River Thames Scheme

Supplementary Consultation
3 September to 7 October 2024

Ferris Meadow Lake Options Appraisal Report

Appendix C - Flood Modelling Option Testing Report

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1. Flood model option testing

1.1 Background

1.1.1 This appendix describes the hydraulic modelling used to assess flood risk for each of the Ferris Meadow Lake (previously referred to as Ferry Lane Lake) options.

1.2 Approach

1.2.1 The 2016 Recalibrated 1D-only flood model was used for this option testing. This is consistent with the approach used in previous option testing and design development. The 1D-only version of the model is very accurate for predicting in-channel water levels and flows and provides a fair basis for comparing options.

1.2.2 The 5% (1 in 20) annual chance flood was used for option comparison. Again, this is consistent with the approach used in previous phases of the design development. The 5% annual chance flood is the magnitude where the flood channel is most effective, so provides the clearest single comparison point.

1.2.3 The objective for this flood modelling was to identify configurations of each option to achieve similar hydraulic performance to the current scheme design (the same water level in the River Thames at the Spelthorne channel offtake upstream of Chertsey weir and flood levels within ±0.05m along the Spelthorne channel). Alternative variants were tested by adjusting the channel width (and tunnel diameter) to achieve this objective. For simplicity, only the selected variant is reported here.

1.3 Options Tested

1.3.1 Options 1-5, 7 and 8, sketches of which can be found in Appendix A, were tested in the flood model, relating to the downstream connection between the Spelthorne channel and the River Thames.

1.3.2 Options 6a and 6b were not tested because there is no material change in flood conditions compared to Option 1:

- The additional small channel will only operate in non-flood conditions – that is not an aspect we test in the flood model.
- In flood conditions:
  - The gate into the additional small channel will be closed. As long as the top of the gate (when closed) is at least at the height of the flood channel bank, there will be no material change in flooding. Flow will remain in channel until it overtops the banks. At which point, flow into the Chap will be controlled by the culvert beneath Ferry Lane, as it is with the current design.
  - The gates on the flood channel for Option 6b will be open so will not obstruct the flow down the flood channel.

1.4 Implementation in the flood model

1.4.1 This section describes the changes made to implement these options in the flood model. The dimensions given are for the final selected variants described in the Results section:

- Option 1:
  - No change required.
- Options 2 to 4:
  - Outlet weir (FCS19) moved to within the field just upstream of the Ferry Lane road. This weir is needed to prevent the groundwater level being drained down through the flood channel in non-flood conditions.
  - The same weir levels for FCS19 were retained – 9.20mAOD for the main weir and 8.84mAOD for the fish pass.
  - A weir width of 94m was used for FCS19, which is the same as weir FCS18 near the M3 crossing. The FCS19 weir width is 75m in the current design (Option 1). The results are not particularly sensitive to the weir width – using 75m would give marginally worse performance – but using 94m helps slightly in terms of the channel width needed for these options.
  - A rectangular channel shape was used, with constant bed level of 6.75mAOD (the bed level at the Ferry Lane road bridge). The flood results are not sensitive to the bed level. This was the simplest approach but a slight gradient in the bed could also have been used, continuing the upstream gradient.
  - The bank level between the flood channel and Ferris Meadow Lake was taken as 10.25mAOD. This is a typical ground level in this area and would mean the Spelthorne channel would overtop this bank into Ferris Meadow Lake in approximately the 10% (1 in 10) annual chance flood. By that time, the River Thames would already have overtopped its bank and be flowing into Ferris Meadow Lake. The flood channel would perform slightly worse if the banks were raised to fully contain the flow in the 5% (1 in 20) annual chance flood.
- Option 5:
  - This was modelled as a conduit, with an invert level of -10mAOD. Standard culvert inlet and outlet losses were applied with an open connection to the flood channel and the River Thames.
  - The tunnel entrance is assumed to be upstream of Ferry Lane road, so the LA12 bridge is removed from the model for this option.
  - The tunnel would function as an inverted syphon. The tunnel invert is not critical for hydraulic performance, since the entrance and exit will be submerged when it operates.
- Option 7:
  - The channel cross-sections through Ferris Meadow Lake curtailed to the edge of the separation bund.
  - Residual lake area represented separately, with an assumed separation bund level of 10.25mAOD.
- Option 8:
  - As with options 2 to 4, the outlet weir (FCS19) was moved to upstream of the Ferry Lane road. The same crest elevations were retained and the crest length was kept as 75m for this option.

