APPENDIX 9E

Model Validation

9E-1 INTRODUCTION

9E-1.1 Background

9E-1.1.1 In 1996, Delft Hydraulics were commissioned under an Agreement with the Hong Kong Government to set up, calibrated and validated their three-dimensional suite of hydraulic and water quality models to cover a large coastal area around Hong Kong. Subsequently, under many previous Agreements with the Government of Hong Kong, the models have been applied in a large number of marine environmental studies in Hong Kong's coastal waters. Under these studies, the models have been applied using a number of different model grids covering different areas of Hong Kong's coastal waters at different spatial resolutions depending on the requirements of each particular study.

9E-1.1.2 For the current Investigation, it is important that the model includes the coastal waters to the South of Lantau Island to ensure that, if the proposed development does have the potential to impact on tidal flows passing North Lantau Island, the applied boundary conditions do not artificially force a flow through the relatively narrow channel between North Lantau and the New Territories and that any tidal or residual circulation around Lantau Island can correctly respond to any effects from the proposed development.

9E-1.1.3 The proposed hydraulic and water quality model studies were described in a working paper submitted to EPD previously in order to meet the requirements of the EIAs for HKLR (ESB-110/2003), TM-CLKL (ESB 175/2007) and HKBCF (ESB 183/2008) and one existing Delft3D model, the Western Harbour Model (WHM) (**Figures 1.1** and **1.2** in **Appendix 9E**), was considered suitable for application under the current Investigation with some refinements. In order to meet the specific needs of the model studies for the TM-CLKL+HKBCF+HKLR, the WHM model grid was refined and smoothed to improve the resolution of the proposed reclamations.

9E-1.2 Model Grid Refinement

9E-1.2.1 The model grid refinement was undertaken principally to improve the spatial resolution of the model in the Airport Sea Channel, off the north east corner of Chek Lap Kok and around the project areas. The refined model grid in the vicinity of the proposed reclamations is shown in detail in **Figure 1.3** in **Appendix 9E** which also shows an approximate layout for the TM-CLKL+HKBCF+HKLR combined reclamation and the LLP (72ha and 40ha reclamations) and the proposed remaining Tung Chung development to illustrate the proposed resolution of the model grid in these areas (70m-100m).

9E-1.2.2 In **Figure 1.4** in **Appendix 9E**, the refined and original model grids have been overlaid in order to highlight the refinements which have been made. As noted above, the changes to the model grid were made in the coastal area around the project areas off the eastern coast of Chek Lap Kok and in the Airport Sea Channel. However, as a result of the curvilinear model grid system, changes in a relatively small area can also result in small changes to the model grid further afield as can be seen in **Figure 1.4** in **Appendix 9E**. In the refined grid, the resolution of Victoria Harbour was reduced slightly compared to the original model grid. However, Victoria Harbour is remote from the study area and any small reduction in resolution in this area would not adversely affect the model results.

9E-1.2.3 Having refined the model grid, in order to demonstrate that the grid refinement has not adversely affected the original calibration of the WHM, it was necessary to carry out identical simulations with both the original WHM and with the refined grid model (referred to below as the WHM-RG) and to compare the results from both simulations.

9E-1.3 Model Spin-up Period

9E-1.3.1 When carrying out these simulations, the model must begin from specified initial conditions which may or may not be completely consistent with the simulated coastline and bathymetry (for example, after new reclamations have been added to the model dataset) and so the simulations must include an initial period of time, called the spin-up period, during which time any transient effects caused by inconsistencies in the initial conditions can dissipate. The models are used to simulate a 15-day sequence of spring and neap tides which are assumed to repeat every 15 days. Whether the spin-up period which has been allowed is sufficiently long can be determined by running the model for 15 days or longer after the spin-up period followed by a second period of the same duration. If the spin-up period has been sufficiently long, the results from the two successive simulations should be sufficiently similar to demonstrate that any transient effects have dissipated.

9E-1.4 Presentation of Model Results

9E-1.4.1 Selected representative results are presented in **Appendices 9E1 to 9E3** from the simulations which were carried out to demonstrate that the original WHM model calibration has not been adversely affected by the grid refinement and that the selected spin-up period is sufficiently long to allow the model to reach dynamic equilibrium with the model results repeating every 15 days.

