Annex 9.6

Assessment of the Effects of Relocation of the E.ON Outfall on Thermal Recirculation

(HR Wallingford)

Able Marine Energy Park

Assessment of the effects of relocation of the E.ON outfall on thermal recirculation

Technical Note DDR4808-01

HR Wallingford

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Document Information

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1. Introduction

Able UK Ltd proposes to construct a Marine Energy Park (MEP) near Immingham on the southern bank of the Humber estuary. The MEP will be a facility for the construction of offshore wind turbines, and other activities associated with sources of renewable energy.

The MEP will consist of a large reclamation approximately 1300 m long along the shore and up to 400 m wide in the offshore direction. Immediately to the north of the reclamation there are two existing outfalls for two gas-fired power stations, which are located some 2 km inland of the proposed reclamation. One plant is operated by Centrica and the other by E.ON. These outfalls discharge cooling water from the power stations.

HR Wallingford has already undertaken a thermal dispersion modelling study of the cooling water discharges following the construction of the quay, and predicted the effects on thermal recirculation to the E.ON intake (Reference 1). Subsequent to that report, the design of the quay has been modified so that the breakwater constructed close to the E.ON outfall has been removed and the front (offshore) face of the quay has been moved closer to the shore. Both these changes are likely to result in less recirculation at the E.ON intake than was predicted for the earlier design of the quay.

Sediment transport modelling, also undertaken by HR Wallingford, has indicated that there is a high risk that the intake and outfall structures for the E.ON plant will experience significant siltation (Reference 2).

One potential option to resolve the issue of siltation at the E.ON outfall is to relocate it to the front face of the MEP quay. This report describes additional thermal modelling to determine the likely effect of relocating the outfall on temperatures at the E.ON intake, compared to those predicted for the existing outfall location.

1.1 COORDINATE SYSTEM

The coordinate system used in the model and this report is British National Grid (OSGB36). Vertical positions have been related primarily to Ordnance Datum Newlyn (ODN). Units are metres in both the horizontal and vertical directions.

Some levels have been provided relative to Chart Datum (CD) which is roughly the level of lowest astronomical tide. At Immingham, CD is 3.90 m below ODN.

2. Thermal assessment

The same modelling approach as used in the earlier thermal modelling (Reference 1) was applied in this additional work. The layout of the quay and associated dredging for the final layout of the quay was taken from the sediment transport modelling (Reference 2). The model bathymetry for existing conditions and the revised layout is shown in Figure 2.1.

Intake and outfall flows from the two power stations have been introduced into the model. The E.ON outfall was positioned at its new location on the front face of the quay, at the same elevation as the existing outfall (approximately -5 m ODN). As the sea bed in front of the quay will be dredged to -11m CD (-14.9 m ODN), the outfall will no longer be located close to the sea bed.

The dispersion of the thermal plumes has been simulated over several tidal cycles, for four combinations of tidal and wind conditions.

2.1 INTAKE AND OUTFALL PARAMETERS

Data provided by the power station operators suggests that the ambient water temperature is around 18°C in summer and around 10°C in winter.

The E.ON outfall temperature is about 27°C in summer, which implies that the discharge has excess temperatures of around 9°C; in winter, the outfall temperature is around 21°C which implies that the discharge has excess temperatures of around 11°C. For this study, a constant value of 10°C was assumed.

Less definite information has been supplied about the Centrica discharge, but its behaviour seems broadly similar; therefore this has also been assumed to have a constant excess temperature of 10°C.

These parameters are summarised, together with the relevant flow rates, in Table 2.1.

Table 2.1 Intake and outfall parameters

	E.ON	Centrica
Intake flow rate (m^3/s)	0.7	0.4
Outfall flow rate (m^3/s)	0.7	0.3
Outfall excess temperature (°C)	10	10

2.2 ENVIRONMENTAL CONDITIONS

The thermal dispersion simulations were run for spring tides and neap tides, under calm conditions, and assuming a constant wind blowing from the west at 7 m/s.

Calm conditions were used because they often give the most adverse predictions for the accumulation of heated water in the vicinity of a discharge. The wind condition was selected because the Admiralty Pilot suggests that this is representative of the most commonly occurring winds.

