The Lake Lothing (Lowestoft) Third Crossing Order 201[*]

Document SCC/LLTC/EX/38: Environmental Statement Volume 3 – Appendix 17C

Sediment Transport Assessment Table of changes

Revision 0

Planning Act 2008

The Infrastructure Planning (Examination Procedure) Rule 2010

PINS Reference Number: TR010023

Author: Suffolk County Council

Document Reference: SCC/LLTC/EX/38

Date: January 2019

This page is intentionally left blank

Table of changes

This document provides a comparison between the Sediment Transport Assessment (Environmental Statement Appendix 17C) (Document Reference 6.3, PINS Document Reference APP-201) as submitted as part of the Development Consent Order application and the Sediment Transport Assessment (Revision 1) (Document Reference SCC/LLTC/EX/36), following feedback from the Environment Agency

EA comment number	Page/ Paragraph	Environment Agency Comment	Applicant's Response	Response Page/Paragraph
EA // 1	3.1.2	Please provide more details of the tides you have used, and how they have been selected. You descriptions seem to be at odds with Table 3.1 / Fig 3.1. (HAT and LAT are the highest and lowest levels, respectively, reached due to purely tidal variation. They are levels, and do not vary in time.) For a dynamic study in a tidal dominated area, I would expect you to consider spring tides and neap tides, coupled with a range of atmospheric effects. You seem to have taken a different approach, based on deriving tidal levels for flood assessment. It is not clear that it is appropriate for an assessment of sediment dynamics.	More detail has been provided in the report to justify method used. The use of the EA guidance provides a recognised structured framework to produce the tidal boundaries. This process creates a tidal curve profile based on existing gauge data available. To that end, the shape of the curve is captured and scaled for various peaks and troughs. Using this approach allows the model to predict the current speeds in a range of events and shows the current speeds in everyday and extreme events in the basin. The use of the peak level in the HAT and LAT scaling simulates a large and small ebb/flood tide profile which is considered similar to the Spring and Neap tides however falls within the EA guidance for tidal curve derivation.	Section 3
EA // 2	Fig 3.1	Please review the captions for the lines, and correct the vertical axis label.	This has been addressed in the report.	Fig 3.1

EA comment number	Page/ Paragraph	Environment Agency Comment	Applicant's Response	Response Page/Paragraph
EA // 3	section 4.2.1	Please define 'glass walling effect'.	This is a common modelling term. Typically, glass walling creates flow routes and ponding in the model results which are not accurate representations of reality. In the extreme 0.1% AEP event, water reaches the edge of the model domain and the water assumes an infinitely high wall here that water will pond against as boundaries have not been applied to allow water out of the model domain. Glass walling does not occur in the other events modelled and the 0.1% AEP event was simulated purely as a sensitivity test of the model.	Paragraph 4.2.1
EA // 4	fig 4.1	Please improve the basemap resolution, if possible. (Also on later figures.)	Unfortunately this is not possible. Care has been take to ensure the figures are as clear as possible in the report.	N/A
EA // 5	section 4.2.2 (model mesh)	I note that your mesh includes unstructured and (regular) quad sections. You have chosen nested quads for the high and ultra-high resolution parts. Please explain this choice.	It is best practice to use quadrilaterals where possible. Given that a linear channel is being represented, rather than the open sea, quadrilaterals were deemed most appropriate to represent Lake Lothing. The quads fit well with the orientation of the estuary.	Paragraph 4.2.3
EA // 6	section 4.2.2 (model mesh)	Please also comment on the mesh growth from the high to ultra-high sections, and at the edge of the river channel. The transitions look rather abrupt, which could affect the model predictions. In particular, the transition from regular grid to unstructured has produced some very small triangles. Please comment on the effects this may have on the calculations, and the tests you have done to ensure connectivity.	Using a Finite Volume solver allows difference sized cells next to each other providing two corner nodes are shared. This doesn't generate numerical errors between cells and produces a stable model. The results at the locations where the mesh resolution changes were checked and were found to be smooth - this has been documented in the report.	Paragraph 4.2.3
EA // 7	section 4.2.2 (model mesh)	Please display the model mesh and bathymetry over the whole domain, as well as the detail around the structures.	This has been added to the report.	Figure 4-3, 4.5