9E-1.4.2 When comparing the results from the original WHM and from the WHM-RG, the simulated tidal levels, water velocities and salinities were compared at a large number of locations but, in this report, only the results from sensitive receivers WSR9a and WSR49 (**Figure 1.5** in **Appendix 9E**) have been presented which are typical of the results obtained at the other locations. In addition, the tidal and residual discharges across the 8 sections shown in **Figure 1.5** in **Appendix 9E** were also compared.

9E-2 ACCEPTABILITY OF THE REFINED MODEL GRID

9E-2.1 Model Validation

9E-2.1.1 Both the WHM and the WHM-RG were used to simulate tidal and seasonal flows for the Year 2010 which is considered a baseline year. This scenario was based on the coastline and bathymetry expected to be relevant prior to the start of construction in 2010 and was required to generate the baseline hydraulic conditions which would be used in the sediment plume simulations and to validate the refined model grid. Having refined the model grid, it was important to confirm that the grid refinement had not altered the original calibration of the Western Harbour Model.

9E-2.1.2 It was to be expected that, in the vicinity of the grid refinement, the refined model would have an improved resolution of the local the tidal flows and so some local differences between the refined grid model and the original Western Harbour

Model are to be expected. The overall, large scale, calibration of the model, however should not have changed.

9E-2.1.3 In order to assess the impact of the grid refinement, results from the original Western Harbour Model and the refined grids model were compared at a number of sensitive receivers and representative results are presented in **Appendix 9E1** at WSR9a and WSR49 together with the accumulated and instantaneous flows across selected discharge sections (**Figure 1.5** in **Appendix 9E**).

9E-2.1.4 Figures 1-4 in **Appendix 9E1** present the water surface levels; Figures 5-8 present the simulated salinities in each model; Figures 9-12 present the simulated water speeds; and Figures 13-28 present the instantaneous and accumulated flows across each discharge section. It can be seen that the simulated water surface levels, salinities and water speeds are very similar in each model and the grid refinement has not appeared to have changed the model calibration.

