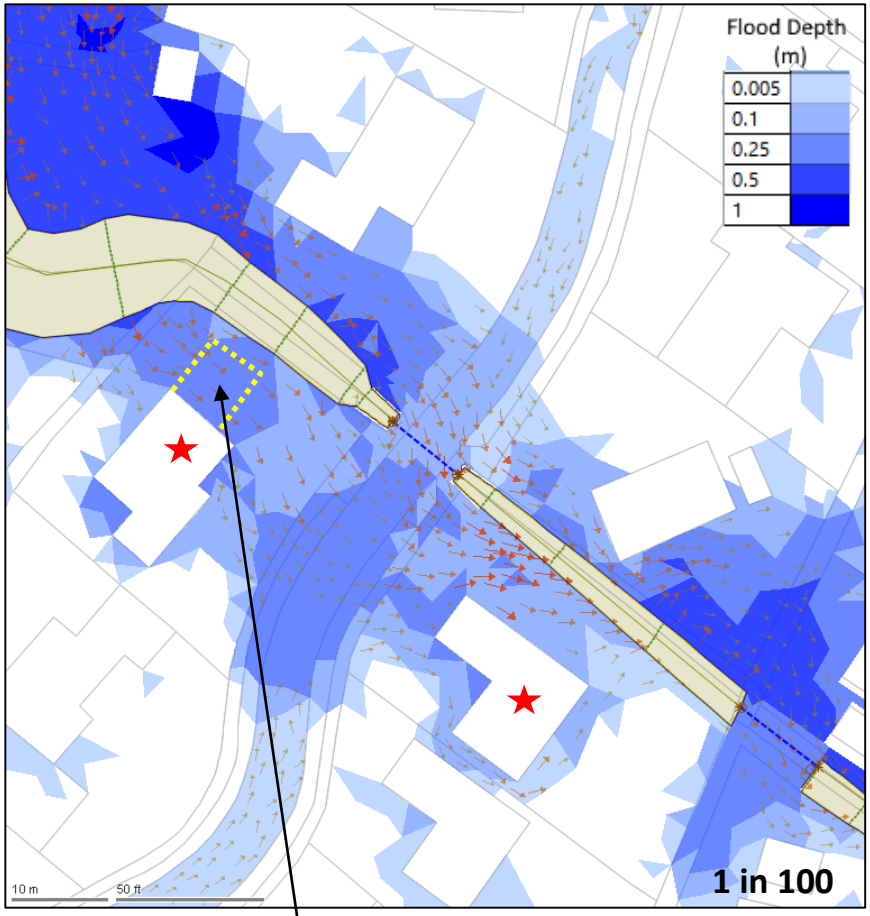
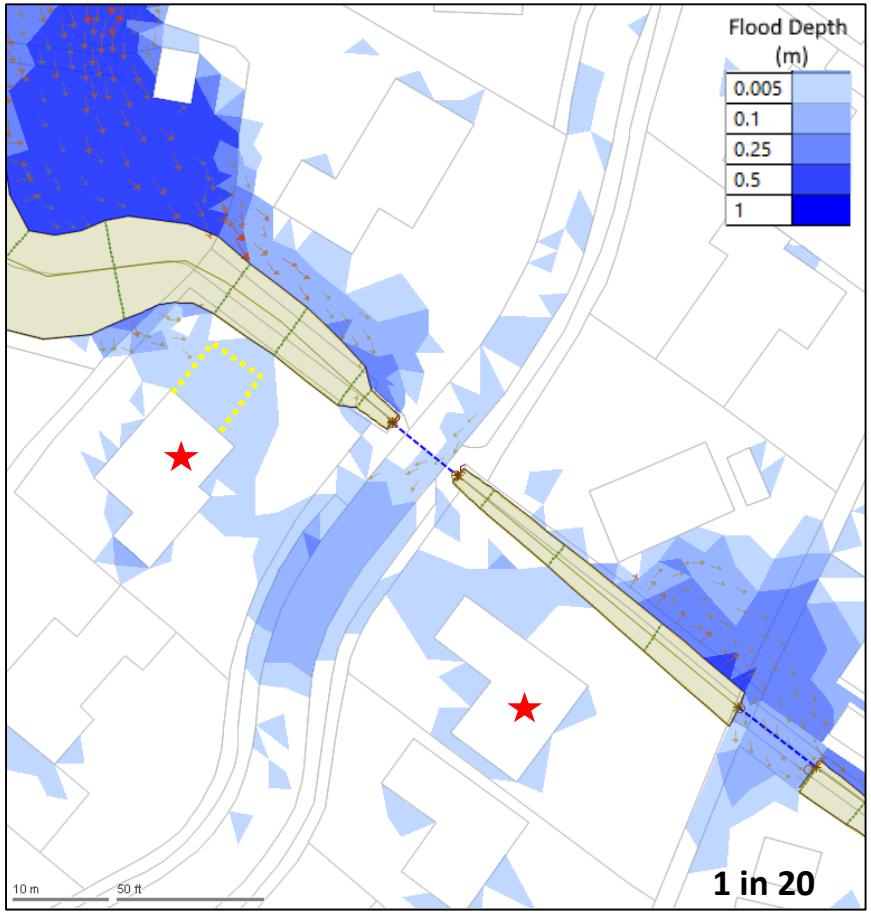
Baseline – Pond Close





New garage not represented in model (to be added)

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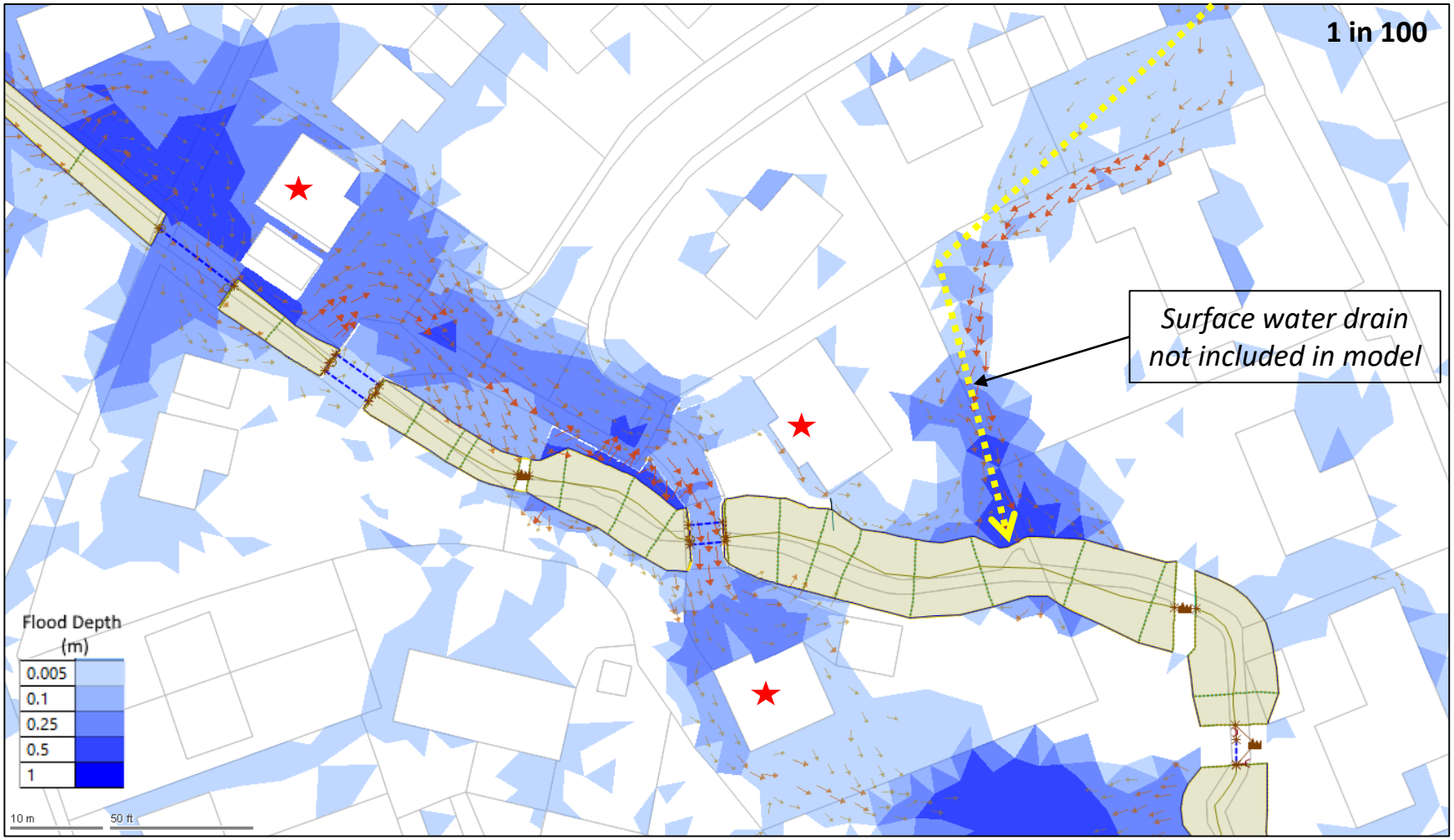
Baseline – Oak Grove (1 in 100)



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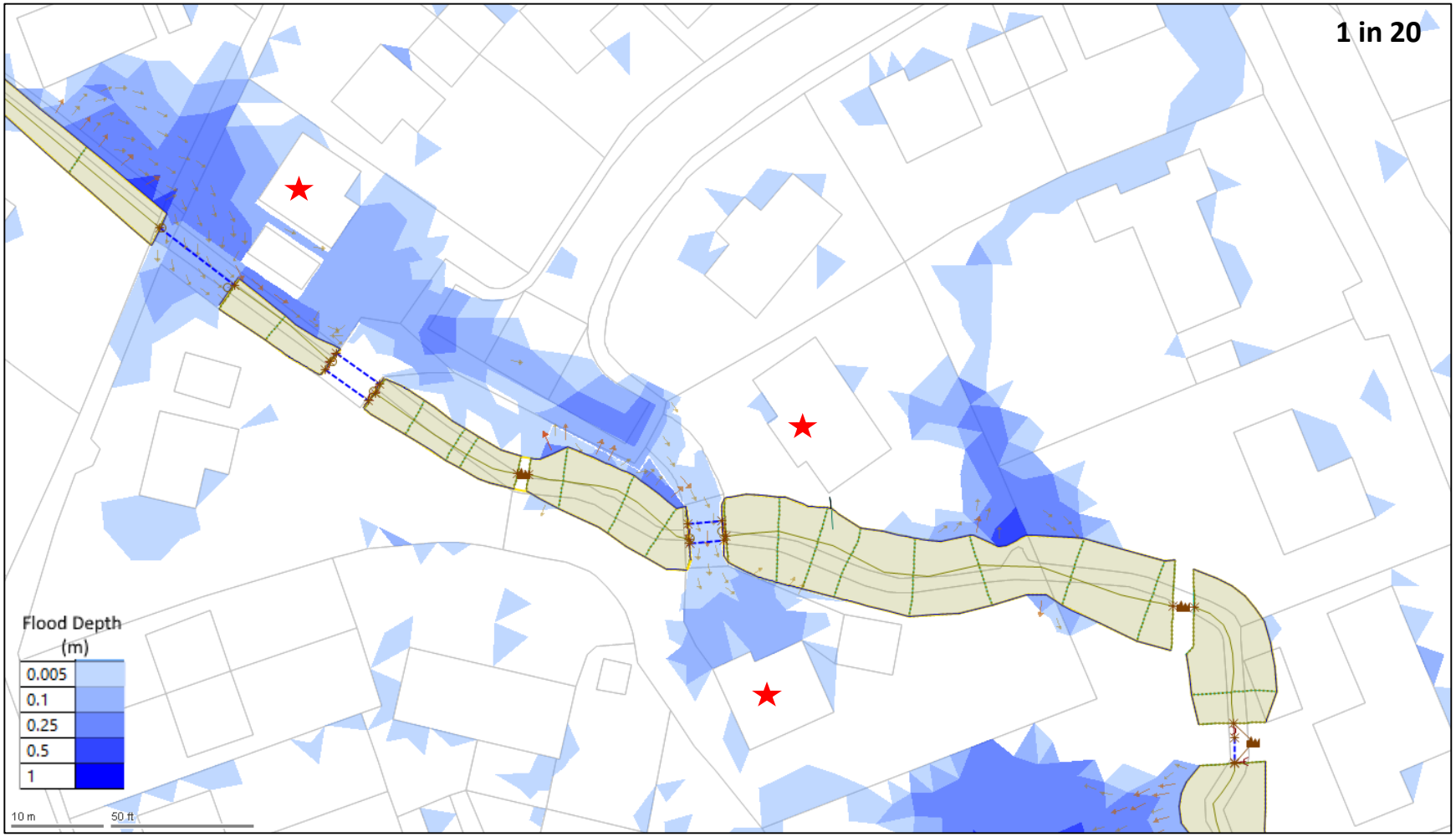
Baseline – Oak Grove (1 in 20)



