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Chapter 1 Developer Name and Office Address

1.1 Developer Name

Greater Changhua Northwest Offshore Wind Power Co., Ltd. Preparatory Office

(This Amendment: Greater Changhua Northwest Offshore Wind Power Co., Ltd.)

1.2 Office Address

I. 14F-1, No. 36, Songren Rd., Xinyi Dist., Taipei City

II. (This amendment: 11F-2, No. 37, Huashan Rd., Changhua City)

Table 1-1 Developer's Name, Office Address and Person in Charge

Name	Greater Changhua Northwest Offshore Wind Power Co., Ltd. Preparatory Office (This Amendment: Greater Changhua Northwest Offshore Wind Power Co., Ltd.)
Office Address	14F-1, No. 36, Songren Rd., Xinyi Dist., Taipei City (This amendment: 11F-2, No. 37, Huashan Rd., Changhua City)
Person in Charge	Jack Maxwell Sawyer

Chapter 2 Signature of Comprehensive Assessors andImpact Assessment Authors

Table 2-1 Signature of Comprehensive Assessors and Impact Assessment Authors (1/3)

Comprehensive	Name	LIU, JAI-KUN	Signature	
	Service unit	Unitech New Energy Engineering Co., Ltd.		
	Education	Master of Civil Engineering, National Taiwan University		
	Experience and Certification	24 years of experience in consultant company		
Comprehensive	Name	CHANG, TUNG-HUA	Signature	
	Service unit	Unitech New Energy Engineering Co., Ltd.		
	Education	Master of Environmental Engineering, Jiaotung University		
	Experience and Certification	13 years of experience in consultant company		
Air quality	Name	CHANG, TUNG-HUA	Signature	
	Service unit	Unitech New Energy Engineering Co., Ltd.		
	Education	Master of Environmental Engineering, Jiaotung University		
	Experience and Certification	13 years of experience in consultant company		
Air quality	Name	CHANG, REN-REN	Signature	
	Service unit	Unitech New Energy Engineering Co., Ltd.		
	Education	Master of Public Health, Chungshan Medical University		
	Experience and Certification	1 year of experience in consultant company		

Table 2-1 Signature of Comprehensive Assessors and Impact Assessment Authors (2/3)

Underwater Noise	Name	CHEN, QI-FANG	Signature	
	Service unit	Department of Engineering Science and Ocean Engineering, National Taiwan University		
	Education	PhD in Marine Engineering, Massachusetts Institute of Technology		
	Experience and Certification	Professor of Engineering and Ocean Engineering, National Taiwan University (current). Conducting research in underwater acoustic technology for national defense for 19 years (1991.3~now). Research from the past 5 years include: Underwater noise source investigation (Changhua Dacheng Industrial Harbor), Ecology and important habitat planning for Chinese white dolphin (Development program of Forestry; Forestry Bureau, Council of Agriculture, Executive Yuan).		
Noise vibration	Name	TSAI, HAN-JE	Signature	
	Service unit	Unitech New Energy Engineering Co., Ltd.		
	Education	Master of Environmental Engineering, National Central University		
	Experience and Certification	4 years of experience in consultant company		
Noise vibration	Name	GAO, LI	Signature	
	Service unit	Unitech New Engineering Co., Ltd.		
	Education	Master of National Kaohsiung University of Science and Technology		
	Experience and Certification	1 year of experience in consultant company Waste Process Technician (Class B) IIB370179 (2017) Environmental Education Personnel EP110069 (2017) Wastewater Process Technician （Class A） GA380128 (2018)		
Marine water quality and	Name	YANG, DAI-QIANG	Signature	
	Service unit	Huanhai Engineering Consulting CO., Ltd.		
	Education	Master of Civil Engineering, National Taiwan University, Professional hydraulic engineer		
	Experience and Certification	15 years of experience in consultant company； Professional hydraulic engineer #1006 (（83）專高字第 1006 號)		