- An open connection was made between the last cross-section within Ferris Meadow Lake and the River Thames.

1.5 Results

1.5.1 To achieve the hydraulic objectives (the same flood level in the River Thames at the Spelthorne channel offtake and flood levels within ±0.05m along the Spelthorne channel as for Option 1):

- Option 2 requires a 25m wide channel (when modelled as a rectangular shaped channel).
- Option 3 requires a 30m wide channel (when modelled as a rectangular shaped channel). A wider channel is needed for this route as it is less hydraulically efficient than Option 2.
- Option 4 requires 15m wide channels (when modelled as rectangular shaped channels) on either side of the lake.
- Option 5 requires a 12.5m diameter tunnel, or an equivalent cross-sectional area for multiple barrels.
- Options 7 and 8 do not need any modifications to the structure dimensions.

1.5.2 Peak water level results are shown in Table.1. The locations (1 to 11) are shown in Figure 1.1. This illustrates that flood levels are similar across all the options – this is intentional since the channel widths were adjusted to achieve this objective. There are some minor differences:

- Flood levels in the River Thames are generally marginally lower than for the current design (Option 1) but these differences are very small (up to ±0.03m).
- Option 2, with the flood channel outlet into The Chap, gives a slightly worse performance in the Desborough Loop but slightly better performance in the Desborough Cut compared to Option 1 (the current design). However, the differences are small and water levels remain lower than existing conditions (no detriment is achieved).
- Flood levels in the flood channel are generally slightly higher than for the current design. Again, these differences are small and have no practical impact on the scheme performance.

1.5.3 Table 3 shows peak flows in the River Thames at locations close to Ferris Meadow Lake. The locations (A to D) are shown in Figure 1.2. These results show in-channel flows from the 1D model cross-sections – floodplain spills are not included in these values. This illustrates that:

- For all options, there is close to an even split in peak flows between the Desborough Cut (location A) and the Desborough Loop around Desborough Island (location C) with around 240m^3/s on each side of the island of the 480m^3/s total reaching Walton Bridge. There is some variation between the options but it is small.
- The position of the flood channel outlet does affect the peak flows in the Thames in its immediate vicinity. For Options 2 and 4, the flow entering the Desborough Loop (location B) is lower because the flood channel outlet (or one half of it) enters the Thames downstream of this point. The other options are similar, except Option 5 which has more flow in the Thames at this point because there is less flow through Ferris Meadow Lake.
- The peak flow reaching Walton Bridge (location D) is very similar for all options.

1.5.4 Table 4 shows peak velocities in the new sections of flood channel past Ferris Meadow Lake (only applies to Options 2, 3 and 4). Given that flows and water levels are virtually the same, velocities are inversely proportional to the

channel width. Consequently Option 2 has the highest predicted velocity whereas Option 3 has the slowest. Velocities are slightly higher for Option 4 than 3, because the flow split between the two branches is not equal. These are 1D model outputs so assume uniform velocity across the whole channel cross-section and do not account for 2D or 3D effects around bends.