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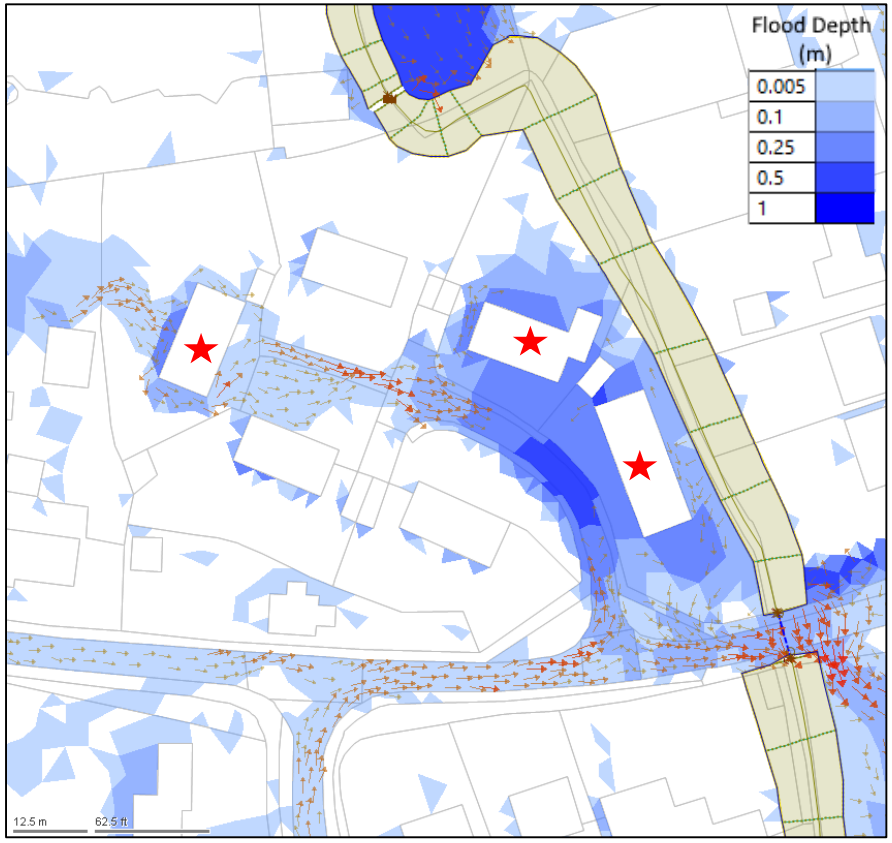
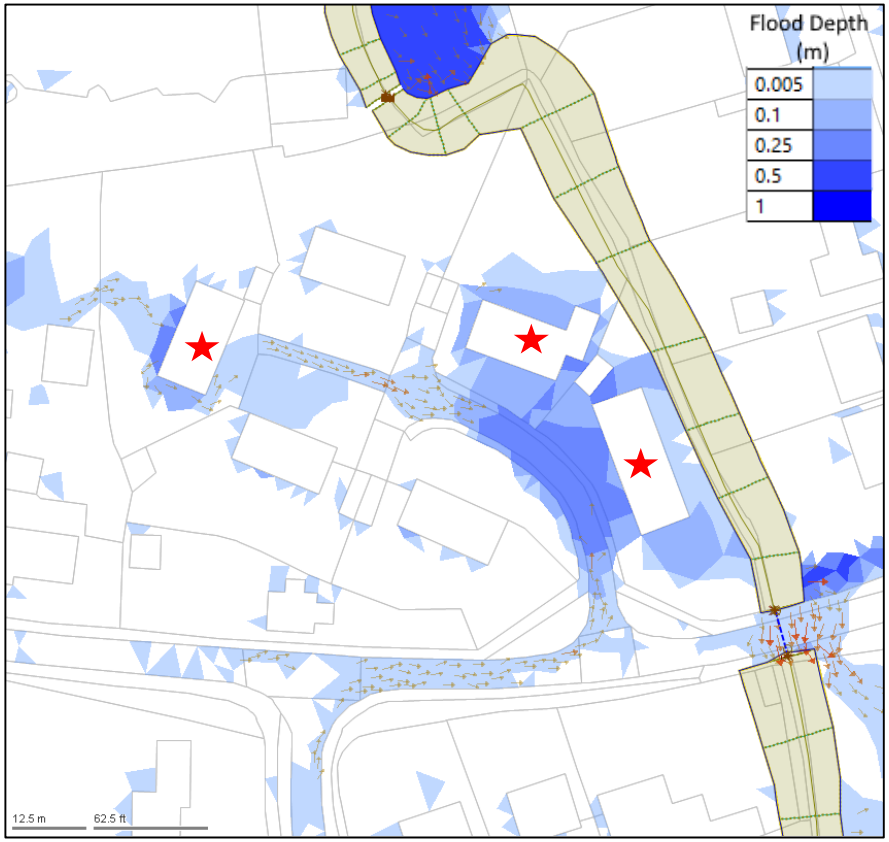
Baseline – Burley Close



1 in 100



1 in 20

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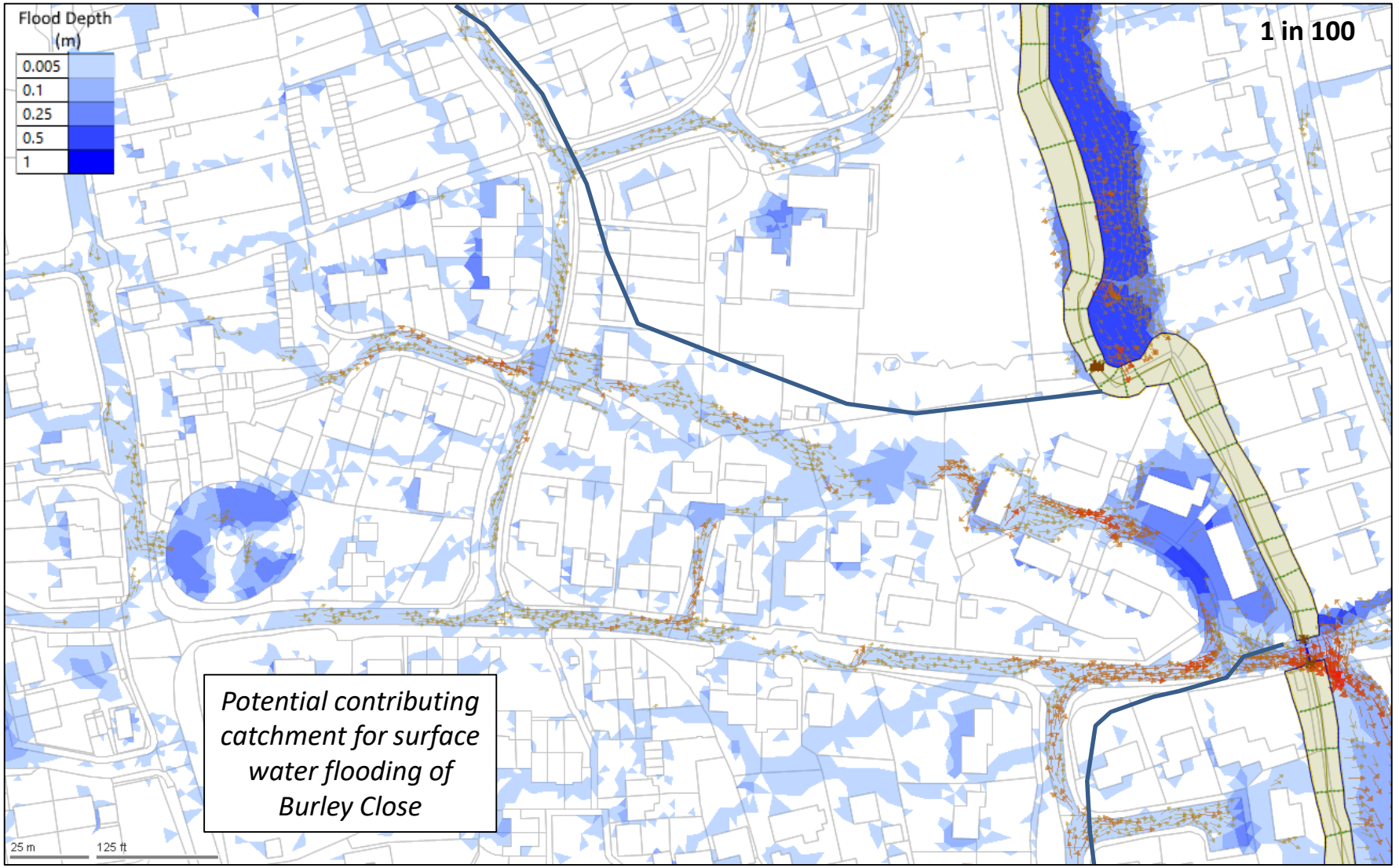
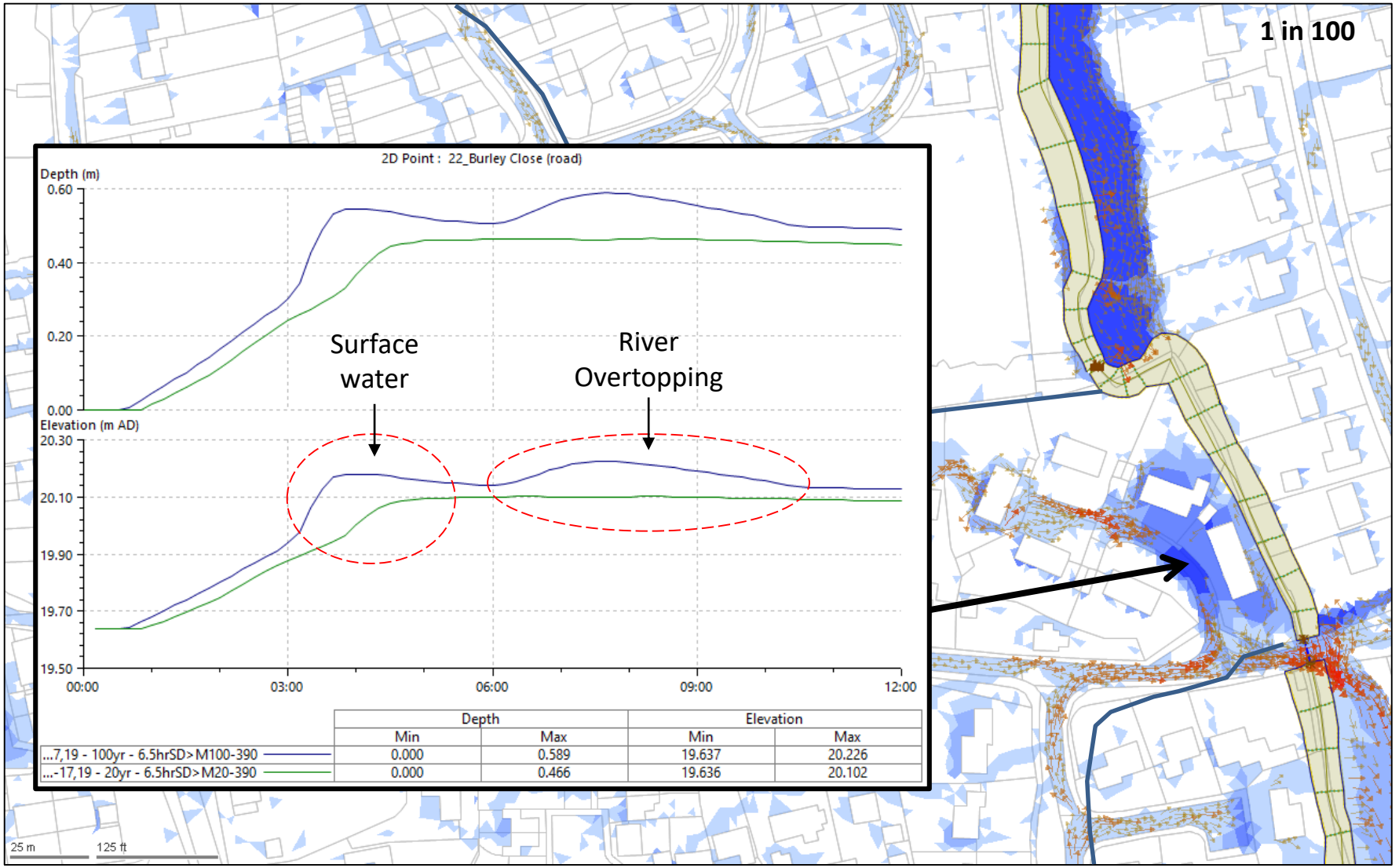
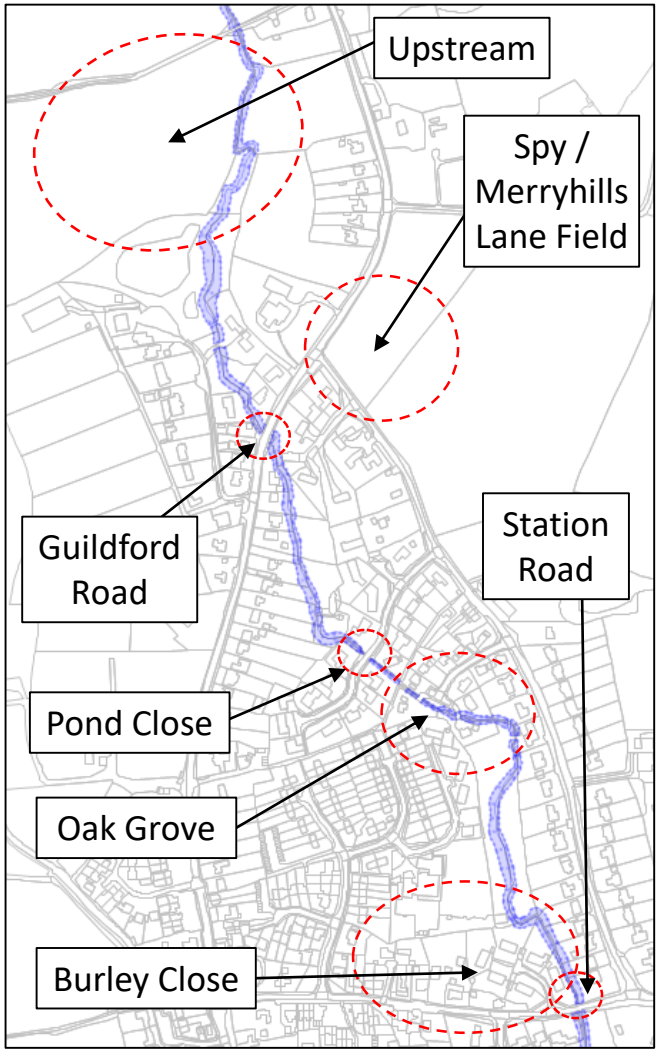
Burley Close SW Catchment