Table 2-1 Signature of Comprehensive Assessors and Impact Assessment Authors (3/3)

Marine Ecology	Name	SHAO, GUANG-ZHAO	Signature	
	Service unit	Sci Mar Co. Ltd.		
	Education	PhD in Ecology and Evolution, State University of New York at Stony Brook		
	Experience and Certification	1. CEO & researcher of Biodiversity Research Center, Academia Sinica Chairman and researcher of Animal Research Center, Academia Sinica. 2. Professor of Biology Research Center, National Taiwan Normal University Extension, School of Continuing Education. 3. Professor and Chairman of Marine Biology Research Center, National Taiwan Ocean University. 4. Professor of Entomology Research Center, National Chung Hsing University 5. Professor of Fishery Research Center, National Taiwan Ocean University. 6. Professor of Department of Oceanography, National Taiwan University. 7. Sophisticated in marine ecology, marine biology, fish ecology, marine 8. biodiversity, fishery biology and database.		
Bird	Name	LIEN, YU-YI	Signature	
	Service unit	Formosa Natural History Information Ltd.		
	Education	Master in Plant Pathology and Microbiology, National Taiwan University		
	Experience and Certification	EIS for Offshore Wind Project Phase I, EIS for Penghu Low-carbon Offshore Wind Project		
Electromagnetic	Name	WU, QI-RUI	Signature	
	Service unit	Professor and Associate Chairman of Electrical Engineering, National Taiwan University		
	Education	PhD in Electrical Engineering, National Taiwan University		
	Experience and Certification	Hosting 50 electromagnetic field evaluations for electric systems, transient state analysis for submarine transmission system (2008), research on the development and mitigation of 3-vectors electromagnetic field programming for transmission route, electromagnetic field strength measuring project at TPC substation (2005), Effect of Arrangement of Underground Transmission Cable on Electromagnetic Field, Monthly Journal of Taipower's Engineering (2008).		

Chapter 3 Comparison with Previous Applications and Original Content

"Greater Changhua Northwest Offshore Wind Farm Project" (hereinafter referred to as the Project or CHW04) was drafted according to "Application Guideline for the Selection of Proposed Offshore Wind Farm Sites" announced by the Bureau of Energy on 2nd July 2015. The Project is located off the coast of Xianxi and Lukang Townships of Changhua County. At this time, a total of two demonstrative offshore wind farms (OWFs) and 14 potential OWF sites have completed and passed EIA reviews. The basic information for each of these OWFs is summarized in Table 3-1, and the corresponding locations are shown in Figure 3-1. The location of the Project Site with respect to the Chinese White Dolphin (CWD) Important Habitat is shown in Figure 3-2.

The Environmental Impact Statement (EIS) was passed in the 327th Environmental Impact Assessment (EIA) General Assembly on 9th February 2018. The EIS was approved on 10th August 2018 through the issuance of the EPA official letter with the reference number of 1070056951.

The Comparison Table documenting the Amendments to the details of the Project was submitted in October 2018. This Comparison Table clarified the duration of the pre-construction phase environmental monitoring plan. Furthermore, this Comparison Table also added two footnotes to define the starting point of each monitoring task. The Comparison Table was approved on 29th March 2019 through the issuance of the EPA official letter with the reference number of 1080021545.

This is the first Differential Analysis (DA) Report to be issued for this Project. The major amendments contained in this DA report include the change of name and address of the developer, design envelope of the maximum single turbine capacity, design of the turbine foundation, design of the OSS, voltage grade of offshore transmission system, arrangement of onshore transmission facilities, environmental protection countermeasures and environmental monitoring plans. The current and past amendments are provided in Table 3-2. Comparison between the this amendment, previous amendments and originally approved content is provided as Table 3-3.