EA comment number	Page/ Paragraph	Environment Agency Comment	Applicant's Response	Response Page/Paragraph
EA // 8	section 4.2.2 (model mesh)	You mention that the structure footprints are included in the model mesh (baseline & developed). I agree this is best practice, but at this stage I do not know what that footprint is - I don't even know if they are round or square. Please include a figure(s) to demonstrate - perhaps a design drawing, and highlight in the developed case bathymetry.	This has been added to the report.	Figure 4-7 and paragraph 4.2.13
EA // 9	section 4.2.3	You state that ' the Scheme does not impact on the Lock'. Unqualified and unsupported, this is a bold claim. Please explain.	The lock is approximately 1.9km upstream of the proposed bridge. The sediment modelling shows that the impact of the scheme does not extend as far as this. Further information has been added to the report.	This is discussed in detail in the Section 5.2 and Section 5.3
EA // 10	4.2.4	What kind of value is 0.03? If it's Manning's n, please state this when you introduce it.	Manning's n value - report has been updated.	Paragraph 4.2.5
EA // 11	4.2.4	I think you have sold yourself short in this section. The first sentence gives the impression that you pulled the value 0.03 out of thin air. Later, you mention a more considered approach, using sensitivity tests to confirm it. I suggest you turn the whole paragraph around, and shorten it. (Even just refer to section 4.3.)	This has been reworded. An initial value of 0.03n representing a smooth channel based on survey is specified and then a sensitivity test is carried out to assess the suitability of the value. This is common practice in a model build.	Paragraph 4.2.5, Section 4.3
EA // 12	4.2.5	Please show the bathymetry data as well as its coverage.	This has been added to the report.	Figure 4-4, Figure 4-5
EA // 13	4.2.6	You refer to LiDAR at 0.5m resolution. Is this horizontal or vertical?	0.5m horizontal grid size.	Paragraph 4.2.7
EA // 14	4.2.6	You claim "good correlation between the LiDAR and topographical data". Please show the evidence.	The area surveyed on the south quay shows that the ground levels at approximately 3m. This is consistent with the levels measured by the LiDAR and the Quay wall heights provided by the EA. The report has been updated.	Paragraph 4.2.7

EA comment number	Page/ Paragraph	Environment Agency Comment	Applicant's Response	Response Page/Paragraph
EA // 15	4.2.7	You mention the A47 bridge, but it is not visible in the figure. Can you extend the figure to include it?	A label has been added to Figure 4-1	Figure 4-1
EA // 16	4.2.7	If I understand this correctly, you have generated a tide curve offshore, and then applied it upstream of the A47 bridge. What allowance have you made for the complex variations in flow across the model boundary, which will be generated by eddies around the harbour walls, bridge, etc. on the flood tide?	We acknowledge that the outer harbour will create eddies which will result in energy loss. However due the resolution of the model at that location (approximately 5m) and the constriction at the A47 bascule bridge (approximately 25M wide) it is highly likely that the length scale of the eddies created in the outer harbour will be smaller than the model can explicitly simulate through the A47 constriction.	Paragraph 4.2.8
EA // 17	4.2.7	In what way is this 'conservative'?	We acknowledge that the outer harbour will create eddies which will result in energy loss. However due the resolution of the model at that location (approximately 5m) and the constriction at the A47 bascule bridge (approximately 25M wide) it is highly likely that the length scale of the eddies created in the outer harbour will be smaller than the model can explicitly simulate through the A47 constriction. This is considered conservative because in practice, the impact of the Outer Harbour reduces the tidal range and rate of change of water level whereby reducing the expected velocities Lake Lothing will experience. In this assessment, by applying the tidal boundary that is derived for the Outer Harbour entrance, the model will experience slightly larger velocities that reality using this approach.	Paragraph 4.2.8
EA // 18	4.2.8	What was the result of the sensitivity test?	provided in section 4.3	Section 4.3