Burley Close Flooding



Flood Alleviation Options



- 19 Mitigation option combinations modelled
- Options include all those set out by the Operation Watershed funding
- Additional options included for areas deemed of interest from original study (Oak Grove and Pond Close)
- Further options included toward mitigating surface water flooding of Burley Close.

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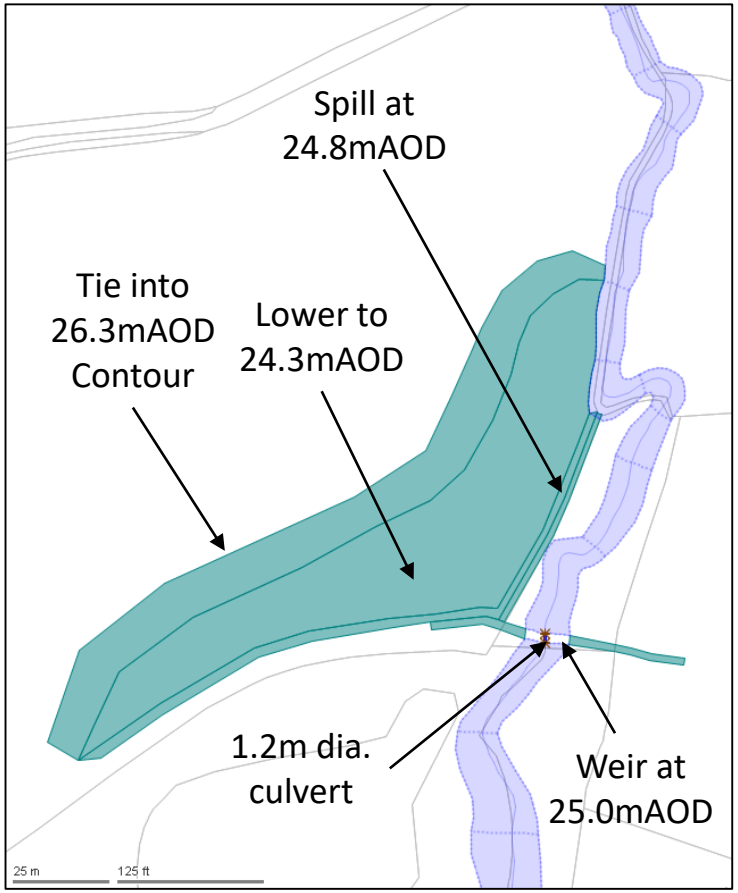
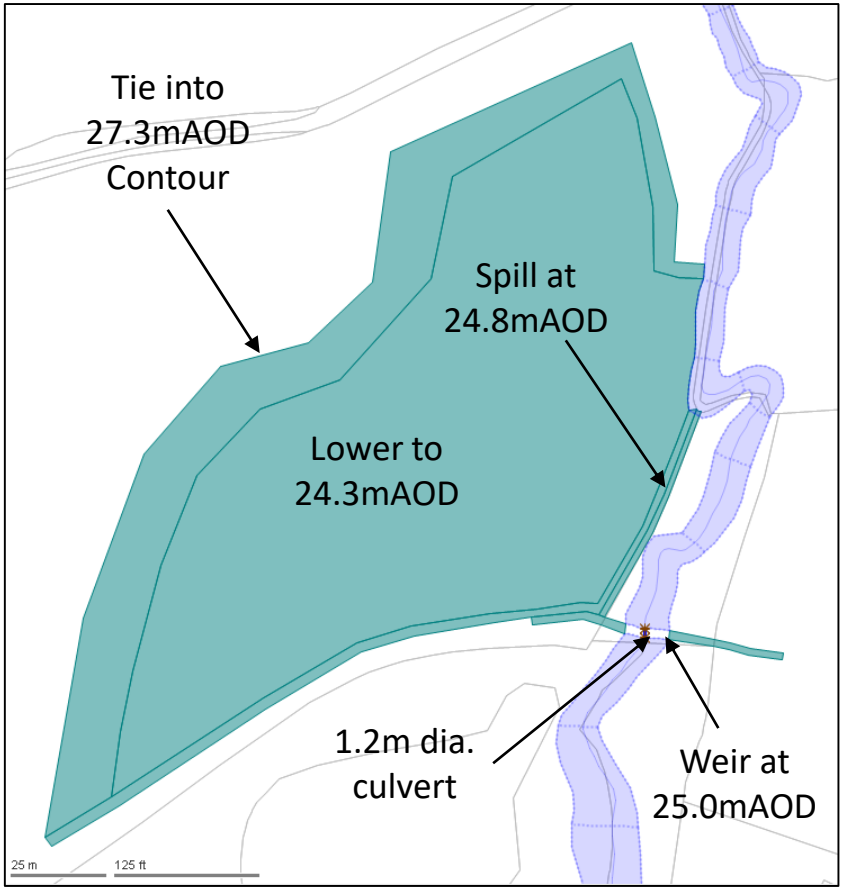
Upstream Options

- 3 Mitigation options
- Reduction in upstream flow rate
  - Increased channel roughness for channel upstream of North Hall (to 'woodland' type roughness)
- Upstream flood storage ponds
  - New stream embankment (weir) across the river channel opposite North Hall fields to approx. 1.3 high from bed level and 0.8m from top of bank level
  - 1.2m diameter culvert through embankment
  - Right bank spill bund to new pond 0.2m lower than stream embankment weir [at 0.3m above stream bank level]
  - New pond area lowered by 0.5m from spill level
  - 2 Pond size options
  - **Flood Storage Pond Version 1:** Max 2m excavation [0.55 hectares]
  - **Flood Storage Pond Version 2:** Max 3m excavation [1.64 hectares]

Upstream Flood Storage Ponds



FS Pond Version 1
[0.55 Ha]



FS Pond Version 2
[1.64 Ha]

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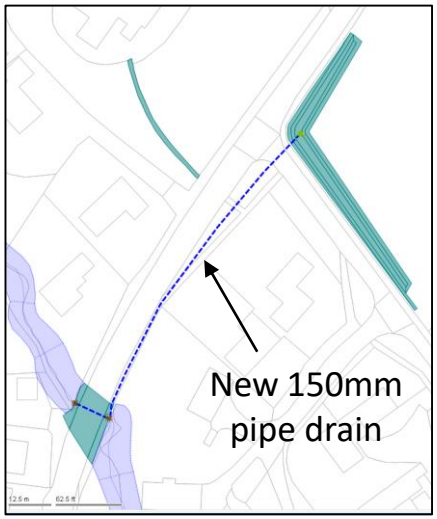
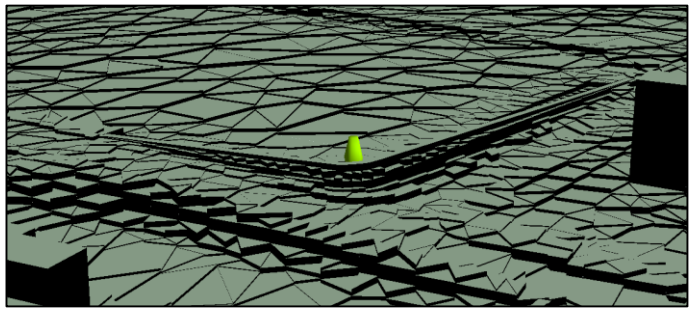
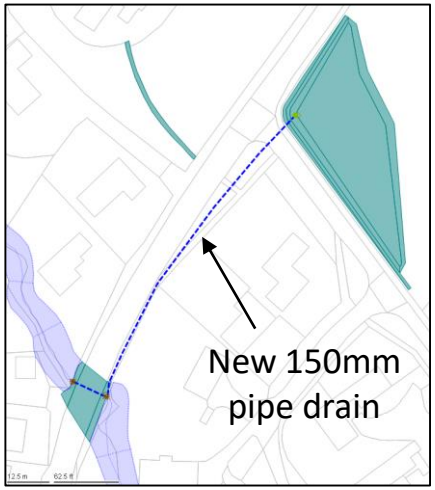
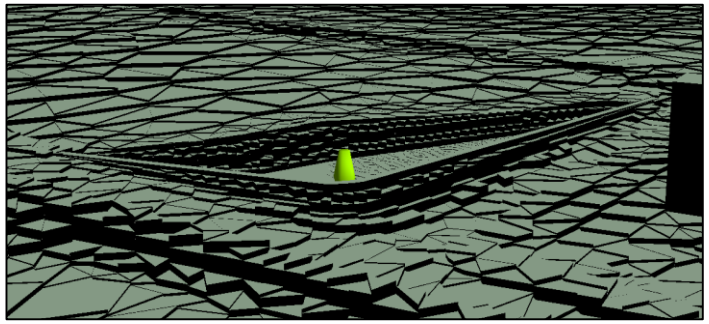
Spy/Merryhills Lane Field Options





- 2 Modelled Options
- Raise bund 0.5m (max 1m high vs Spy Ln)
- <u>Ditch:</u> Ditch lowered by 0.5m depth
- <u>Pond:</u> Pond lowered by 0.5m depth along bund and 1m depth along uphill bank





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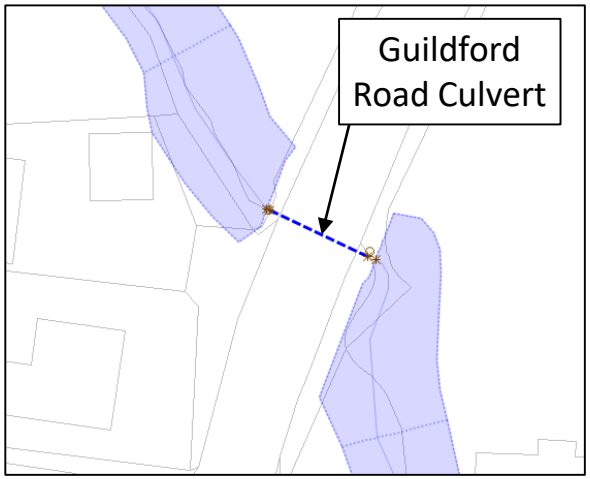
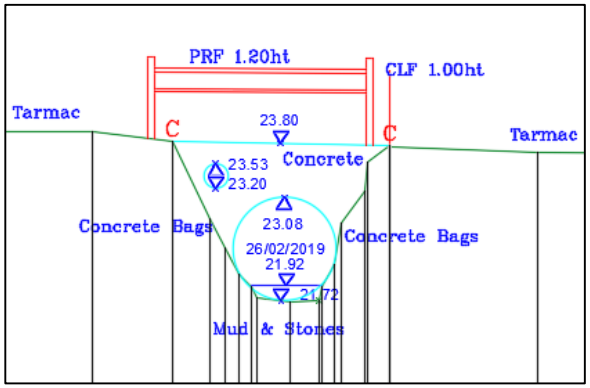
Guildford Road Options