Table 3-1 Summary of the OWF Projects in Changhua Area

Project Name	Brief Description of Development
Fuhai Offshore Wind Power Project (First Phase)	The project is located 8km offshore from the west of Fangyuan township, Changhua County. Installation: 2 WTG, 1 weather observation tower. This is an OWF demonstration project.
Offshore Wind Power Project Phase I	The project is located 5km offshore from the west of Fangyuan township, Changhua County. Installation: 30 WTG. This is an OWF demonstration project.
Greater Changhua NE Offshore Wind Farm Project (CHW03)	The project is located offshore from Xianxi Townships of Changhua County. Closest distance to shore is 34.7 km. Total proposed capacity of 570MW. This project is located at potential site #13 of the "Application Guideline for the Selection of Proposed Offshore Wind Farm Sites" decreed by the BoE.
Greater Changhua SW Offshore Wind Farm Project (CHW02)	The project is located offshore from Xianxi and Lukang Townships of Changhua County. Closest distance to shore is 50.1 km. Total proposed capacity of 642.5MW. This project is located at potential site #14 of the "Application Guideline for the Selection of Proposed Offshore Wind Farm Sites" decreed by the BoE.
Greater Changhua SE Offshore Wind Farm Project (CHW01)	The project is located offshore from Xianxi and Lukang Townships of Changhua County. Closest distance to shore is 35.7 km. Total proposed capacity of 613MW. This project is located at potential site #15 of the "Application Guideline for the Selection of Proposed Offshore Wind Farm Sites" decreed by the BoE.
Hai Long #2 Offshore Wind Farm Project	The project is located offshore from Fuxing and Fangyuan Townships of Changhua County. Closest distance to shore is 45 ~ 55 km. Total proposed capacity of 532 MW. This project is located at potential site #19 of the "Application Guideline for the Selection of Proposed Offshore Wind Farm Sites" decreed by the BoE.
Hai Long #3 Offshore Wind Farm Project	The project is located offshore from Fuxing and Fangyuan township, Changhua County as well as Baisha township, Penghu County. Closest distance to shore (Penghu) is 50 ~70 km. Total proposed capacity of 512 MW. This project is located at potential site #18 of the "Application Guideline for the Selection of Proposed Offshore Wind Farm Sites" decreed by the BoE.
Formosa III Offshore Power Project –Wind Power I	The project is located offshore from Shengang, Fuxing and Fangyuan Townships of Changhua County as well as Baisha Township of Penghu County. Closest distance to shore (Changhua) is 62.1 km. Total proposed capacity of 552 MW. This project is located at potential site #11 of the "Application Guideline for the Selection of Proposed Offshore Wind Farm Sites" decreed by the BoE.
Formosa III Offshore Power Project –Wind Power II	The project is located offshore from Xianxi, Fuxing and Lukang Townships of Changhua County as well as Baisha Township of Penghu County. Closest distance to shore (Changhua) is 50.3 km. Total proposed capacity of 732 MW. This project is located at potential site #16 of the "Application Guideline for the Selection of Proposed Offshore Wind Farm Sites" decreed by the BoE.

Table 3-1 Summary of the OWF Projects in Changhua Area(Continued)