EA comment number	Page/ Paragraph	Environment Agency Comment	Applicant's Response	Response Page/Paragraph
EA // 19	4.2.9	"The model is assumed to be insensitive to the initial conditions" Surely you can check this?	Wording has been changed refering the reader to the sensitivity testing	Paragraph 4.2.9 refers to Section 4.3 which concludes in paragraph 4.5.6
EA // 20	4.2.10	What is the point of this section? It makes some bold statements, with no substantiation. It raises concerns and fails to calm them. I suggest you either expand it, or delete it.	The purpose of this section is to explain why existing structures have not been modelled.	Paragraph 4.2.11
EA // 21	4.2.12	A diagram would help greatly here. Please state clearly the shape of the pile footprints, and the height at which you have represented them.	A pile footprint drawing has been added, the piles are circular with approximately 1m diameter in reality and have been represented as approximately 1mx1m squares in the model. The piles are represented to 3mAOD, this represents approximately 12m of vertical pile.	Figure 4-7 and paragraph 4.2.13
EA // 22	4.2.14	This description is not clear enough. Please state the range of water depths around the piers, and how this translates into vertical mesh structure. As noted above, you have not stated the bathymetry so I have no idea how deep the water is. In particular, I would like to know the layer thicknesses at the bed and surface, as this will indicate the accuracy ot the speed predictions at the bed.	This has been added to the report.	Paragraph 4.2.15 and Figure 4-5

EA comment number	Page/ Paragraph	Environment Agency Comment	Applicant's Response	Response Page/Paragraph
EA // 23	4.2.15	What is the point of this paragraph? I can paraphrase "TUFLOW FV uses default methods for representing 3D effects, and we haven't messed with them." I suggest you either delete it or change the focus, to confirm you are using best-practice methods. This type of detail might be better in a technical appendix describing the model basis - I don't think you have provided one.	The paragraph has been misunderstood, we have not used the default options (TUFLOW-FV turbulence default is to use a user specified constant eddy viscosity and diffusivity) for the turbulence models and this paragraph is to discuss the options. Best practice for tidal applications is to use the parametric and Smargorinsky methods in 3D model. The paragraph has been re-worded to explain this in greater detail and remove any confusion.	Paragraph 4.2.16
EA // 24	4.2.15	"better" than what?	Further text has been added	Paragraph 4.2.16
EA // 25	4.3.5	You present the sensitivity test results as current speeds at a single time in the simulation, at a range of points. Please include some plots of current patterns, to give context, and show the variation over time.	An additional plot has been added	Section 4.3
EA // 26	4.3.5	Are there no data against which you can calibrate the model?	There was no velocity measurements available or collected for is assessment.	N/A
EA // 27	4.3.9	According to Table 4.1, you have not varied the roughness in the river channel, so this claim is not substantiated.	Table 4-1 has been re-worded for clarification	Table 4-1
EA // 28	4.3.11	Please explain the qualification "up to the point where the water leaves the channel".	further explanation has been added	Paragraph 4.3.13
EA // 29	4.4	There is no need to quote the name of your log file in a report for public consultation. More broadly, this section is undermined by its final sentence. If sensitivity testing is the best check, what is the point of this discussion on CFL numbers?	re-word - it is best practice to check the grid performance using the CFL numbers and is a recommended check in the model build.	Section 4.4
EA // 30	4.5.3	"The graph shows the water depths in chart datum." These are water surface elevations, not depths.	Updated	Paragraph 4.5.3
EA // 31	4.5.4	Reference to Figure 4-9 is wrong. Should be 4-6, or 4-7?	Updated	Paragraph 4.5.4

EA comment number	Page/ Paragraph	Environment Agency Comment	Applicant's Response	Response Page/Paragraph
EA // 32	4.5.4	If I understand this correctly, you have scaled the input tide curve to match the observed water level at the comparison point (tide gauge). This is a model calibration process.	This is considered a verification process because data is only available from one primary source, in this case the tidal gauge at the A47 bridge. Using this data we can simulate an event to have confidence in the model combined with other secondary sources of information such as anecdotal reports and reports of flooding events.	N/A
EA // 33	fig 4.7	I think the time axis units are hours, not days.	Updated	Figure 4-11
EA // 34	4.5.5	Figure ref for speeds should be 4-9, not 4-8.	Updated	Paragraph 4.5.5
EA // 35	Section 4	This section raises a lot of questions. You have carried out a set of sensitivity tests, and then calibrated the tide curve, amplifying it by about 3%. How have you carried this finding through into the model configuration, and the predictive tests?	Additional text has been added to the report.	Section 4
EA // 36	Section 4	I note that the initial model setup has been done in 2D. This is fine, but you should conduct your final calibration, baseline and sensitivity tests in the (3D) model that you will actually use for the predictions. You should also focus attention on the bed velocities, as you have noted that these are the most important for sediment transport. I haven't seen any indication that this is the case. Please comment.	This approach is considered best practice - further information has been added to the report.	Section 4
EA // 37	5.1.2	This claim is not substantiated. Does the current speed (particularly at the bed) not depend on the water depth?	Further discussion has been added to the report - the current speed depends on the rate of change in water surface elevation and tidal range which corresponds to the peak level and the next trough level.	Section 4.3 and para 4.3.13
EA // 38	5.1.3	Figure 5.1 does not show the stated range of particle sizes - no variation is apparent. Reference is made to Appendix 12B, which I haven't seen. Perhaps there is more detail there?	The purpose of the figure is to show the range of particle sizes that could be found in an estuarine system and the surveyed particle sizes are at the smaller end of this scale.	Figure 5-1
EA // 39	Table 5.1	This table does not seem to make sense (cf. comment EA // 1)	See response to EA //1	N/A