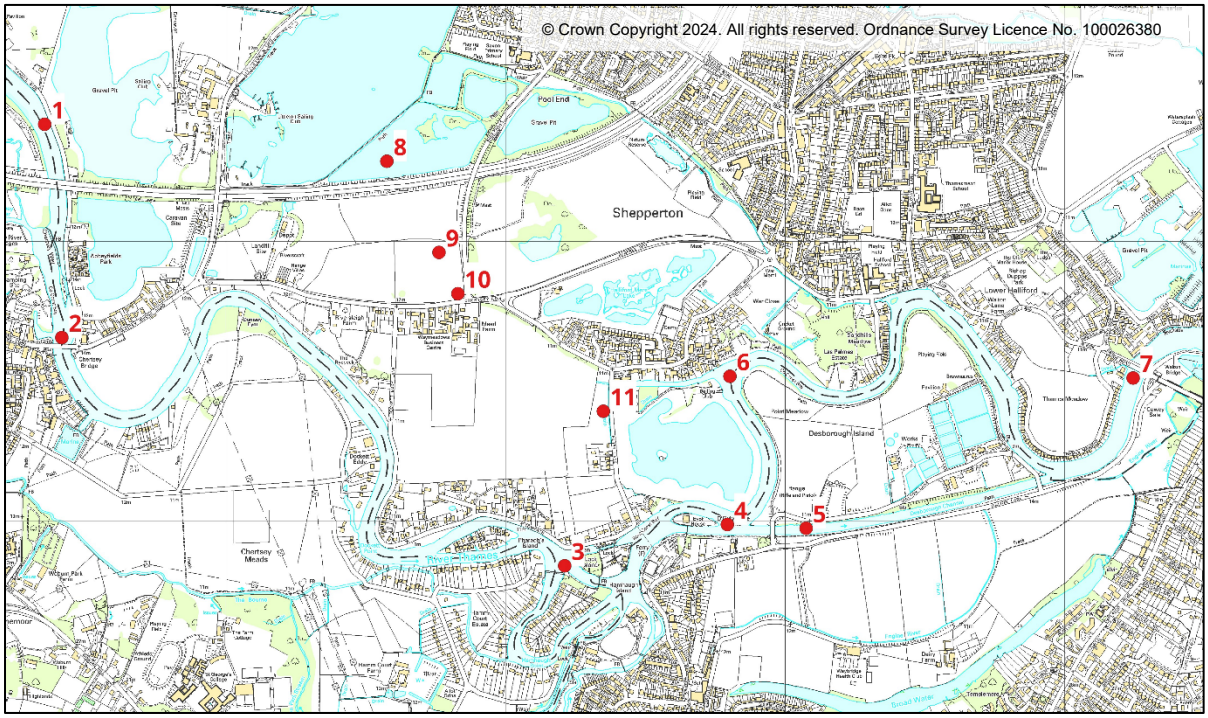

Figure 1.1 Level comparison locations

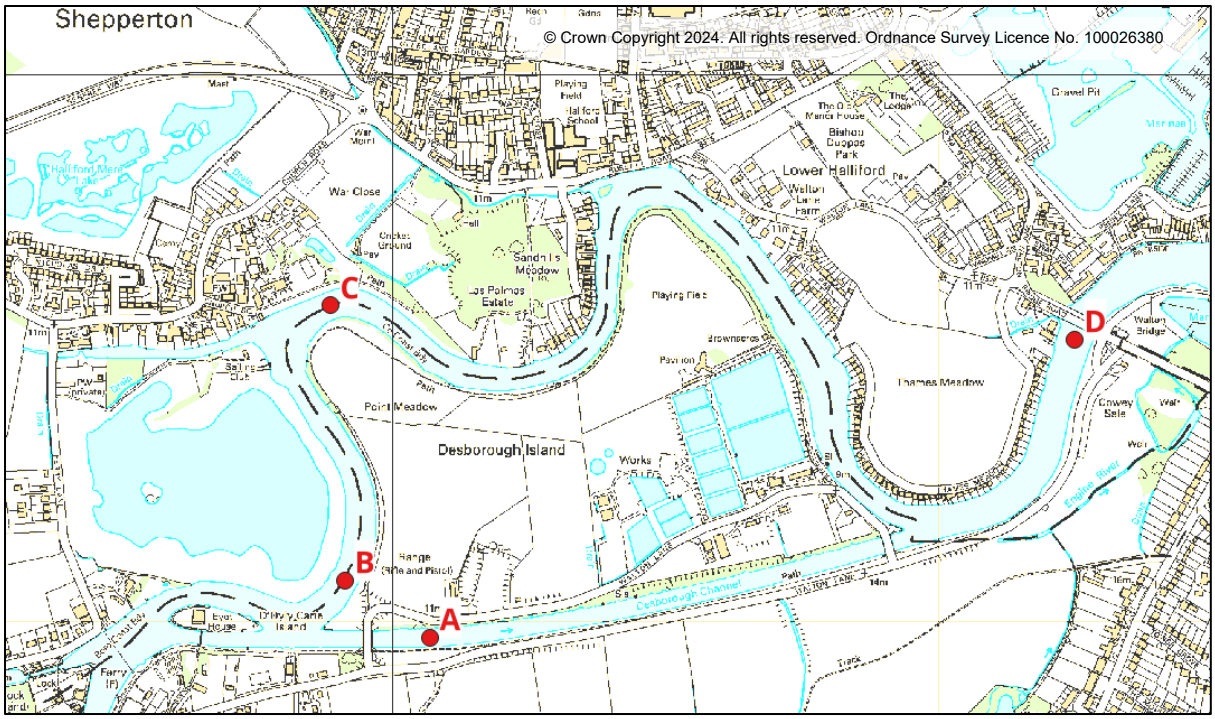

Figure 1.2 Flow comparison locations

Table.1: Peak water levels in 5% (1 in 20) annual change flood (mAOD) along the River Thames

Location	Model node	Existing conditions	Option 1 / 6a / 6b	Option 2	Option 3	Option 4	Option 5	Option 7	Option 8
1: Spelthorne channel offtake	20.012U	12.77	12.02	12.01	12.02	12.01	12.01	12.01	12.01
2: Chertsey Bridge	19.062U	12.31	11.72	11.71	11.72	11.71	11.71	11.71	11.71
3: Shepperton weir (u/s)	19.001	11.18	10.94	10.91	10.94	10.92	10.92	10.93	10.93
4: D'Oyly Carte Island	18.112	10.67	10.62	10.59	10.61	10.59	10.60	10.60	10.61
5: Desborough Cut	18c.072A	10.46	10.40	10.38	10.39	10.39	10.39	10.39	10.39
6: The Chap	18.100	10.60	10.54	10.57	10.55	10.56	10.55	10.55	10.54
7: Walton Bridge	18.044	10.05	9.96	9.96	9.96	9.96	9.96	9.96	9.95

Table 2: Peak water levels in 5% (1 in 20) annual change flood (mAOD) along the Spelthorne Channel