2.3 RESULTS

Similar results were found for all the four environmental cases tested with the revised quay layout and the E.ON outfall located along the front face of the proposed quay. Contour plots of surface and bed excess temperature are shown only for spring tide calm conditions (Figures 2.2 and 2.3). These plots show plume dispersion patterns at the sea surface and sea bed, at times corresponding approximately to High Water (HW) and Low Water (LW) slack. As in the previous simulations for existing conditions and the earlier MEP quay layout (Reference 1), excess temperatures above 0.5°C are predicted only very close to the Centrica and E.ON outfalls around HW and LW. The plume from the relocated E.ON outfall is not visible at the bed in these plots as the outfall will no longer be located near the bed. At HW, the Centrica plume is evident at the sea bed close to the outfall, and mixed through the depth somewhat further away. The period of HW slack is very brief at this location and the tide has already turned near the quay at the model output time selected. Hence the plumes from both outfalls are shown being carried seaward at HW. The thermal plumes from both outfalls are dispersed fairly rapidly.

The excess temperatures predicted at the E.ON intake (Figures 2.4 to 2.7) are lower than those previously predicted for the existing outfall location with the earlier quay design. Under spring tides, two peaks of around 30 minutes each appear about 1 hour after LW and 30 minutes after HW. Under calm conditions, the surface temperature is predicted to peak at 0.3°C to 0.4°C above the ambient values near HW and LW, while the near-bed value is less than 0.1°C. Similar results are predicted for a neap tide, and when a constant wind is applied to both tidal cases.

3. Conclusions

With the final layout of the MEP quay in place, relocating the E.ON outfall to the front face of the quay is predicted to lead to water temperatures at the E.ON intake that are lower than those for the earlier quay design and with the E.ON outfall located in its present position. Peak temperatures at the E.ON intake are predicted to be 0.3°C to 0.4°C above the ambient value for no more than 1 hour per tide. At other times, the excess temperature at the intake is predicted to be less than 0.1°C.

After completion of the modelling studies described in this Technical Note, Able UK Ltd advised HR Wallingford that there may be a need to relocate the Centrica outfall as well as the E.ON outfall. If this is required, then one option could be to relocate the Centrica outfall to the same place as the relocated E.ON outfall. In that case, the combined thermal plume produced is likely to behave similarly to the plume for the E.ON outfall alone as discussed in this report. As the Centrica discharge is typically less than the E.ON discharge, the horizontal extent of the plume for a particular excess temperature at any time is likely to be no greater than twice that shown in this Technical Note. Similarly, it is considered likely that the peak surface excess temperature near the E.ON intake will probably be no greater than about twice that shown in this Technical Note. This opinion is unsupported by modelling at the present time, and should be confirmed by additional modelling if the option of moving the Centrica outfall is to be pursued further.

4. References

1 HR Wallingford, 2011 Able Marine Energy Park near Immingham, Assessment of proposed reclamation impact on recirculation at E.ON intake / outfall, Report EX 6503, November 2011

2 HR Wallingford 2011 Able Marine Energy Park 3D Mud Modelling, Assessment of the effects of a proposed development on the south bank of the Humber Estuary on fine sediments, Report EX 6603, November 2011