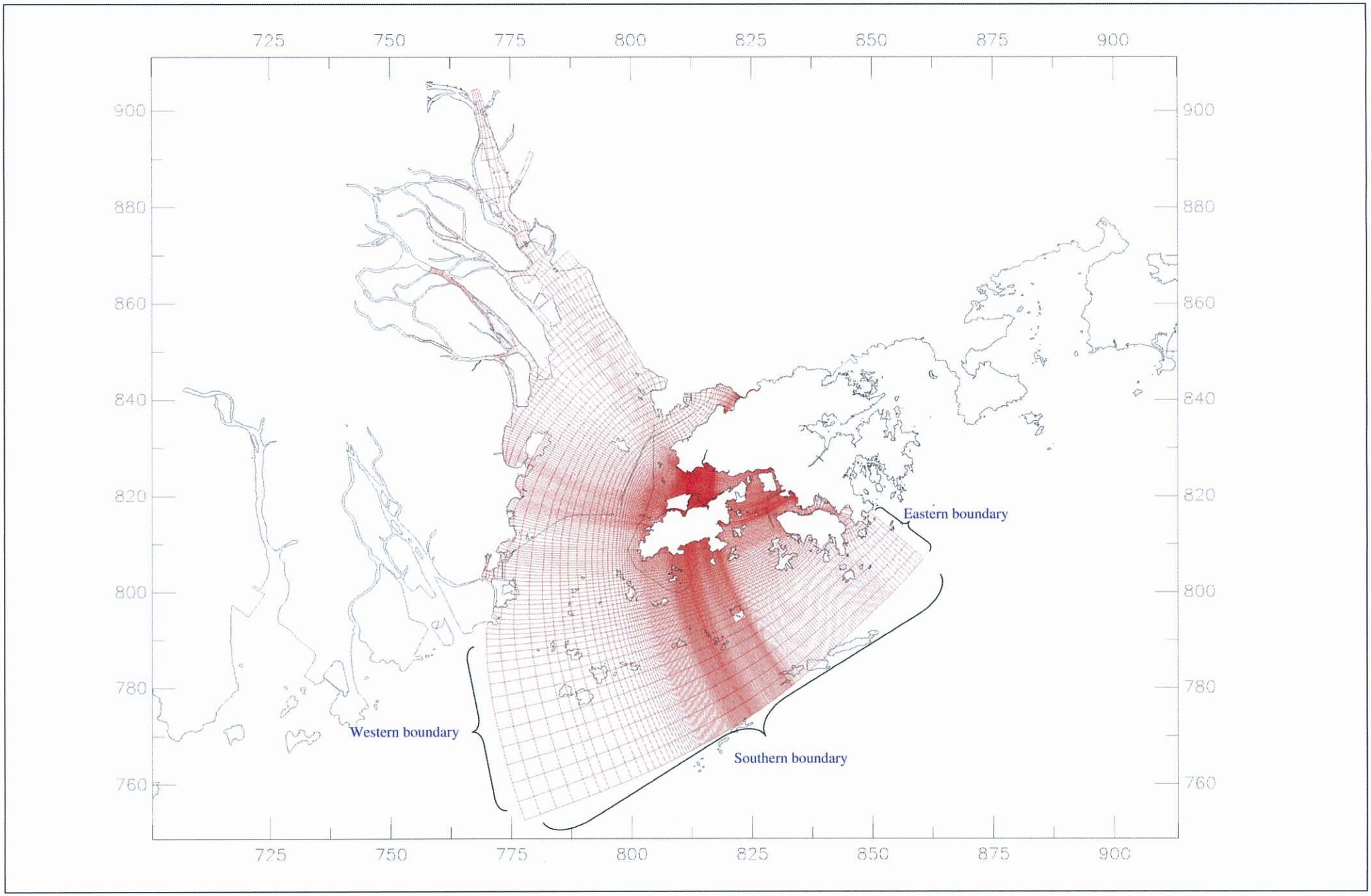
9E-2.1.5 In the Airport Sea Channel, the model grid has been improved and it is to be expected that the refined grid would result in an improved simulation of the tidal and residual flows. Figures 15 & 16 in **Appendix 9E1** do show that the simulated flows in the refined grid model differ from those simulated by the original Western Harbour Model. Similarly, the flows across the Airport North Section also differ to some extent and this is to be expected as a result of the improved resolution of the new model grid. Across the remaining discharge sections, both models simulate similar discharges except in Victoria Harbour. In Victoria Harbour, as a result of the refinement of the model grid north of Lantau Island, the resolution in Victoria Harbour was reduced. As a result, the simulation of the tidal flows was not as accurate in the refined grid model. However, Victoria Harbour is remote from the area of interest and the reduced resolution in Victoria Harbour is not considered to be important with respect to the current study.

9E-2.1.6 From the comparison of the model results, it was concluded that the grid refinement had not altered the calibration of the model.

9E-3 ACCEPTABILITY OF THE SELECTED SPIN-UP PERIODS

9E-3.1.1 In addition to comparing the original Western Harbour Model with the refined grid model to ensure that the calibration had not been affected by the refined grid, it was also necessary to ensure that the spin-up period was sufficiently long to allow any transient effects generated by the initial conditions to dissipate and to allow the model to reach equilibrium. In order to do this, the model was run for successive identical periods of 15-day spring neap tidal cycles and the results from the 3rd and 4th periods were compared. Representative plots of discharges across major sections, time histories of water levels, salinities and current speeds which demonstrate that the model had reached equilibrium after 3 successive simulation periods are presented in **Appendix 9E2**.

9E-3.1.2 The flow simulation for the 2011 construction scenario for Sequence B was based on initial conditions taken from the stabilised 2011 scenario for construction Sequence A and additional comparisons between the results from an additional spin-up period and subsequent production simulation for Sequence B was made to ensure that the model had reached dynamic equilibrium for Scenario B. The results from this comparison are presented in **Appendix 9E3** and it can be seen that the results from both simulations are very similar and that the model had reached equilibrium.