EA comment number	Page/ Paragraph	Environment Agency Comment	Applicant's Response	Response Page/Paragraph
EA // 40	5.1.4	I think you mean 'versus' rather than 'verses'. Or you could use the English word 'against'.	Updated	Paragraph 5.1.4
EA // 41	5.1.4	Please interpret the diagram for the reader by stating the range of erosion speeds that apply here. I think they are above 1m/s - is this correct? - and it would be very helpful to state this.	Additional information has been included in the report and on the results figures.	Section 5
EA // 42	5.2.1	A layer thickness of 1m does not provide a detailed estimate of speed at the bed. (cf. comment EA // 21)	Additional information has been included in the report. 1m vertical resolution provides sufficient accuracy for this assessment. The resolution was chosen as a balance between numerical accuracy, model run time and results resolution. 1m is considered a suitable balance.	Paragraph 4.2.15
EA // 43	5.2.2	What stage of the tide does 53.30 hours correspond to? And why was this time chosen to present water speed?	Further information has been included in the report.	Section 5
EA // 44	5.2.2	Figure 5.3 seems to suggest that current speeds throughout the model domain are below the threshold for sediment resuspension. (I assume the units on the colour scale are m/s.) Therefore the figure does not show (as you claim) that "the existing regime carries clay into the domain on the flood tide."	We believe there is confusion around the interpretation of the results. Based on the modelling, the current speed is not sufficient to resuspend sediments already within the harbour as stated in your response however the speed and particle size is within the 'transport' area of the Hjulstrom Curve. Taking into account the anecdotal evidence provided by the Harbour Master of speeds and the need for dredging each year, this increase in sedimentation must come from external sources. As the flow upstream of Lake Lothing is controlled by a lock gate which is highly unlikely to be the main source of the sediment, the incoming tide must contain suspended sediments picked up outside of the study area and carried in on the incoming tide.	Paragraph 5.2.2
EA // 45	5.2.2	The anecdotal data that the harbour suffers from siltation is very relevant to this study. You could make more of this.	This has been updated in the report.	Section 5

EA comment number	Page/ Paragraph	Environment Agency Comment	Applicant's Response	Response Page/Paragraph
EA // 46	Table 5.2	This table is difficult to interpret. I would like to see the total speeds in the developed case. The increase due to the scheme is relevant, but could be summarised. A map would be much more accessible than a table.	Table has been removed and maps added to the results section.	Figure 5-3 to figure 5-26
EA // 47	5.2.5	As mentioned previously, a map would be more useful than a table. Please specify the critical speeds to enable a direct comparison.	Table has been removed and maps added to the results section.	Figure 5-3 to figure 5-26
EA // 48	5.2.8	You show timeseries of the change in speed, but without a timeseries of the actual speed this is difficult to understand. I suggest that you supply these, together with the difference plots. Please also give consideration to the time axis. A number of model hours is not meaningful to a lay reader. The most useful approach could be to superimpose a tide curve so that the times of high and low water (etc) can be seen. Also, text refers to point P2 but fig 5.4 is for point P1, which is it P1 or P2?	Further information has been included in the report.	Section 5.2
EA // 49	5.2.9	Again, a map would help enormously here.	Maps have been added to the results section	Section 5
EA // 50	6.1.2	Is flood risk relevant to this report?	Flood risk has been dealt with in the Flood Risk Assessment. The focus of this report is to investigate the impact on sediments in likely tidal scenarios.	N/A
EA // 51	6.1.4	This description does not appear consistent with the scaling you mentioned in section 4.5.4.	This has been updated in the report.	Paragraph 6.1.4
EA // 52	6.1.5	The sediment sizes are different from those quoted in section 5.1.3.	This has been updated	Paragraph 6.1.5
EA // 53	6.1.8	This statement is vague, and not strongly supported by the evidence presented.	Further information will be provided.	Section 5