Survey upstream of culvert

- 1 Modelled option
- Existing culvert is a 1.3m circular concrete culvert
- No space for a twin circular culverts
- Replace with 2.4m wide x 1.2m high rectangular culvert
- Max width of upstream stream channel
- >2 times increase in flow area

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Pond Close Options

- 1 Modelled option
- Brick headwalls removed to approximate concrete level (assumed replaced by suitable railings)

<u>Option not currently modelled (only beneficial if downstream culverts widened)</u>

- Existing culvert approx. 1.8m wide 1.1m high
- Could potentially increase width from 2.4m to 3.0m
- Culvert height likely required to remain 1.1m high

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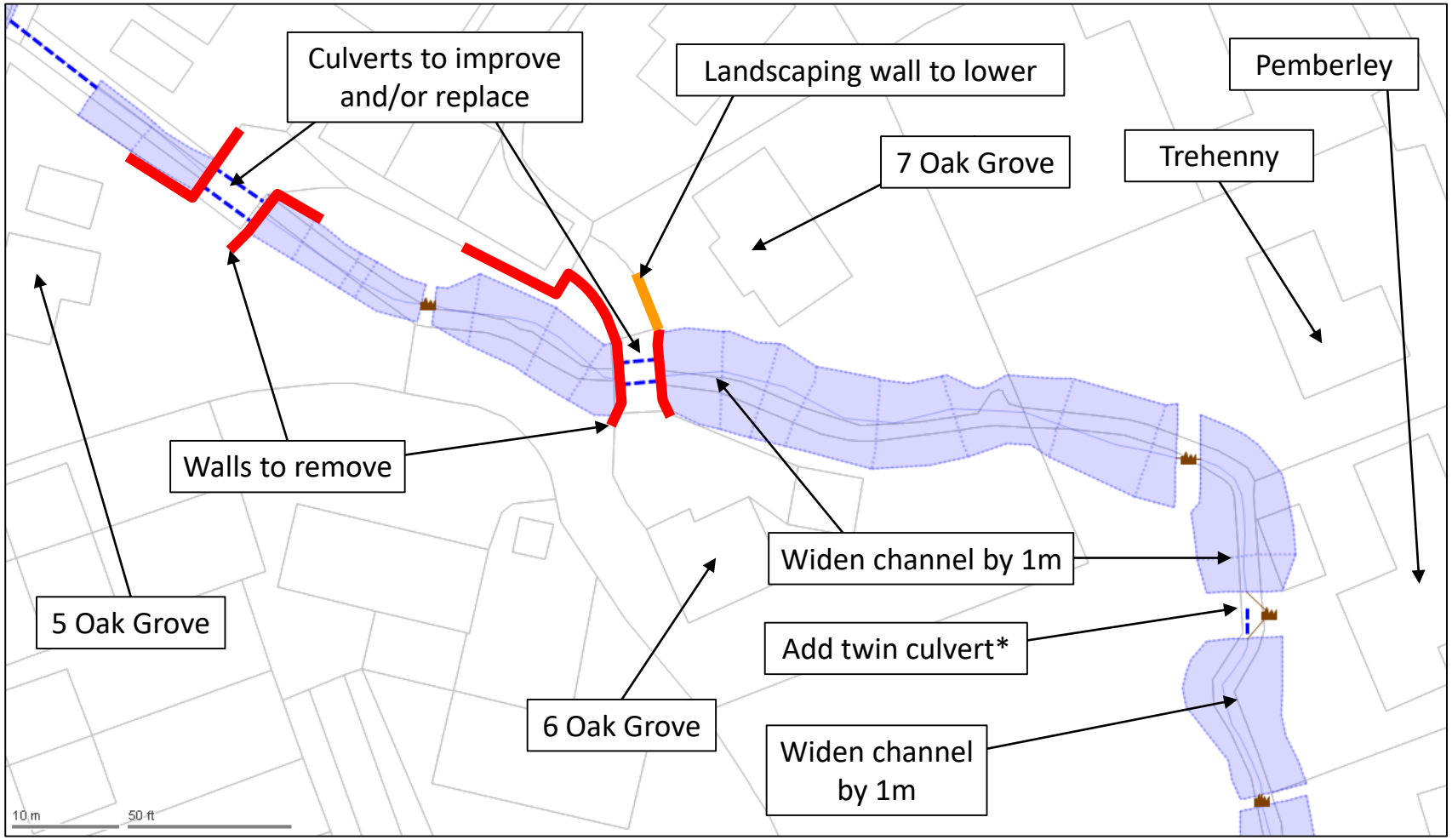
Oak Grove Options

- 5 Modelled Option Combinations
- Mitigation improvements include:
  - Desilting existing left culvert for 6 Oak Grove
  - Widening channel downstream of 6 Oak Grove bridge
  - Removing brick headwalls and adjacent brick walls for bridges to no's 5 and 6 Oak Grove
  - Removing low brick landscaping wall for no. 7 Oak Grove
  - Replacing both twin 1.2 dia. Culvert bridges with 3.0m wide x 1.2m high rectangular culverts
  - Adding new 1m diameter culvert at 'Trehenny' plus upstream and downstream channel widening including at 'Pemberley'

Oak Grove Options



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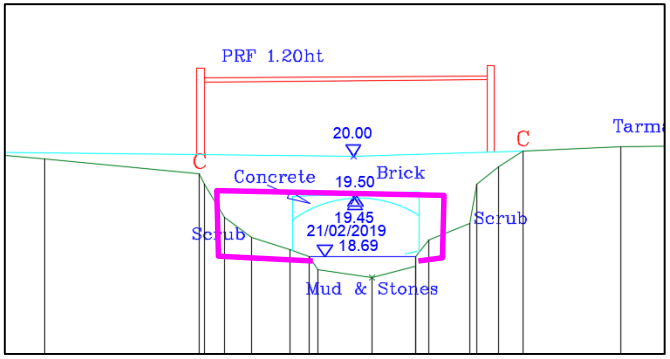
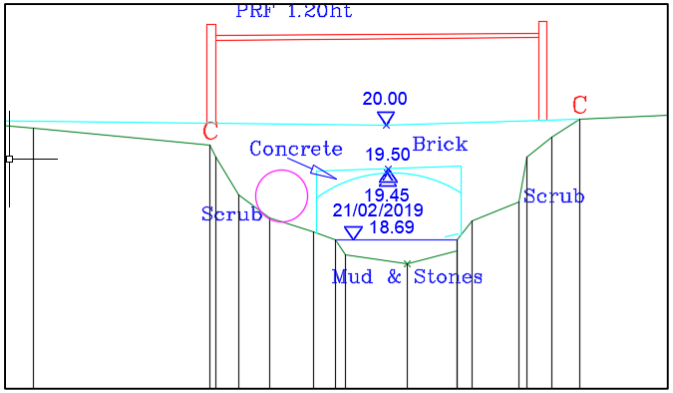
Station Road Options

- 2 Modelled options



- Replace existing bridge opening
  - Retain existing base due to existing (unknown) pipe / services
  - Widen width to a 3m wide opening
  - Retain existing soffit level



- High level bypass
  - 0.6m diameter pipe to left of existing opening
  - Soffit level at existing soffit level
  - Existing electrical substation at downstream prevents any opening to the right

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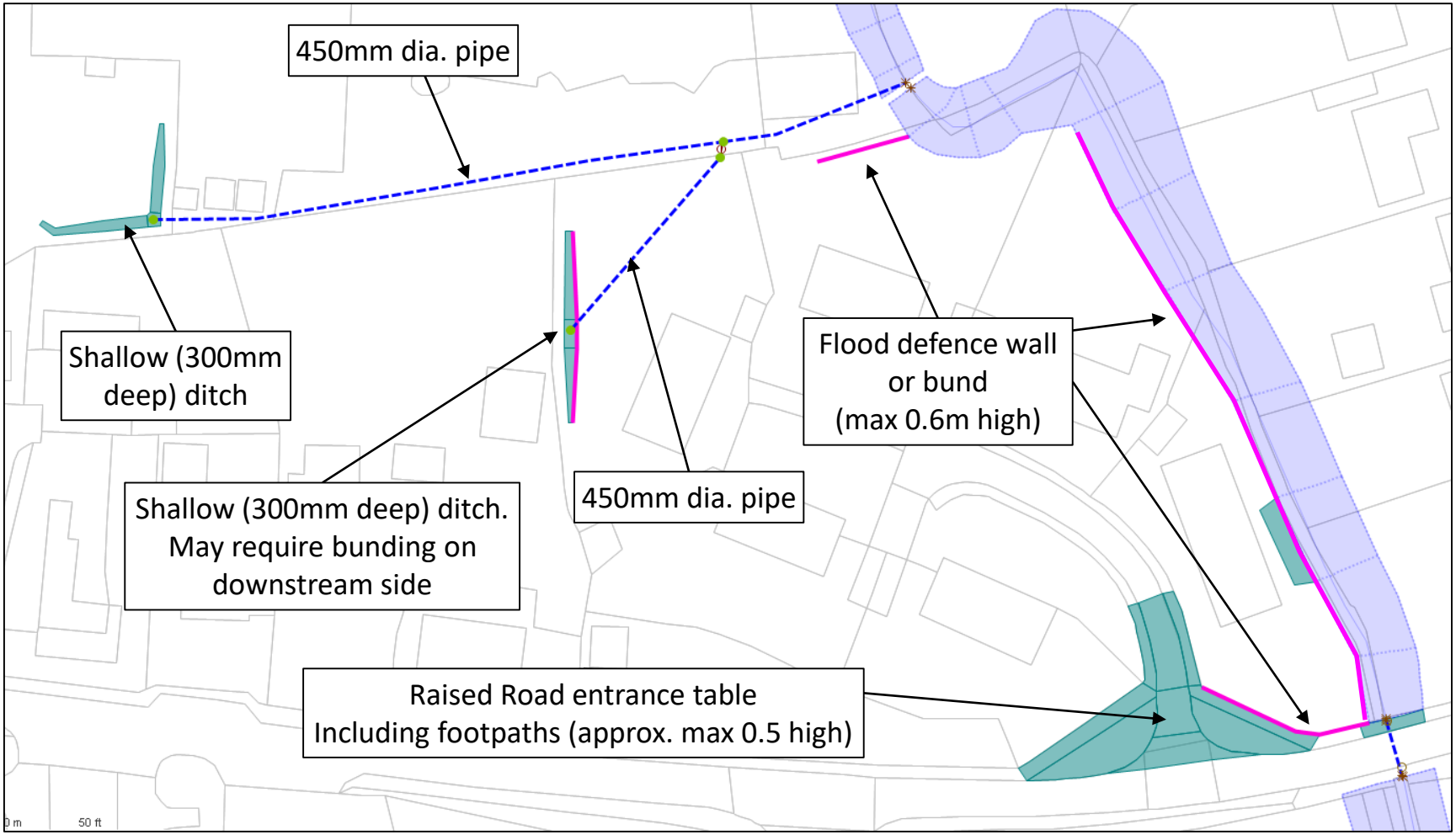
Burley Close Options

- 5 Modelled Option Combinations
- Mitigation improvements include:
  - School surface water interception ditch (300mm deep) and new 450mm diameter pipe drain to stream
  - Surface water interception (300mm deep) ditch at 3 Burley Close and connection to new school drainage pipe
  - Raise flood defence wall along rivers edge and up Station Road (approx. max 0.6m high)
  - New raised table entrance to Burley Close (max raising approx. 0.5m at entrance)

<u>Not modelled:</u>

- Existing or additional road drainage to stream from Burley Close

Burley Close Options



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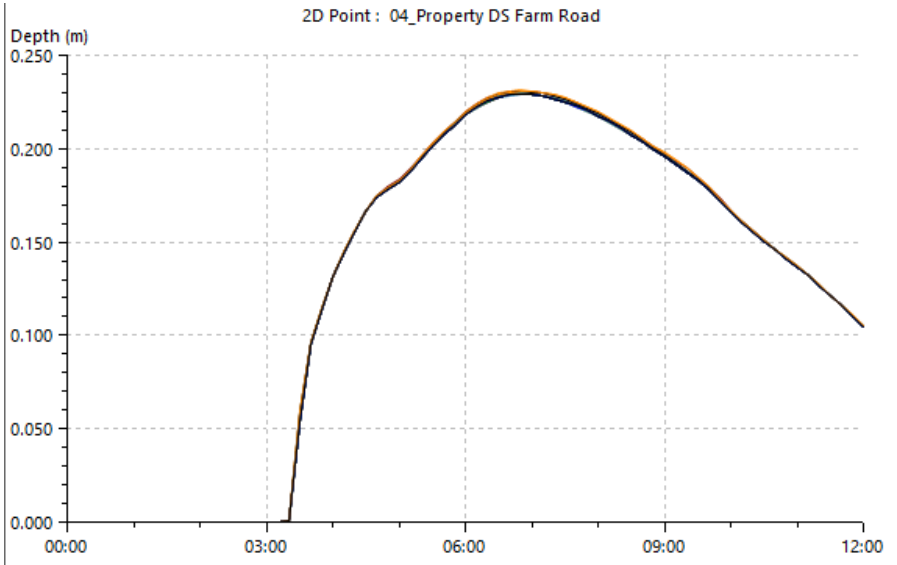
Option Impact Assessment