路政署
HIGHWAYS DEPARTMENT
港珠澳大橋香港工程管理處
Hong Kong - Zhuhai - Macao Bridge
Hong Kong Project Management Office

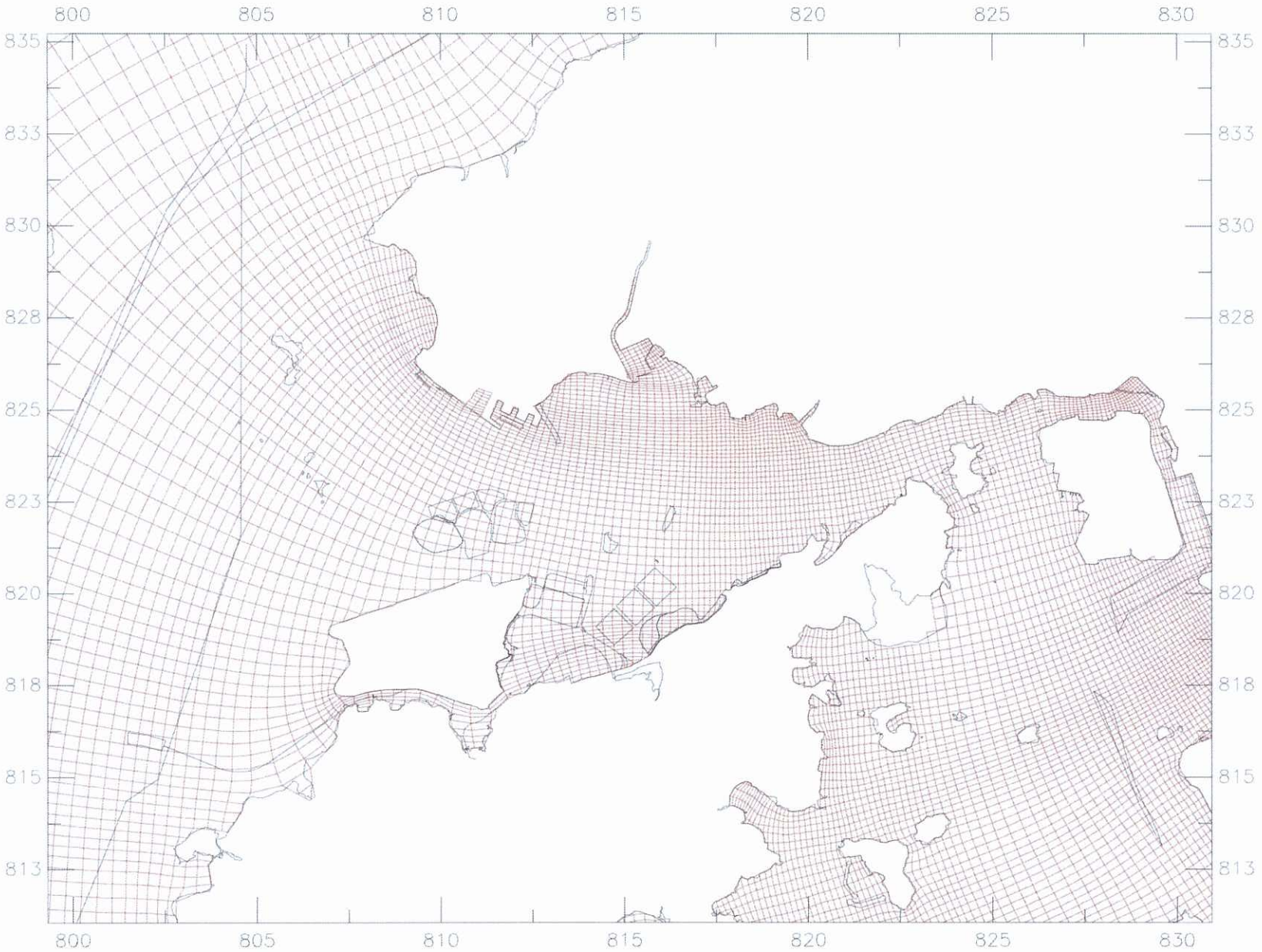
ARUP
奧雅納工程顧問
Ove Arup & Partners
Hong Kong Limited