Figures

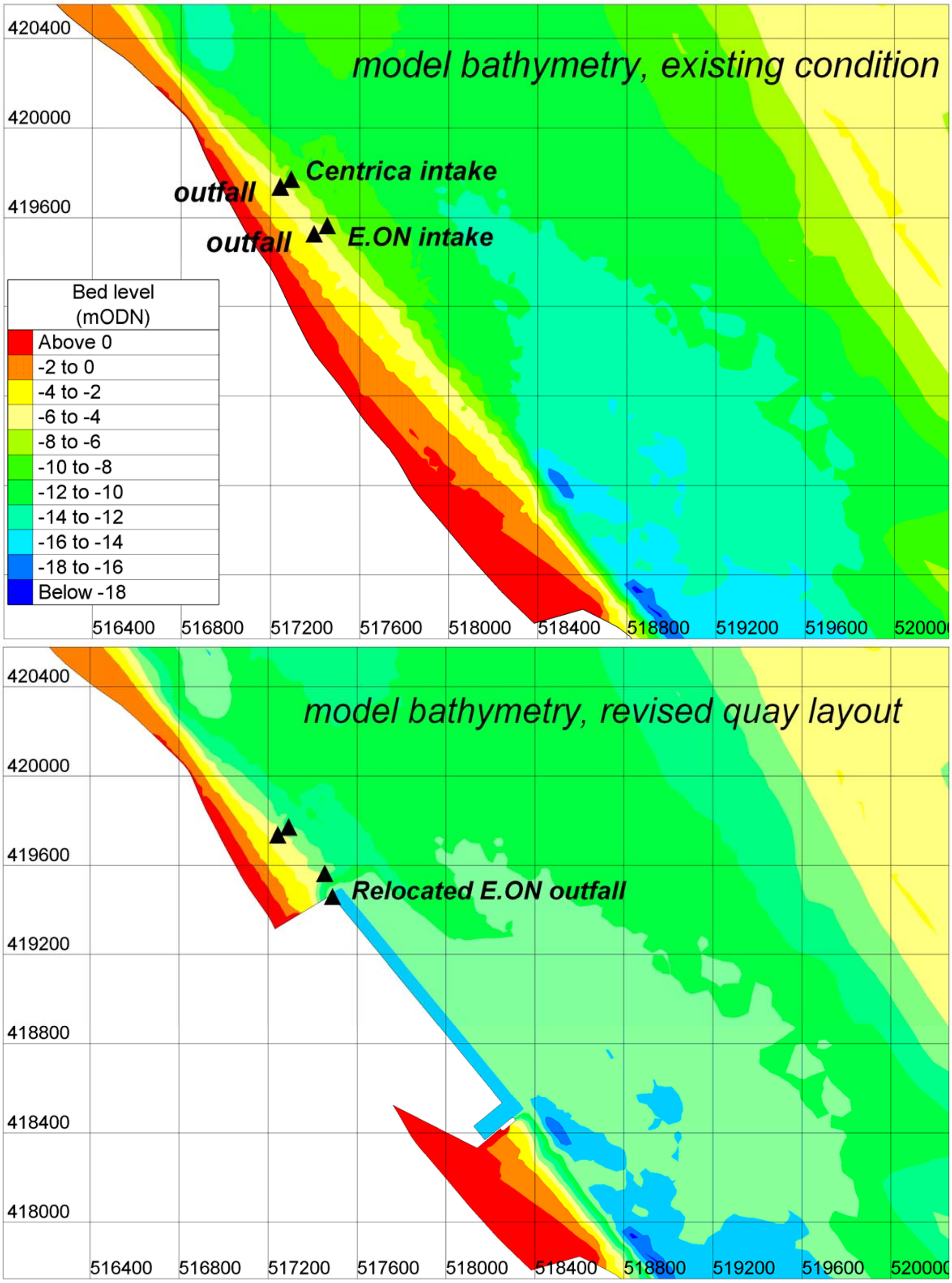

Figure 2.1 Site layouts; existing and revised developed case

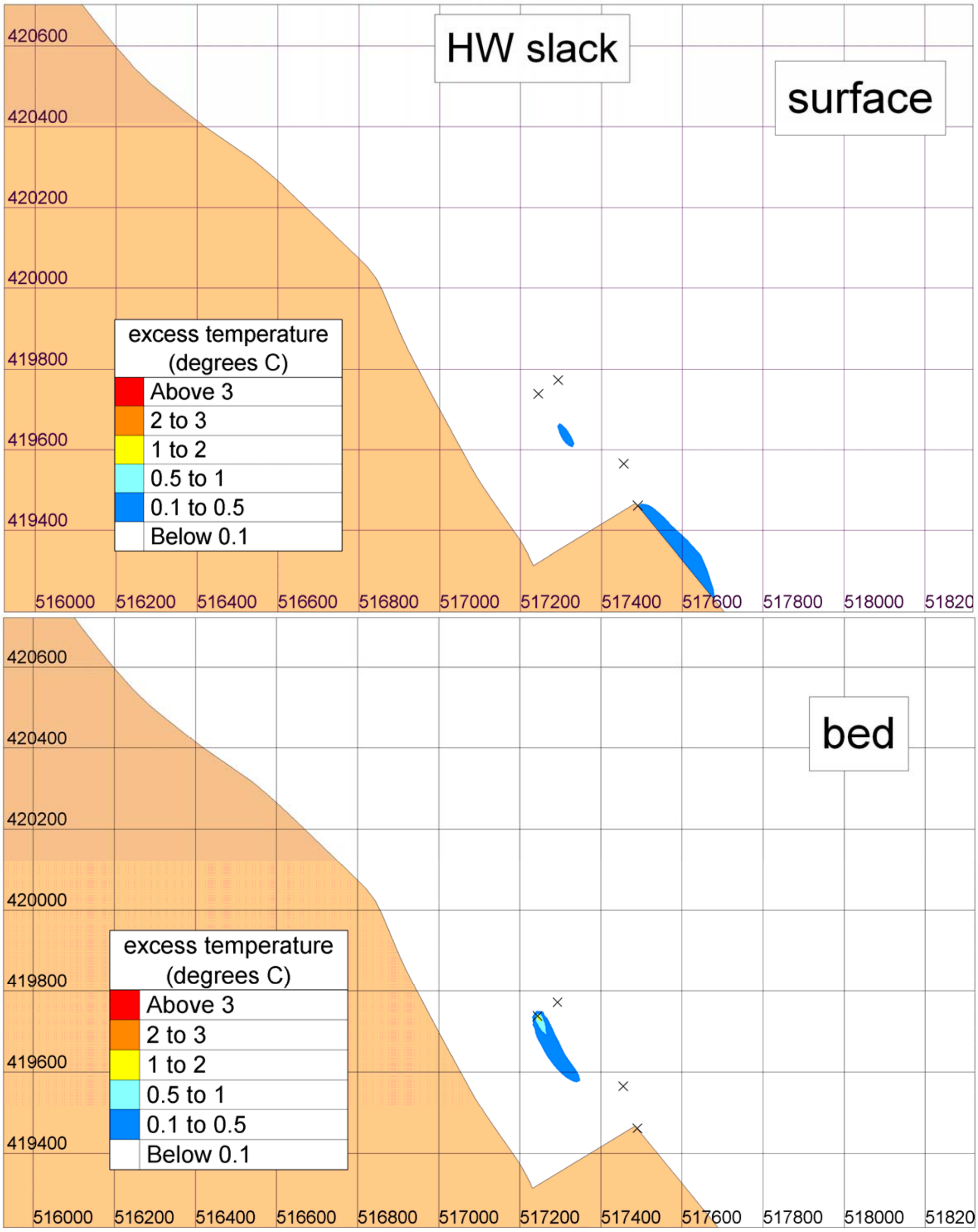

Figure 2.2 Predicted thermal dispersion patterns at High Water, final layout with E.ON outfall relocated, spring tide, calm conditions