- Focus for this presentation is limited to the 1 in 100 event

Upstream (At Farm Road)



	Depth	
	Min	Max
...,15-17,19 - 100yr - 6.5hrSD>M100-390	0.000	0.229
... Rd - Upsize Culvert M100-390 [Opt 1]	0.000	0.229
...channel Roughness M100-390 [Opt 2]	0.000	0.231
...F - Ditch and Bund M100-390 [Opt 3]	0.000	0.229
...Pond/Bund Storage M100-390 [Opt 4]	0.000	0.229
... School Interception M100-390 [Opt5]	0.000	0.230
...d Prop Interception M100-390 [Opt 6]	0.000	0.230
...ert - Upsize Culvert M100-390 [Opt 7]	0.000	0.229
...L Overflow Culvert M100-390 [Opt 8]	0.000	0.229
... Flood Defence Wall M100-390 [Opt 9]	0.000	0.229
...d Entrance Raising M100-390 [Opt 10]	0.000	0.229
... and Channel Imp M100-390 [Opt 11]	0.000	0.229
... All Improvements M100-390 [Opt 12]	0.000	0.229
...ve Brick Headwalls M100-390 [Opt 13]	0.000	0.229
...lood Storage Pond M100-390 [Opt 14]	0.000	0.231
... All Improvements M100-390 [Opt 15]	0.000	0.231
...Channel Widening M100-390 [Opt 16]	0.000	0.229
... All Improvements M100-390 [Opt 17]	0.000	0.229
...torage Pond (Max) M100-390 [Opt 18]	0.000	0.231
... All Improvements M100-390 [Opt 19]	0.000	0.229

- No upstream increase in peak flood water levels
- Max difference 2mm considered within modelling tolerance

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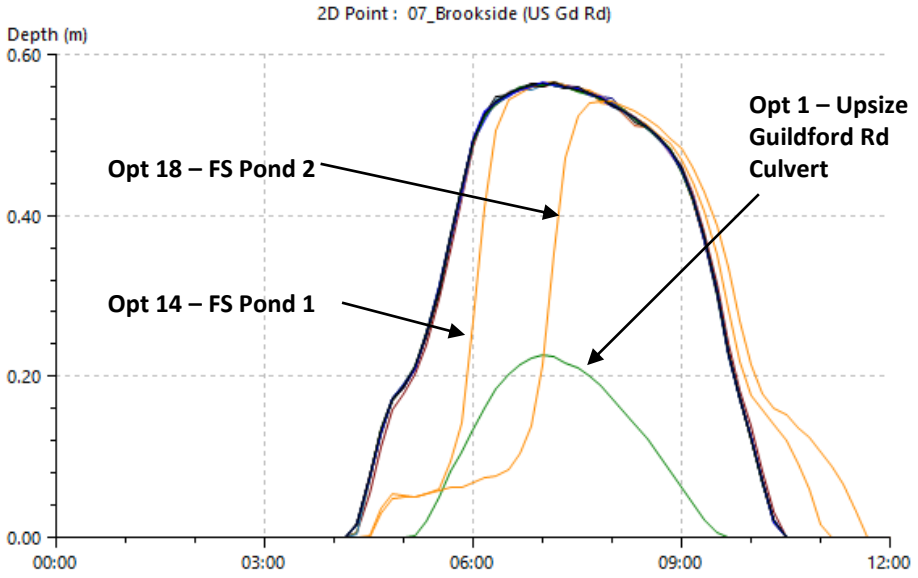
Brookside



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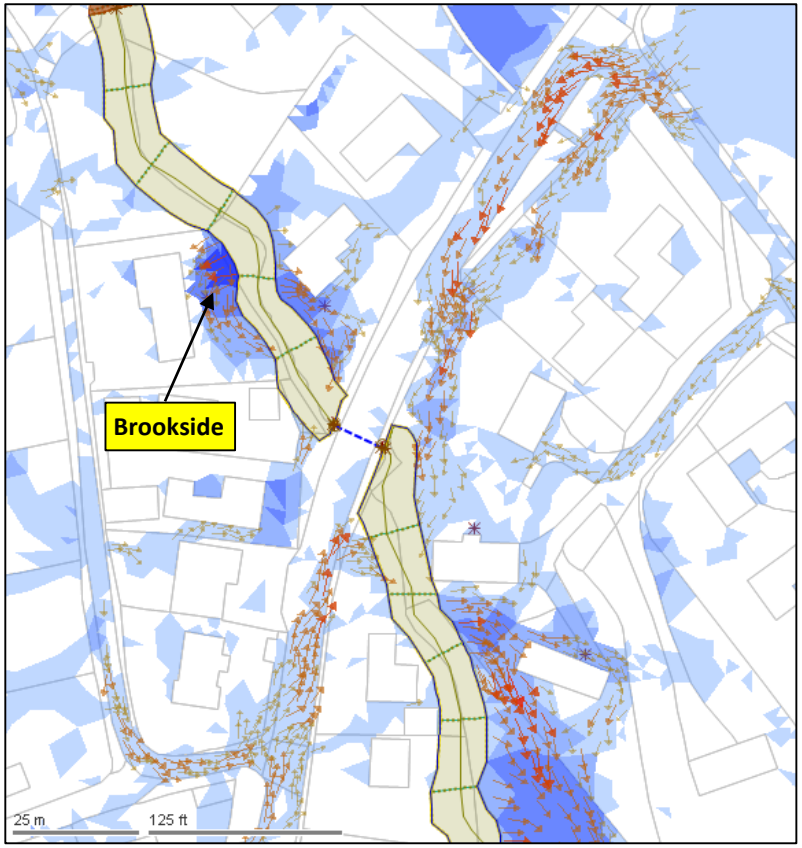
... School Interception M100-390 [Opt5]	0.000	0.565
...d Prop Interception M100-390 [Opt 6]	0.000	0.566
...ert - Upsize Culvert M100-390 [Opt 7]	0.000	0.563
...L Overflow Culvert M100-390 [Opt 8]	0.000	0.565
... Flood Defence Wall M100-390 [Opt 9]	0.000	0.563
...d Entrance Raising M100-390 [Opt 10]	0.000	0.563
... and Channel Imp M100-390 [Opt 11]	0.000	0.564
... All Improvements M100-390 [Opt 12]	0.000	0.563
...ve Brick Headwalls M100-390 [Opt 13]	0.000	0.563
...lood Storage Pond M100-390 [Opt 14]	0.000	0.565
... All Improvements M100-390 [Opt 15]	0.000	0.564
...Channel Widening M100-390 [Opt 16]	0.000	0.563
... All Improvements M100-390 [Opt 17]	0.000	0.565
...torage Pond (Max) M100-390 [Opt 18]	0.000	0.541
... All Improvements M100-390 [Opt 19]	0.000	0.565



1 in 100 – Opt 1 – Upsize Guildford Rd Culvert

Flood Depth (m)

0.005
0.1
0.25
0.5
1

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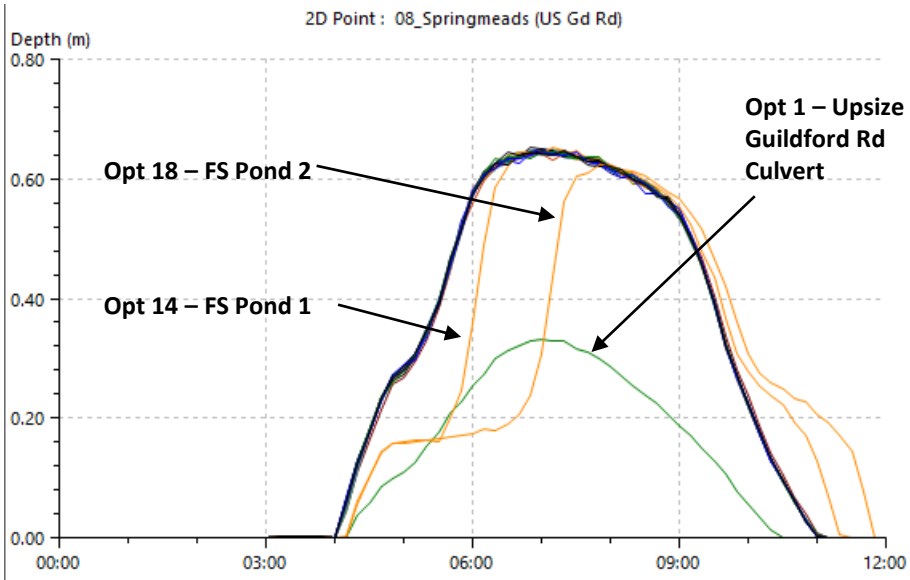
Springmeads



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	Min	Max
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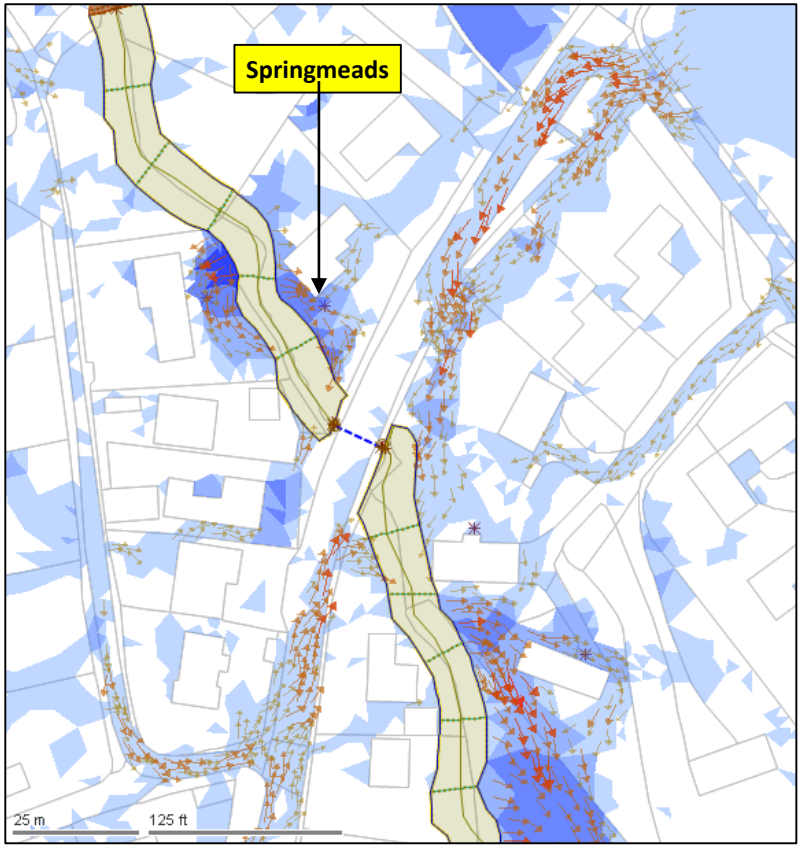
...Pond/Bund Storage M100-390 [Opt 4]	0.000	0.648
... School Interception M100-390 [Opt5]	0.000	0.646
...d Prop Interception M100-390 [Opt 6]	0.000	0.649
...ert - Upsize Culvert M100-390 [Opt 7]	0.000	0.645
...L Overflow Culvert M100-390 [Opt 8]	0.000	0.643
... Flood Defence Wall M100-390 [Opt 9]	0.000	0.649
...d Entrance Raising M100-390 [Opt 10]	0.000	0.648
... and Channel Imp M100-390 [Opt 11]	0.000	0.652
... All Improvements M100-390 [Opt 12]	0.000	0.644
...ve Brick Headwalls M100-390 [Opt 13]	0.000	0.646
...lood Storage Pond M100-390 [Opt 14]	0.000	0.653
... All Improvements M100-390 [Opt 15]	0.000	0.647
...Channel Widening M100-390 [Opt 16]	0.000	0.644
... All Improvements M100-390 [Opt 17]	0.000	0.645
...torage Pond (Max) M100-390 [Opt 18]	0.000	0.623
... All Improvements M100-390 [Opt 19]	0.000	0.648