Drawing Title

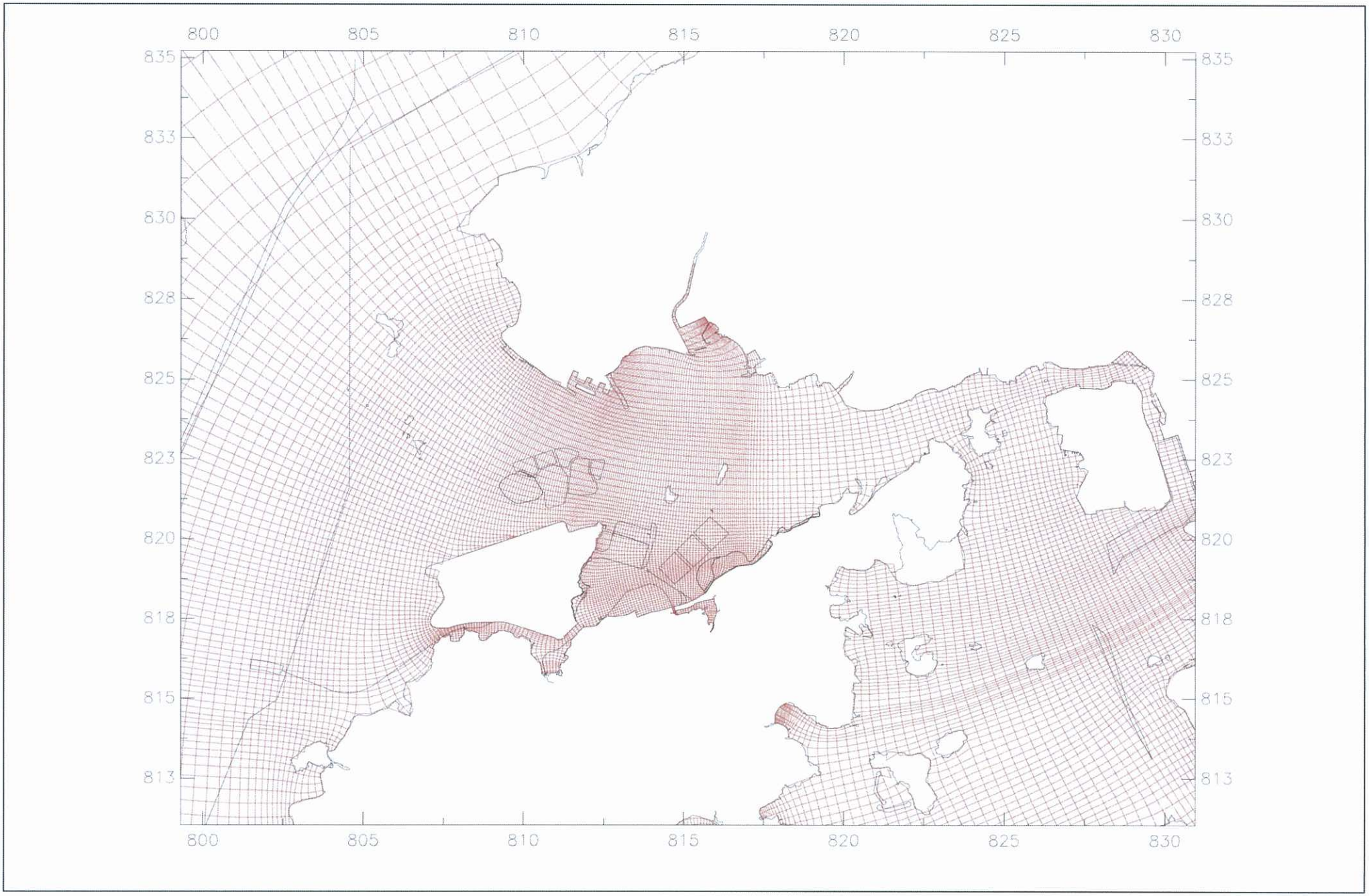
Coverage of Western Harbour Model

Drawing No.

Figure 1.1



路政署 HIGHWAYS DEPARTMENT 港珠澳大橋香港工程管理處 Hong Kong - Zhuhai - Macao Bridge Hong Kong Project Management Office	ARUP 奧雅納工程顧問 Ove Arup & Partners Hong Kong Limited	Drawing Title: **Original Model Grid (WHM)**	Drawing No.: **Figure 1.2**



路政署
HIGHWAYS DEPARTMENT
港珠澳大橋香港工程管理處
Hong Kong - Zhuhai - Macao Bridge
Hong Kong Project Management Office