Project Name	Brief Description of Development
Formosa III Offshore Power Project –Wind Power III	The project is located offshore from Xianxi, Fuxing and Lukang Townships of Changhua County as well as Baisha Township of Penghu County. Closest distance to shore (Changhua) is 38.8 km. Total proposed capacity of 720 MW. This project is located at potential site #17 of the "Application Guideline for the Selection of Proposed Offshore Wind Farm Sites" decreed by the BoE.
Offshore Wind Power Project Phase II	The project is located offshore from Shengang, Xianxi, Fangyuan and Lukang Townships of Changhua County. Closest distance to shore is 9 km. Total proposed capacity of 720 MW. This project is located at potential site #26 of the "Application Guideline for the Selection of Proposed Offshore Wind Farm Sites" decreed by the BoE.
Zhongneng Offshore Wind Farm Project	The project is located offshore from Dacheng and Fangyuan township, Changhua County. Closest distance to shore is 7 km. Total proposed capacity of 707.2 MW. This project is located at potential site #29 of the "Application Guideline for the Selection of Proposed Offshore Wind Farm Sites" decreed by the BoE.
Xidao Offshore Wind Power Project	The project is located offshore from the west of Fangyuan township, Changhua County. Distance to shore is: 9-17 km. Total proposed capacity of410 MW.
Changfang Offshore Wind Power Project	The project is located offshore from Fangyuan township, Changhua County. Distance to shore is 14-25 km. Total proposed capacity of 600 MW. This project is located at potential site #27 of the "Application Guideline for the Selection of Proposed Offshore Wind Farm Sites" decreed by the BoE.
Haixia Offshore Wind Power Project (#27)	The project is located offshore from Fuxing and Fangyuan township, Changhua County. Closest distance to shore is 14 km. Total proposed capacity of 600 MW. This project is located at potential site #27 of the "Application Guideline for the Selection of Proposed Offshore Wind Farm Sites" decreed by the BoE.
Fufang Offshore Wind Power Project	The project is located offshore from Fangyuan township, Changhua County. Distance to shore is 16.5-28 km. Total proposed capacity of 410 MW. This project is located at potential site #28 of the "Application Guideline for the Selection of Proposed Offshore Wind Farm Sites" decreed by the BoE.
Haixia Offshore Wind Power Project (#28)	The project is located offshore from Fangyuan and Dacheng township, Changhua County. Closest distance to shore is 14 km. Total proposed capacity of 600 MW. This project is located at potential site #28 of the "Application Guideline for the Selection of Proposed Offshore Wind Farm Sites" decreed by the BoE.