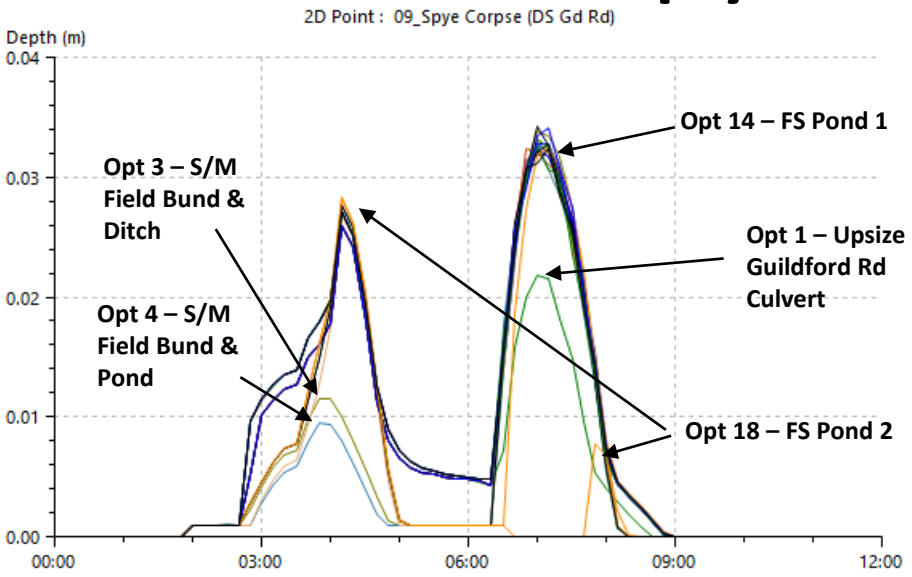
1 in 100 – Opt 1 – Upsize Guildford Rd Culvert

Flood Depth (m)

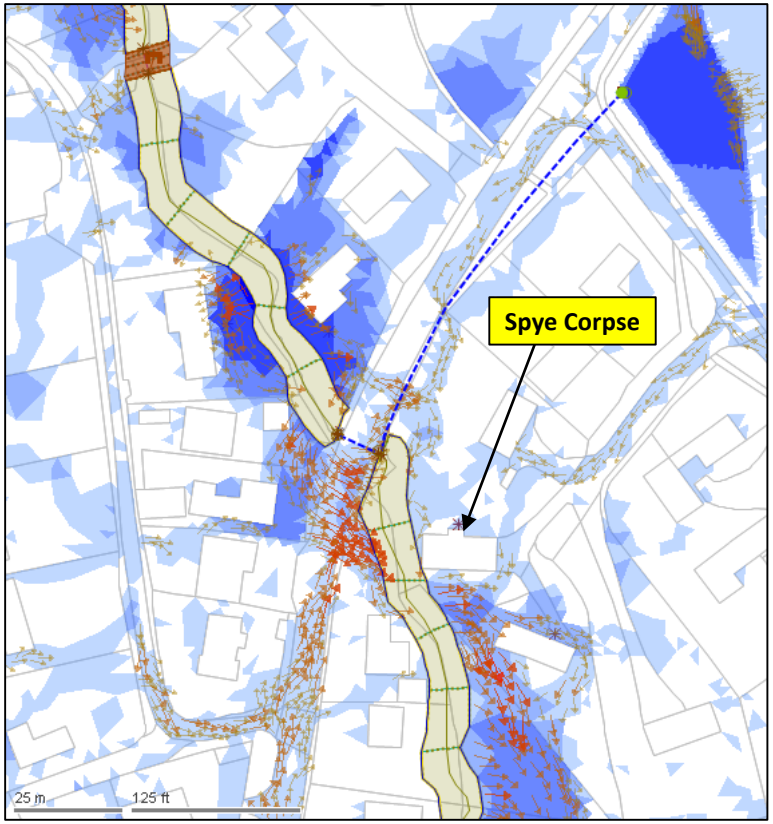
0.005
0.1
0.25
0.5
1

WATER | ENVIRONMENT

Spye Corpse



	Depth	
	Min	Max
...,15-17,19 - 100yr - 6.5hrSD>M100-390	0.000	0.033
... Rd - Upsize Culvert M100-390 [Opt 1]	0.000	0.026
...channel Roughness M100-390 [Opt 2]	0.000	0.032
...F - Ditch and Bund M100-390 [Opt 3]	0.000	0.034
...Pond/Bund Storage M100-390 [Opt 4]	0.000	0.033
... School Interception M100-390 [Opt5]	0.000	0.032
...d Prop Interception M100-390 [Opt 6]	0.000	0.033
...ert - Upsize Culvert M100-390 [Opt 7]	0.000	0.032
...L Overflow Culvert M100-390 [Opt 8]	0.000	0.032
... Flood Defence Wall M100-390 [Opt 9]	0.000	0.032
...d Entrance Raising M100-390 [Opt 10]	0.000	0.033
... and Channel Imp M100-390 [Opt 11]	0.000	0.034
... All Improvements M100-390 [Opt 12]	0.000	0.032
...ve Brick Headwalls M100-390 [Opt 13]	0.000	0.033
...lood Storage Pond M100-390 [Opt 14]	0.000	0.033
... All Improvements M100-390 [Opt 15]	0.000	0.033
...Channel Widening M100-390 [Opt 16]	0.000	0.033
... All Improvements M100-390 [Opt 17]	0.000	0.034
...torage Pond (Max) M100-390 [Opt 18]	0.000	0.028
... All Improvements M100-390 [Opt 19]	0.000	0.032



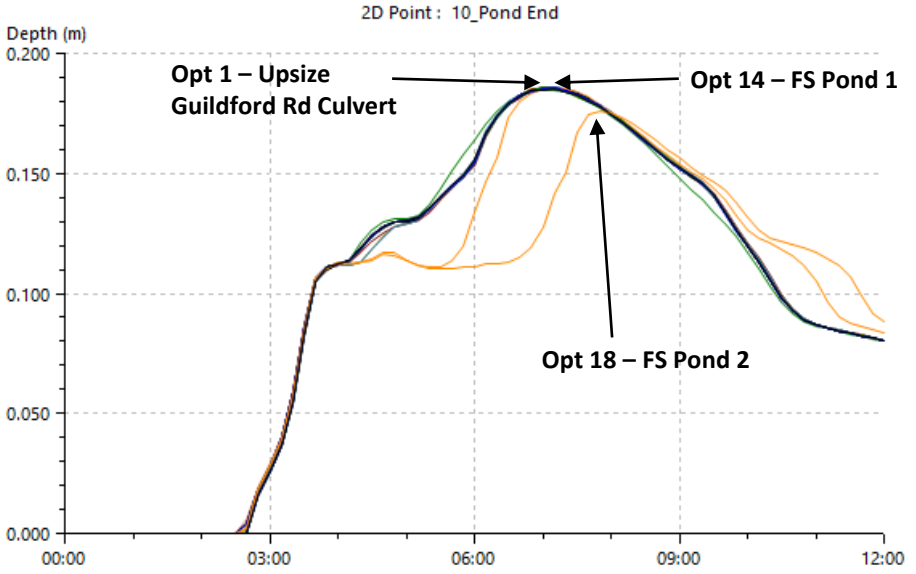
1 in 100 – Opt 4 – Spy/Merryhills Lane Field Bund and Pond Storage

Flood Depth (m)

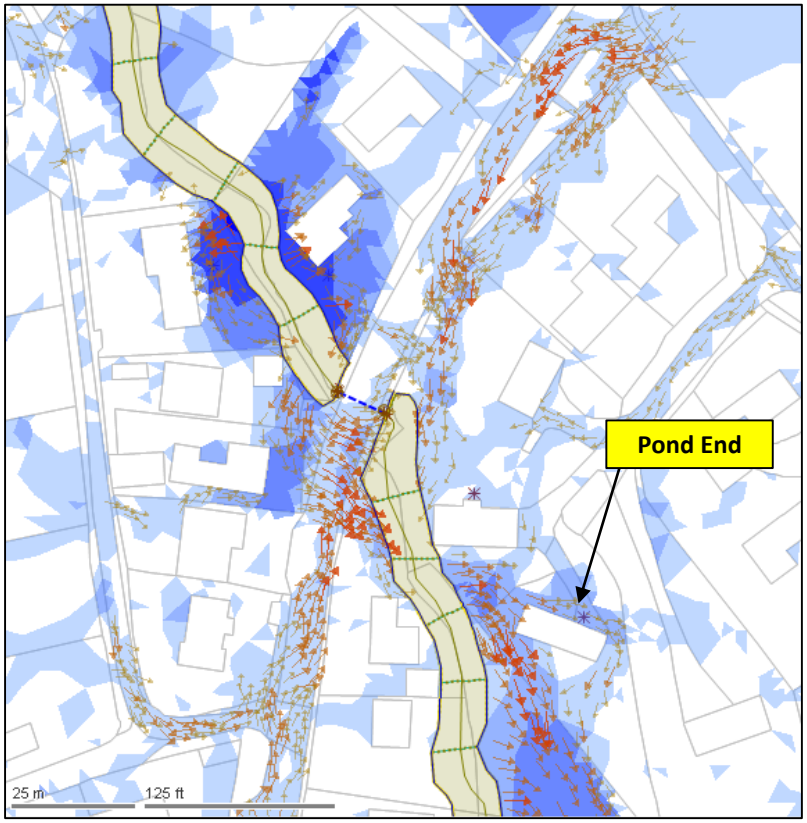
0.005
0.1
0.25
0.5
1

WATER | ENVIRONMENT

Pond End



	Depth	
	Min	Max
...,15-17,19 - 100yr - 6.5hrSD>M100-390	0.000	0.185
... Rd - Upsize Culvert M100-390 [Opt 1]	0.000	0.185
...channel Roughness M100-390 [Opt 2]	0.000	0.185
...F - Ditch and Bund M100-390 [Opt 3]	0.000	0.186
...Pond/Bund Storage M100-390 [Opt 4]	0.000	0.186
... School Interception M100-390 [Opt5]	0.000	0.185
...d Prop Interception M100-390 [Opt 6]	0.000	0.185
...ert - Upsize Culvert M100-390 [Opt 7]	0.000	0.185
...L Overflow Culvert M100-390 [Opt 8]	0.000	0.185
... Flood Defence Wall M100-390 [Opt 9]	0.000	0.185
...d Entrance Raising M100-390 [Opt 10]	0.000	0.186
... and Channel Imp M100-390 [Opt 11]	0.000	0.186
... All Improvements M100-390 [Opt 12]	0.000	0.185
...ve Brick Headwalls M100-390 [Opt 13]	0.000	0.185
...lood Storage Pond M100-390 [Opt 14]	0.000	0.186
... All Improvements M100-390 [Opt 15]	0.000	0.186
...Channel Widening M100-390 [Opt 16]	0.000	0.186
... All Improvements M100-390 [Opt 17]	0.000	0.186
...torage Pond (Max) M100-390 [Opt 18]	0.000	0.176
... All Improvements M100-390 [Opt 19]	0.000	0.185



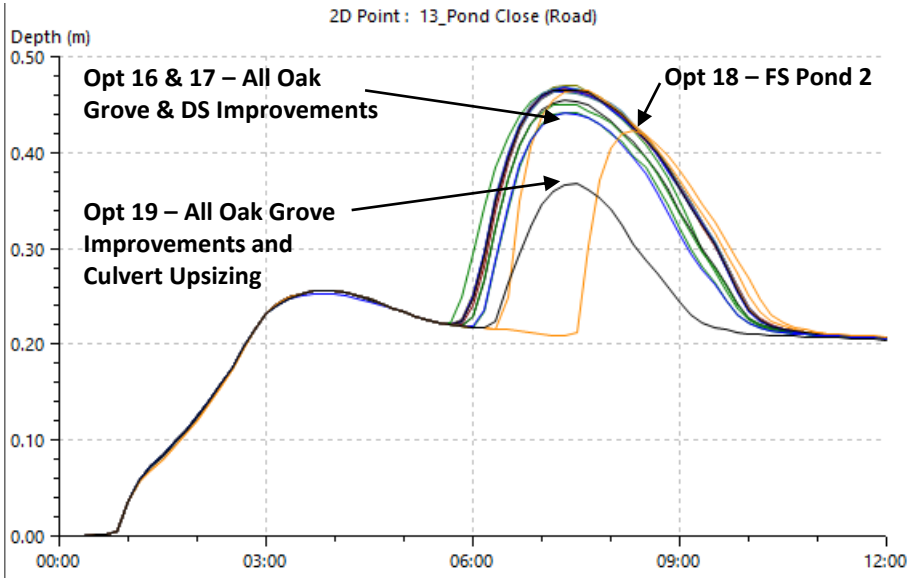
1 in 100 – Opt 18 – Flood Storage Pond Version 2

Flood Depth (m)