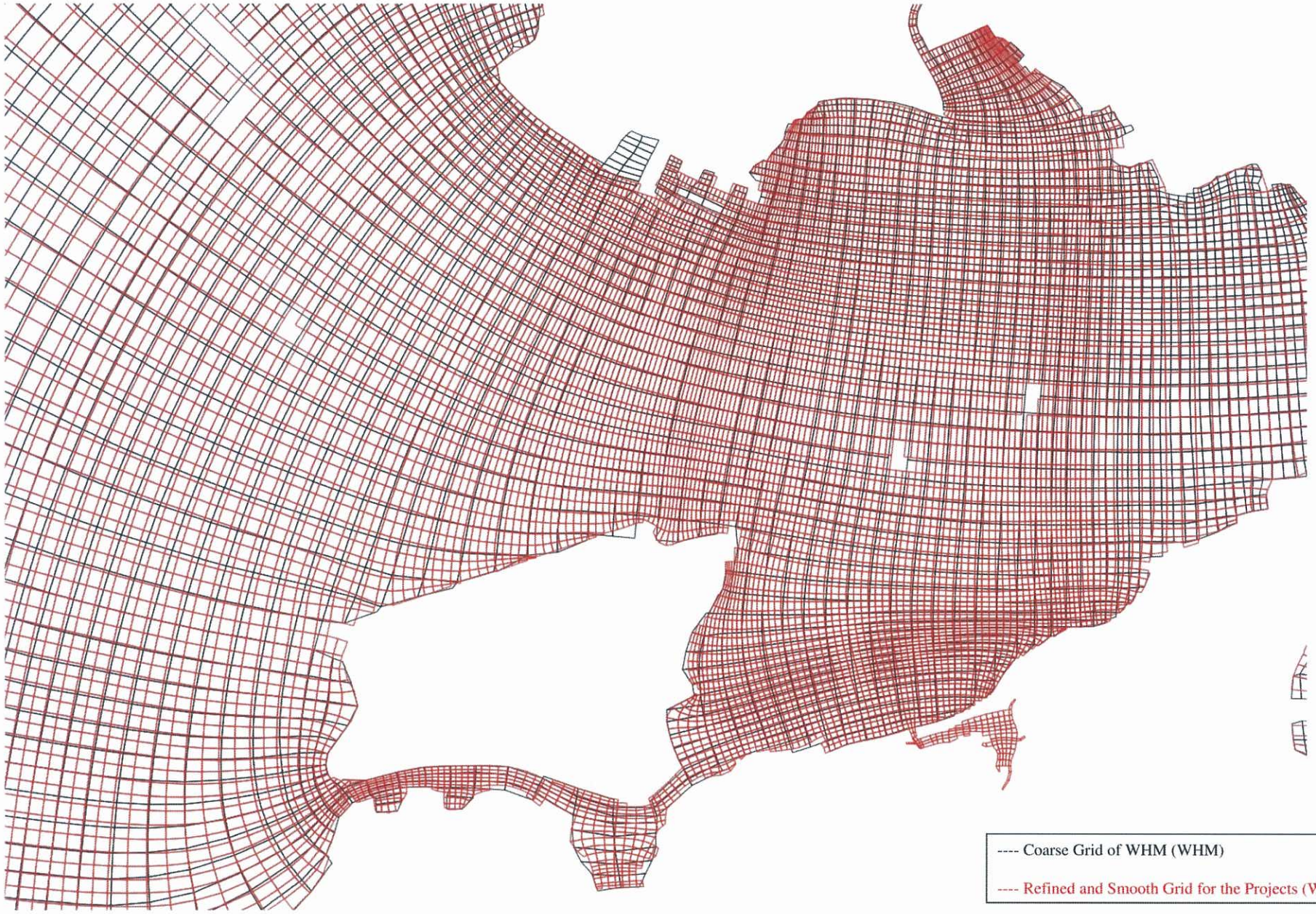
ARUP
奧雅納工程顧問
Ove Arup & Partners
Hong Kong Limited

Drawing Title

Refined Model Grid (WHM-RG)

Drawing No.