EA comment number	Page/ Paragraph	Environment Agency Comment	Applicant's Response	Response Page/Paragraph
EA // 54	general	This study appears to be of very low quality. The report is poorly written, and it may be that the underlying modelling is better than it appears. However I have a significant concern that the consultant does not possess a detailed understanding of tidal dynamics, and that the tidal forcing in the model may be inappropriate for a sediment transport assessment. Since no comparison with measured velocities is provided, it is impossible to confirm whether they are of the correct order of magnitude.	The report has been updated to ensure the comments are addressed and where necessary further explanation/clarification/information has been added.	N/A
EA // 55	HOWEVER	I would expect that the fundamental conclusions are correct, based on the data to which the report refers. * The report quotes typical sediment sizes smaller than 0.003 mm. * For sediment of this size, erosion velocities are in excess of 1 m/s. (Using their Fig 5.2) * Anecdotal evidence is quoted from the Harbour Master that speeds are 'low' within the harbour, which I would interpret as well below 1 m/s. * Therefore it is plausible that relatively small changes to the flow regime within the harbour will not cause erosion, post-construction.	The EA review agrees with the conclusions of the report that the small change in flow pattern caused by the bridge will only have a small impact of the flow regime and will not change the sediment regime. Further information/clarification has been added to the report.	N/A
EA // 56	general	The study only considers the condition post-construction. A greater risk is sediment transport DURING construction of the bridge, as the piers will need to be piled, foundations dug, etc.. If sheet-piled cofferdams are used, these would later be removed; these processes could release significant amounts of sediment into suspension.	At this stage, a detailed construction plan has not been made available. Individual construction tasks such as removing sheetpile piles cannot be simulated because the details of such a task are not available. This assessment considers the wider impacts on sediment movement and has not been developed to assess localised scour impacts. If the EA wanted further information on this at detailed design, it could be provided pursuant to the EA's protective provisions in the DCO	Paragraphs 5.2.46 & 6.1.8

EA comment number	Page/ Paragraph	Environment Agency Comment	Applicant's Response	Response Page/Paragraph
EA // 57	general	There is no reference in this report to protected sites, or any legislation. Perhaps this is picked up elsewhere in the ES package.	Protected sites and legislation have been considered in the WFD assessment. Refer to the HRA (Document Reference 6.5/APP-206)	N/A
EA // 58	4.2.1	"The eastern boundary is 90m west of the A47 Bascule Bridge where the channel narrows and this was considered sufficient because the impact of the Scheme will not extend past the narrow section of channel into the outer harbour" Unqualified and unsupported. Please explain.	This has been discussed in section 5.2 and 5.3, further clarification has been added.	Section 5-2 and 5-3
EA // 59	Table 4.3	I believe this presents depth average velocity, if so should state this is the case	Added to the report, it is the depth averaged speed.	Table 4-3
EA // 60	4.5.3	15 min stage data is available for T341907 on the EA hydrometric archive (Wiski). This data should be obtained and used.	15min stage data was requested from the EA as part of this assessment. Daily average tidal data was provided and has been used in creating the tidal curves.	Appendix A
EA // 61	5.1.1	"A total of eight 3D model runs have been undertaken as part of this assessment, four return periods have been simulated in the present day" What does 'in the present day' mean?	This has been clarified in the report.	Paragraph 5.1.1
EA // 62	Figure 4.5	Are any of the comparison points located between bridge piers? This is where you'd expect to see post scheme speeds to increase relative to baseline.	The comparison points are close to the bridge piles and show a slight increase in speed. This has been shown in points 6 and 11 which are immediately upstream and downstream of the constriction.	Figure 4-7, Figure 4.8
EA // 63	Appendix A, Figure 1	The yellow line is not perpendicular to the tidal boundary as drawn.	The line is simply to show the nearest node in the JBA dataset to the site. The word 'perpendicular' has been removed.	Appendices