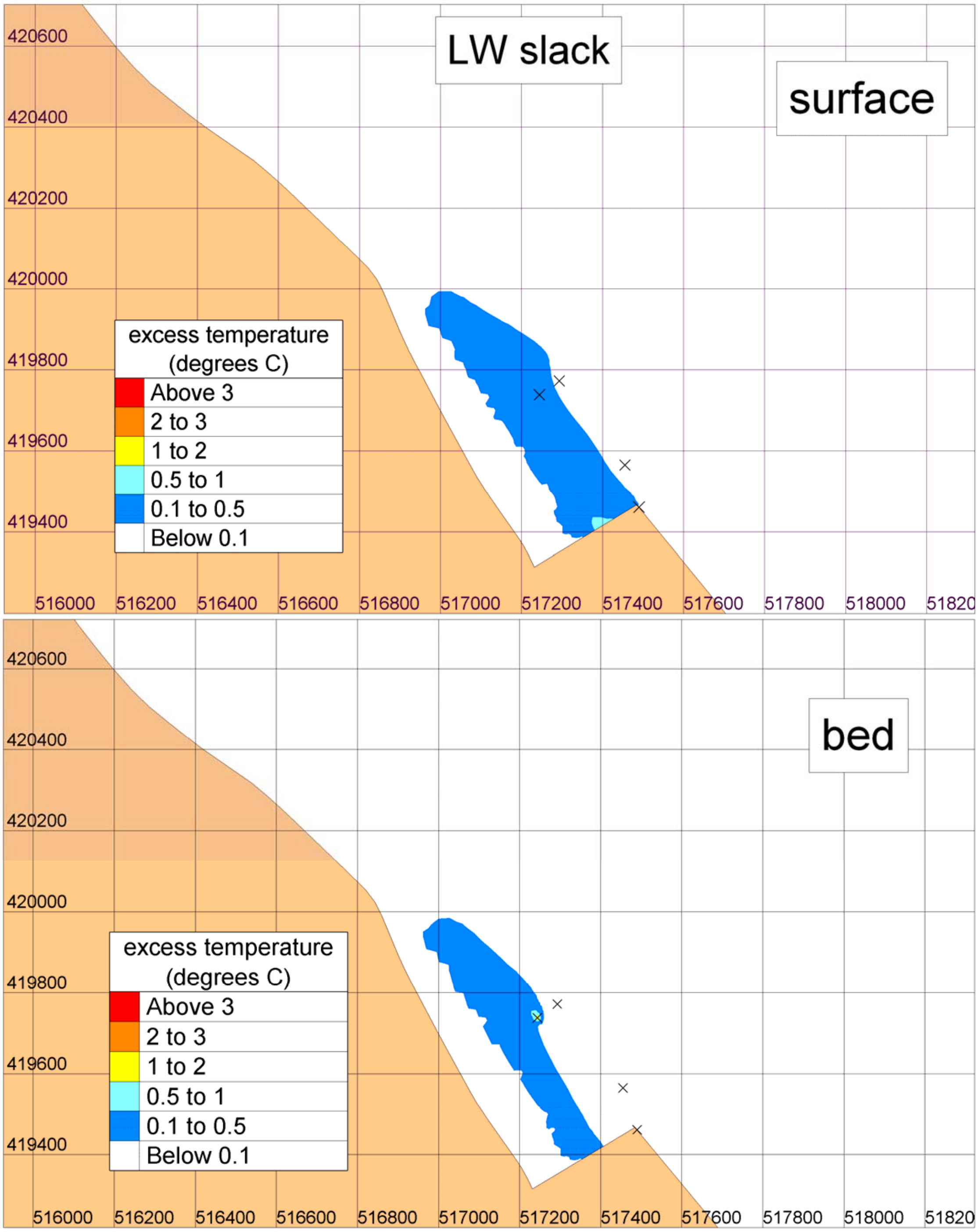

Figure 2.3 Predicted thermal dispersion patterns at Low Water, final layout with E.ON outfall relocated, spring tide, calm conditions