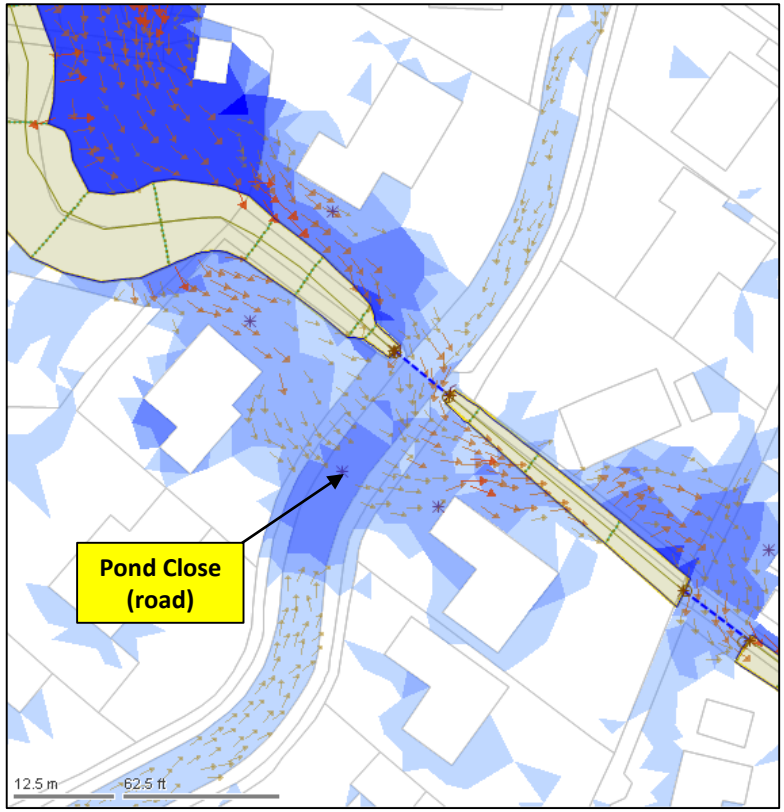
0.005
0.1
0.25
0.5
1

WATER | ENVIRONMENT

Pond Close



	Depth	
	Min	Max
...,15-17,19 - 100yr - 6.5hrSD>M100-390	0.000	0.467
... Rd - Upsize Culvert M100-390 [Opt 1]	0.000	0.468
...channel Roughness M100-390 [Opt 2]	0.000	0.467
...F - Ditch and Bund M100-390 [Opt 3]	0.000	0.470
...Pond/Bund Storage M100-390 [Opt 4]	0.000	0.469
... School Interception M100-390 [Opt5]	0.000	0.467
...d Prop Interception M100-390 [Opt 6]	0.000	0.463
...ert - Upsize Culvert M100-390 [Opt 7]	0.000	0.465
...L Overflow Culvert M100-390 [Opt 8]	0.000	0.466
... Flood Defence Wall M100-390 [Opt 9]	0.000	0.467
...d Entrance Raising M100-390 [Opt 10]	0.000	0.465
... and Channel Imp M100-390 [Opt 11]	0.000	0.455
... All Improvements M100-390 [Opt 12]	0.000	0.451
...ve Brick Headwalls M100-390 [Opt 13]	0.000	0.464
...lood Storage Pond M100-390 [Opt 14]	0.000	0.466
... All Improvements M100-390 [Opt 15]	0.000	0.466
...Channel Widening M100-390 [Opt 16]	0.000	0.442
... All Improvements M100-390 [Opt 17]	0.000	0.441
...torage Pond (Max) M100-390 [Opt 18]	0.000	0.422
... All Improvements M100-390 [Opt 19]	0.000	0.368



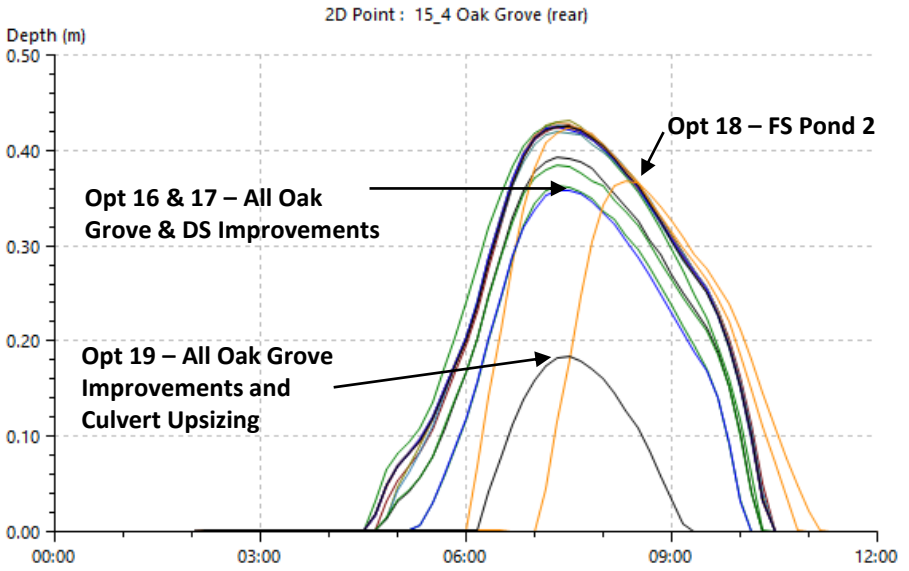
1 in 100 – Opt 19 – All Oak Grove Improvements and Culvert Upsizing

Flood Depth (m)

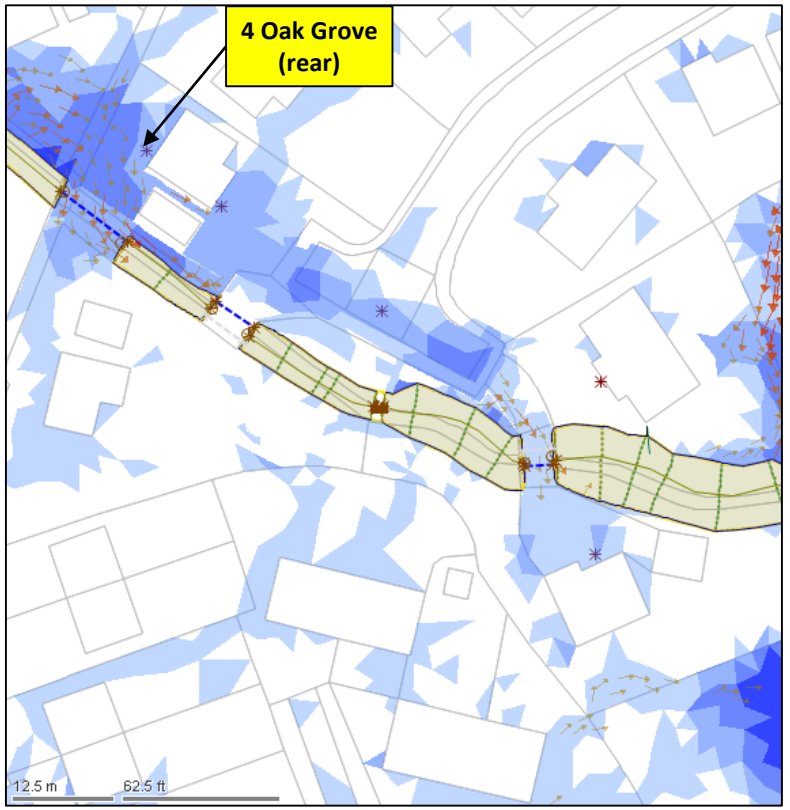
0.005
0.1
0.25
0.5
1

WATER | ENVIRONMENT

4 Oak Grove (Rear)



	Depth	
	Min	Max
...,15-17,19 - 100yr - 6.5hrSD>M100-390	0.000	0.425
... Rd - Upsize Culvert M100-390 [Opt 1]	0.000	0.429
...channel Roughness M100-390 [Opt 2]	0.000	0.427
...F - Ditch and Bund M100-390 [Opt 3]	0.000	0.432
...Pond/Bund Storage M100-390 [Opt 4]	0.000	0.427
... School Interception M100-390 [Opt5]	0.000	0.428
...d Prop Interception M100-390 [Opt 6]	0.000	0.420
...ert - Upsize Culvert M100-390 [Opt 7]	0.000	0.425
...L Overflow Culvert M100-390 [Opt 8]	0.000	0.424
... Flood Defence Wall M100-390 [Opt 9]	0.000	0.424
...d Entrance Raising M100-390 [Opt 10]	0.000	0.424
... and Channel Imp M100-390 [Opt 11]	0.000	0.393
... All Improvements M100-390 [Opt 12]	0.000	0.384
...ve Brick Headwalls M100-390 [Opt 13]	0.000	0.424
...lood Storage Pond M100-390 [Opt 14]	0.000	0.425
... All Improvements M100-390 [Opt 15]	0.000	0.425
...Channel Widening M100-390 [Opt 16]	0.000	0.363
... All Improvements M100-390 [Opt 17]	0.000	0.358
...torage Pond (Max) M100-390 [Opt 18]	0.000	0.368
... All Improvements M100-390 [Opt 19]	0.000	0.185

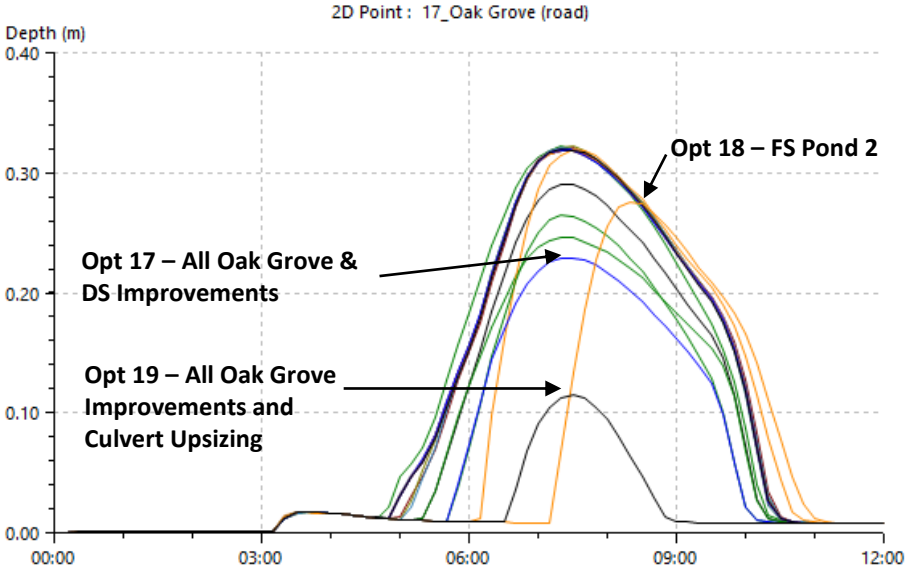


1 in 100 – Opt 19 – All Oak Grove Improvements and Culvert Upsizing

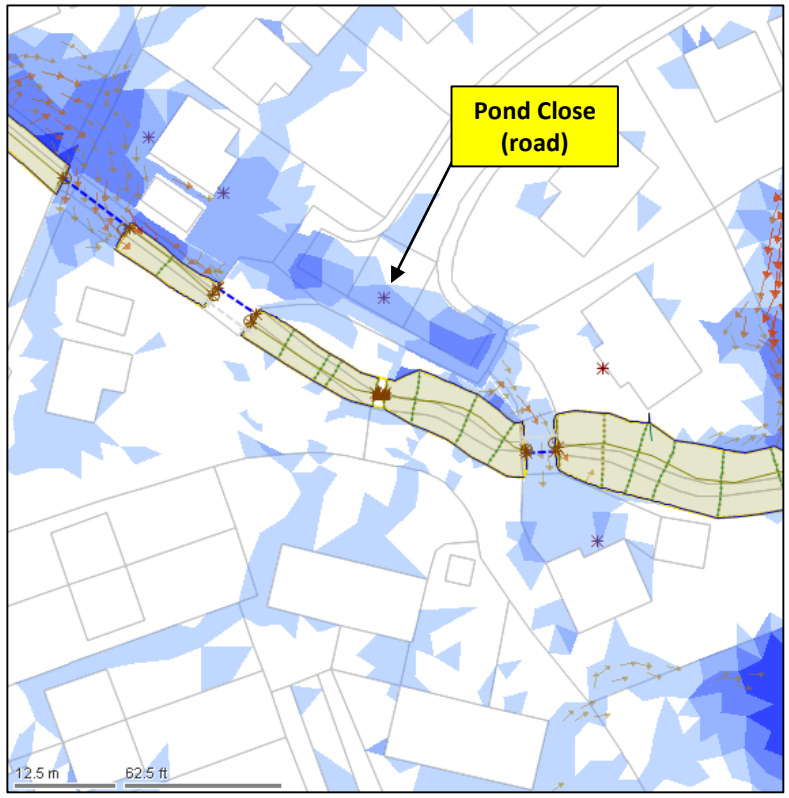
Flood Depth (m)	
0.005	
0.1	
0.25	
0.5	
1	

WATER | ENVIRONMENT

Oak Grove (Road)