Location	Model node	Existing conditions	Option 1 / 6a / 6b	Option 2	Option 3	Option 4	Option 5	Option 7	Option 8
8: Sheepwalk West 2 lake	C3B_1+300	-	11.37	11.39	11.39	11.38	11.36	11.36	11.34
9: FCS18 weir	C3B_1+900	-	11.10	11.11	11.12	11.11	11.09	11.09	11.06
10: Chertsey Road (LA11)	C3N_2+452	-	11.03	11.05	11.06	11.04	11.02	11.02	11.00
11: Ferry Lane road (LA12)	C3N_3+104	-	10.76	10.81	10.81	10.79	10.74	10.73	10.73

Table 3: Peak flow in 5% (1 in 20) annual chance flood (m^3/s) along the River Thames

Location	Model node	Existing conditions	Option 1 / 6a / 6b	Option 2	Option 3	Option 4	Option 5	Option 7	Option 8
A: Desborough Cut	18c.072A	238	239	229	236	232	236	236	240
B: Desborough Loop (u/s The Chap)	18.111	207	208	134	205	137	238	205	213
C: Desborough Loop (d/s The Chap)	18.094	231	235	244	236	241	239	239	238
D: Walton Bridge	18.044	484	480	480	480	480	479	479	478

Table 4: Peak velocities in the new channel around Ferris Meadow Lake

	Option 2	Option 3	Option 4
Peak velocity (m/s)	1.8	1.5	1.6

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