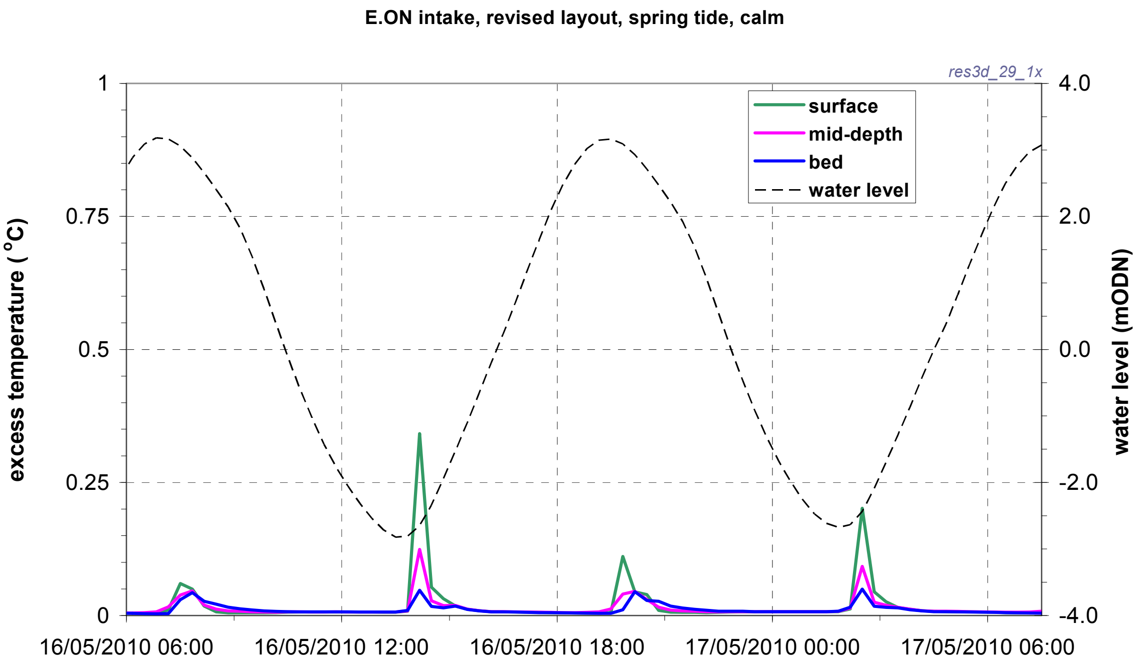

Figure 2.4 Predicted excess temperature variation at the E.ON intake, final layout with E.ON outfall relocated, spring tide, calm conditions

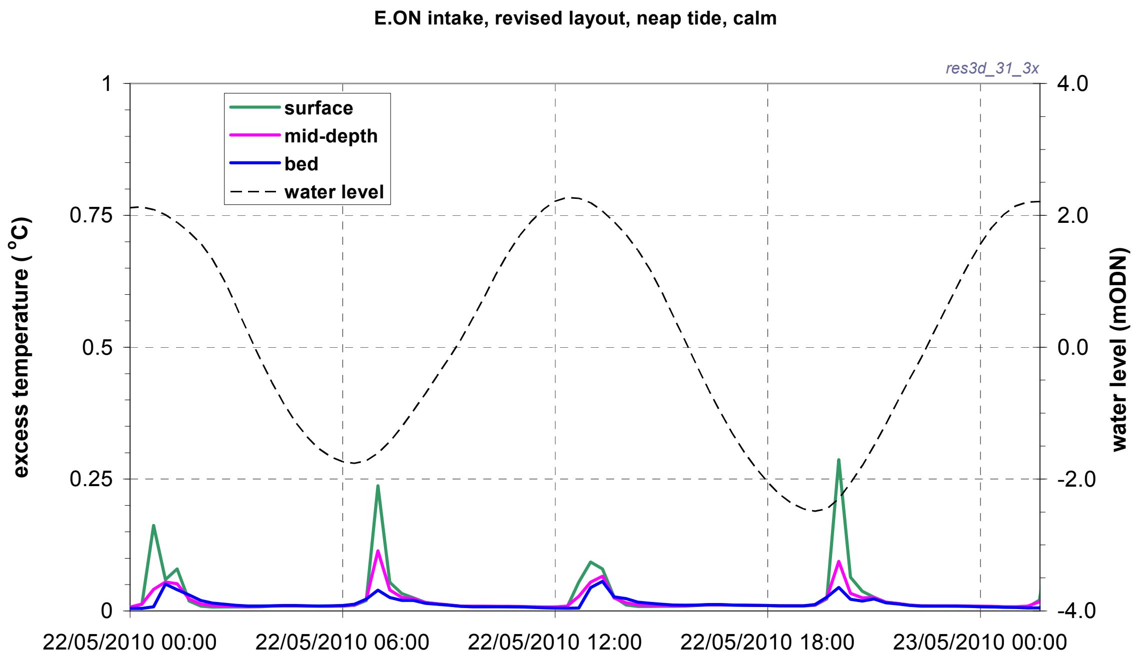

Figure 2.5 Predicted excess temperature variation at the E.ON intake, final layout with E.ON outfall relocated, neap tide, calm conditions