Figure 1.3



路政署
HIGHWAYS DEPARTMENT
港珠澳大橋香港工程管理處
Hong Kong - Zhuhai - Macao Bridge
Hong Kong Project Management Office

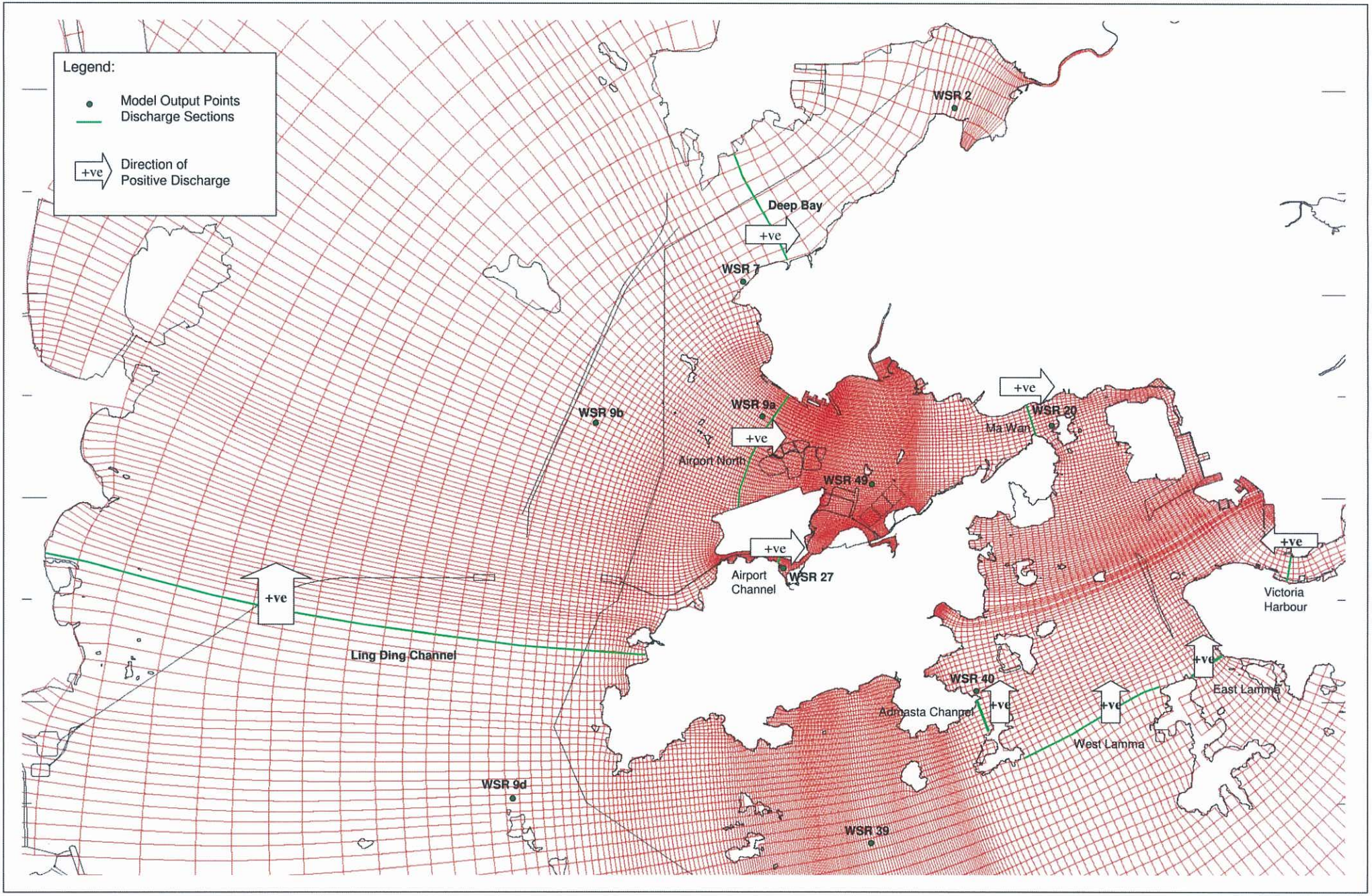
ARUP
奧雅納工程顧問
Ove Arup & Partners
Hong Kong Limited

Drawing Title

Comparison of Original and Refined Model Grids

Drawing No.

Figure 1.4



路政署 HIGHWAYS DEPARTMENT 港珠澳大橋香港工程管理處 Hong Kong - Zhuhai - Macao Bridge Hong Kong Project Management Office	ARUP 奧雅納工程顧問 Ove Arup & Partners Hong Kong Limited	Drawing Title: **Location of Specific Points and Discharge Sections for Model Verification**	Drawing No.: **Figure 1.5**