	Depth	
	Min	Max
...,15-17,19 - 100yr - 6.5hrSD>M100-390	0.000	0.320
... Rd - Upsize Culvert M100-390 [Opt 1]	0.000	0.322
...channel Roughness M100-390 [Opt 2]	0.000	0.320
...F - Ditch and Bund M100-390 [Opt 3]	0.000	0.323
...Pond/Bund Storage M100-390 [Opt 4]	0.000	0.321
... School Interception M100-390 [Opt5]	0.000	0.319
...d Prop Interception M100-390 [Opt 6]	0.000	0.319
...ert - Upsize Culvert M100-390 [Opt 7]	0.000	0.319
...L Overflow Culvert M100-390 [Opt 8]	0.000	0.319
... Flood Defence Wall M100-390 [Opt 9]	0.000	0.320
...d Entrance Raising M100-390 [Opt 10]	0.000	0.319
... and Channel Imp M100-390 [Opt 11]	0.000	0.290
... All Improvements M100-390 [Opt 12]	0.000	0.246
...ve Brick Headwalls M100-390 [Opt 13]	0.000	0.318
...lood Storage Pond M100-390 [Opt 14]	0.000	0.320
... All Improvements M100-390 [Opt 15]	0.000	0.320
...Channel Widening M100-390 [Opt 16]	0.000	0.264
... All Improvements M100-390 [Opt 17]	0.000	0.229
...torage Pond (Max) M100-390 [Opt 18]	0.000	0.276
... All Improvements M100-390 [Opt 19]	0.000	0.116



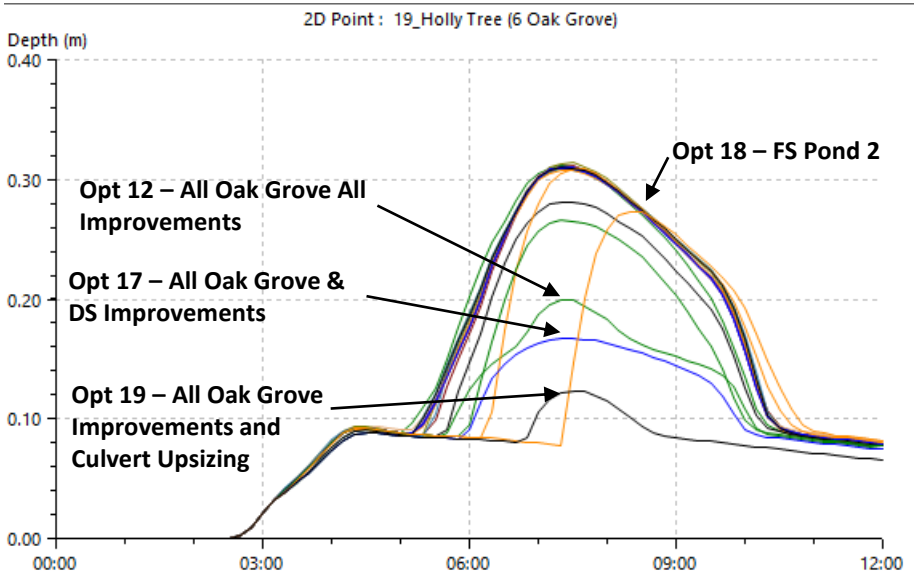
1 in 100 – Opt 19 – All Oak Grove Improvements and Culvert Upsizing

Flood Depth (m)

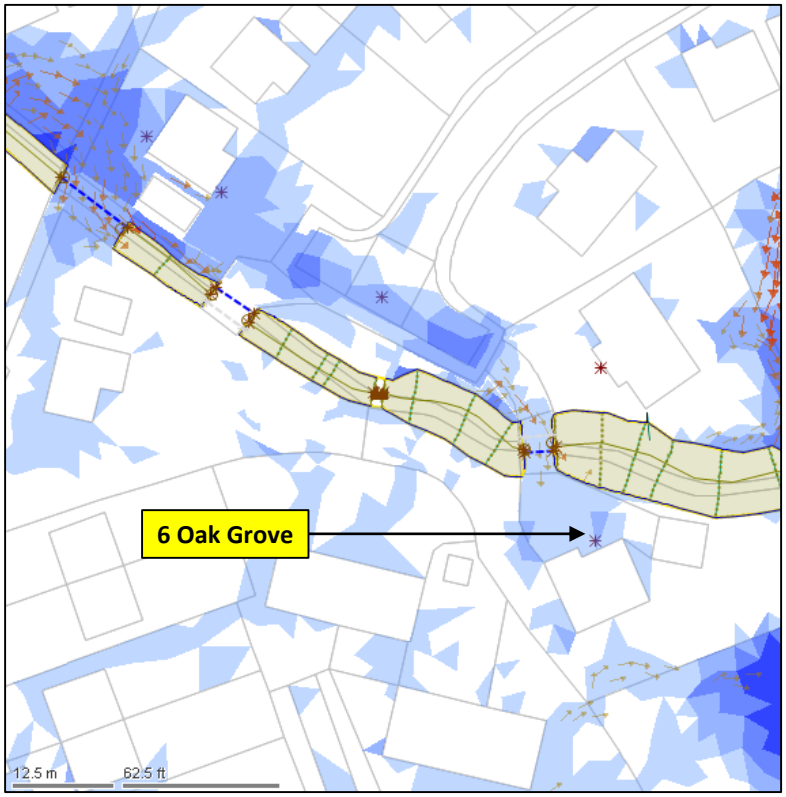
0.005
0.1
0.25
0.5
1

WATER | ENVIRONMENT

6 Oak Grove (Holly Tree)



	Depth	
	Min	Max
...,15-17,19 - 100yr - 6.5hrSD>M100-390	0.000	0.311
... Rd - Upsize Culvert M100-390 [Opt 1]	0.000	0.312
...channel Roughness M100-390 [Opt 2]	0.000	0.311
...F - Ditch and Bund M100-390 [Opt 3]	0.000	0.314
...Pond/Bund Storage M100-390 [Opt 4]	0.000	0.310
... School Interception M100-390 [Opt5]	0.000	0.311
...d Prop Interception M100-390 [Opt 6]	0.000	0.309
...ert - Upsize Culvert M100-390 [Opt 7]	0.000	0.310
...L Overflow Culvert M100-390 [Opt 8]	0.000	0.310
... Flood Defence Wall M100-390 [Opt 9]	0.000	0.311
...d Entrance Raising M100-390 [Opt 10]	0.000	0.308
... and Channel Imp M100-390 [Opt 11]	0.000	0.282
... All Improvements M100-390 [Opt 12]	0.000	0.199
...ve Brick Headwalls M100-390 [Opt 13]	0.000	0.309
...lood Storage Pond M100-390 [Opt 14]	0.000	0.309
... All Improvements M100-390 [Opt 15]	0.000	0.310
...Channel Widening M100-390 [Opt 16]	0.000	0.266
... All Improvements M100-390 [Opt 17]	0.000	0.167
...torage Pond (Max) M100-390 [Opt 18]	0.000	0.273
... All Improvements M100-390 [Opt 19]	0.000	0.123



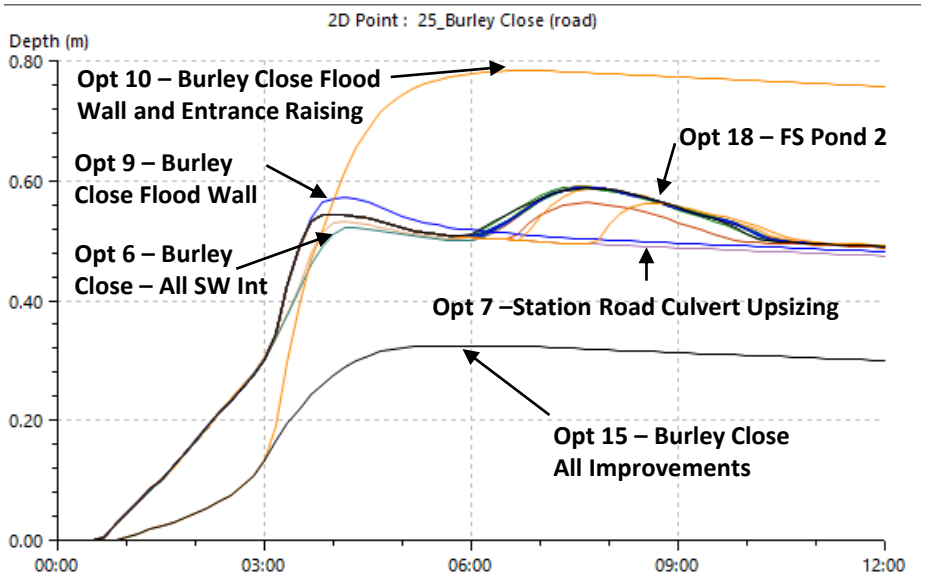
1 in 100 – Opt 19 – All Oak Grove Improvements and Culvert Upsizing

Flood Depth (m)

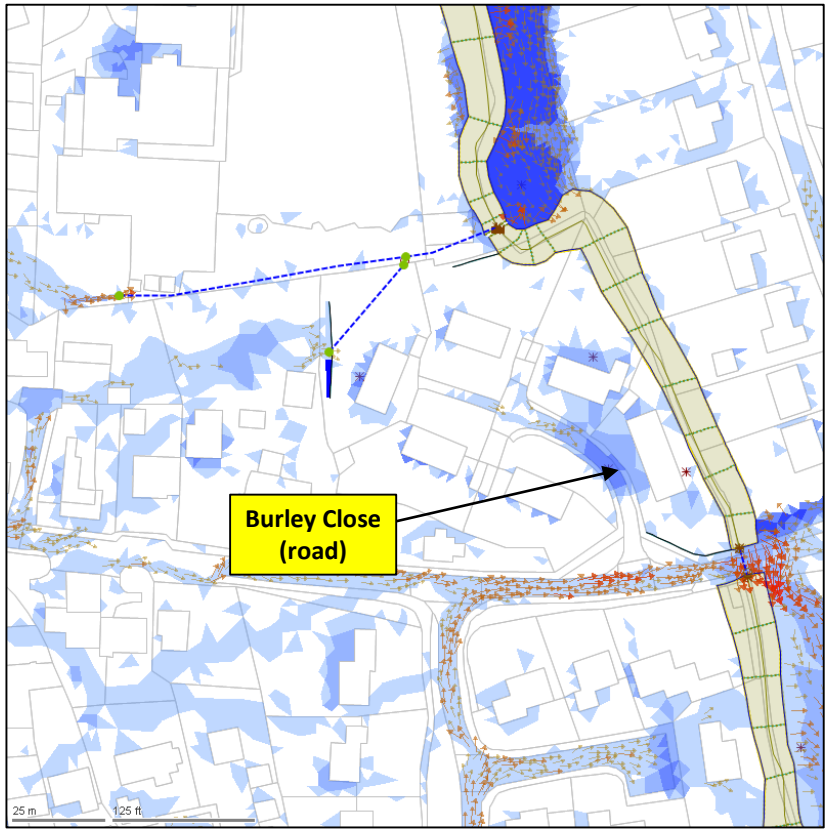
0.005
0.1
0.25
0.5
1

WATER | ENVIRONMENT

Burley Close (road)



	Depth	
	Min	Max
...,15-17,19 - 100yr - 6.5hrSD>M100-390	0.000	0.589
... Rd - Upsize Culvert M100-390 [Opt 1]	0.000	0.590
...channel Roughness M100-390 [Opt 2]	0.000	0.589
...F - Ditch and Bund M100-390 [Opt 3]	0.000	0.592
...Pond/Bund Storage M100-390 [Opt 4]	0.000	0.590
... School Interception M100-390 [Opt5]	0.000	0.589
...d Prop Interception M100-390 [Opt 6]	0.000	0.588
...ert - Upsize Culvert M100-390 [Opt 7]	0.000	0.544
...L Overflow Culvert M100-390 [Opt 8]	0.000	0.564
... Flood Defence Wall M100-390 [Opt 9]	0.000	0.573
...d Entrance Raising M100-390 [Opt 10]	0.000	0.784
... and Channel Imp M100-390 [Opt 11]	0.000	0.589
... All Improvements M100-390 [Opt 12]	0.000	0.588
...ve Brick Headwalls M100-390 [Opt 13]	0.000	0.588
...lood Storage Pond M100-390 [Opt 14]	0.000	0.588
... All Improvements M100-390 [Opt 15]	0.000	0.325
...Channel Widening M100-390 [Opt 16]	0.000	0.587
... All Improvements M100-390 [Opt 17]	0.000	0.588
...torage Pond (Max) M100-390 [Opt 18]	0.000	0.563
... All Improvements M100-390 [Opt 19]	0.000	0.587



1 in 100 – Opt 15 – Burley Close – All Improvements

Flood Depth (m)

0.005
0.1
0.25
0.5
1

WATER | ENVIRONMENT

Summary

- As expected replacement / upsizing of culverts appears to reduce flood water levels
- The upsizing of Guildford Road culvert does not increase existing downstream flood risk (for the 100yr event), however the change is not tested in combination with other downstream improvements
- Improvements at Oak Grove have the potential to reduce flood risk.
- Replacement of Oak Grove culverts (or free span bridges) has upstream benefit at Pond Close.
- The flooding at Burley Close appears to be largely from surface water flooding, therefore any improvement works must restrict surface water inflows into the area.
- The upstream flood storage pond has potential benefit, however a significant area / scheme would be required