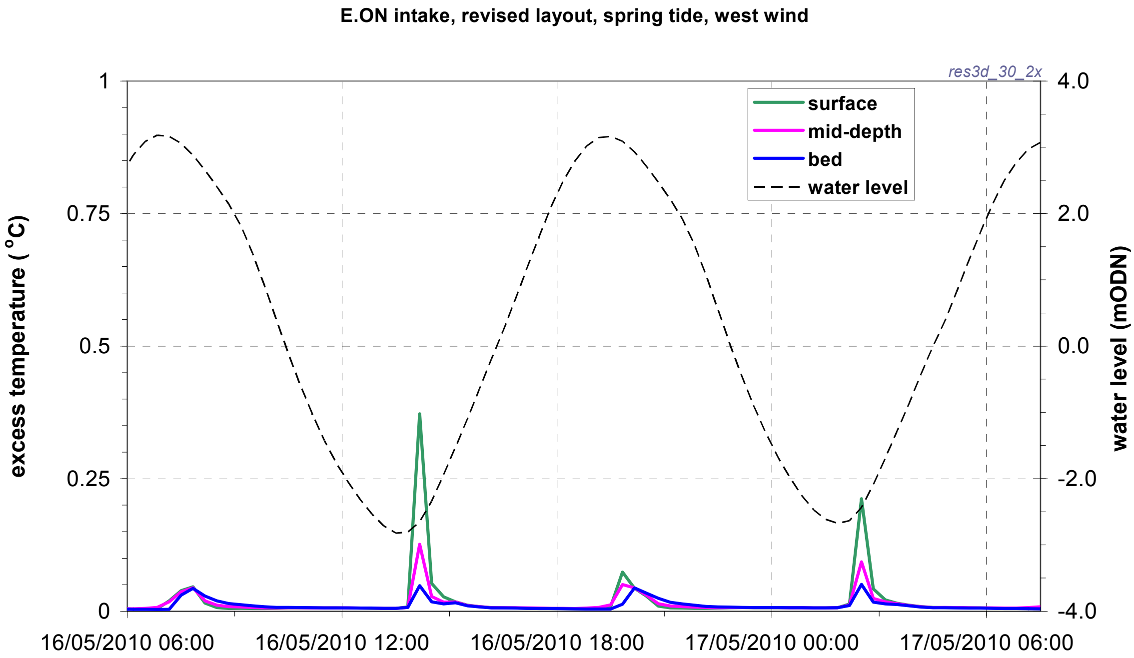

Figure 2.6 Predicted excess temperature variation at the E.ON intake, final layout with E.ON outfall relocated, spring tide, constant wind

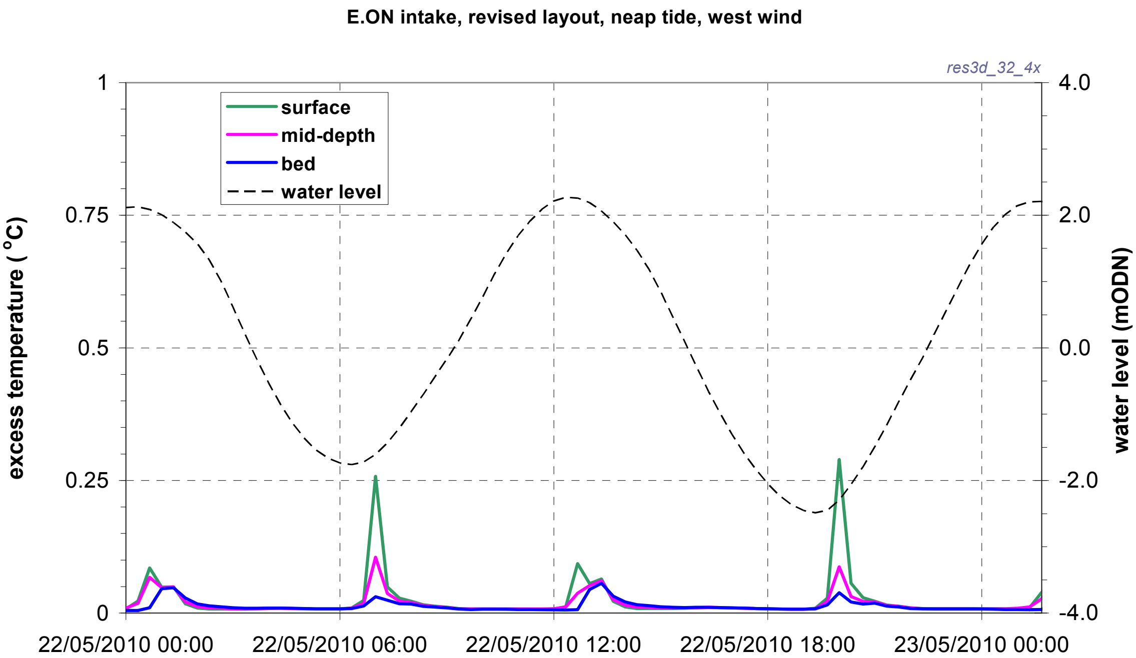

Figure 2.7 Predicted excess temperature variation at the E.ON intake, final layout with E.ON outfall relocated, neap tide, constant wind