Figure 3-1 Locations of Changhua Area OWF that have Passed EIA Review

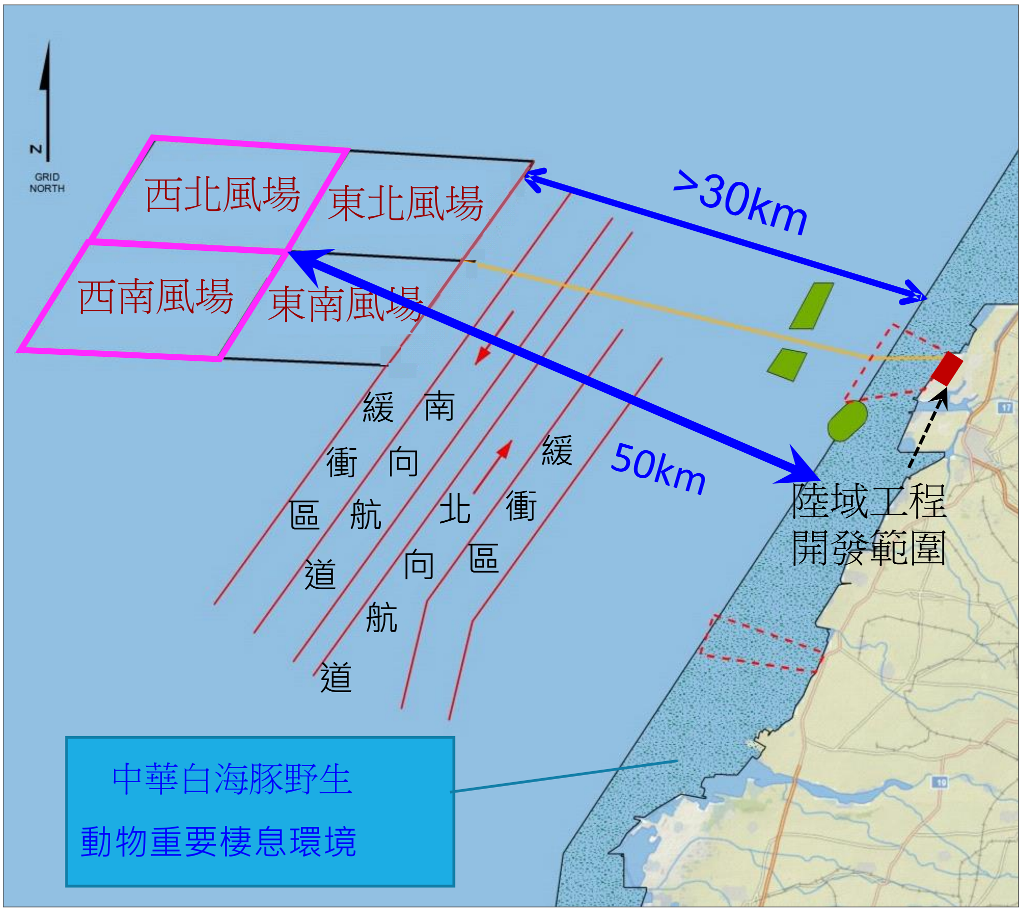


Figure 3-2 Location of Project Site with respect to the Major Habitat of Chinese White Dolphin

Table 3-2 Summary on Previous EIA Amendments

Sequence of Amendment (EIA amendment form)	Main Amendment	Date of Approval & Letter No.
Original Environmental Impact Statement (EIS)	—	10th August 2018 Official letter #1070056951
1st Amendment (Comparison Table)	Clarify the duration of the onshore and offshore environmental monitoring program for the pre-construction and construction phases.	29th March 2019 Official letter #1080021545
This Amendment (1st DA)	1. Change the name and office address of the developer 2. Propose the design envelope for the maximum single turbine capacity of 16MW. 3. Adjust the original design envelope of the pin-pile jacket to accommodate larger turbines; suction buckets jacket is added. 4. Adjust the design for the Offshore Substation (OSS). Increase the footprint of scour protection. 5. Additional voltage grades option of the offshore transmission cable is added. 6. New construction methodology for the marine cable landfall is added. 7. Adjust the arrangement of the onshore substation and onshore cable route. The onshore scope(the onshore substation and onshore cable route) will be built jointly with CHW22. 8. Environmental protection measures for air quality, marine water quality, marine ecology, waste and underwater noise are added. Adjust the underwater acoustic and noise monitoring datum points and associated rationale to the adjustment. 9. Air quality monitoring and underwater filming are added to the existing environmental monitoring plan for the pre-construction and construction phases. 10. Cetacean monitoring is added to the existing environmental monitoring plan for the pre-construction, construction, and operation phases. 11. Add a footnote to the existing environmental monitoring plan for the pre-construction, construction and operation phases, with regards to “Response measures for extended period of poor sea state” and “Response measures for loss of PAM device and data retrieval”	—

Table 3-3 Comparison between this Amendment, Previous Amendments and Original Content

Item		Original Approved EIS Content	1st Amendment (Comparison Table)	This Amendment (1st DA)
Name of developer		Greater Changhua Northwest Offshore Wind Power Co., Ltd. **Preparatory Office**	No change	Greater Changhua Northwest Offshore Wind Power Co., Ltd.
Office address		14F-1, No. 36, Songren Rd., Xinyi Dist., Taipei City	No change	**11F-2, No. 37, Huashan Rd., Changhua City**
Design Envelope for Wind Turbine (Largest Wind Turbines)	Single turbine capacity	8 ~ 11MW	No change	8 ~ **16**MW
	Maximum number of wind turbines	54 ~ 74		**37** ~ 74
	Maximum rotor diameter	195 ~ 210 m		195~**250** m
	Maximum total height/ (blade) upper tip height	250 ~ 265 m (LAT)		250 ~ **305** m (LAT)
	Maximum hub height	153 ~ 160 m (LAT)		153 ~ **180** m (LAT)
	Maximum revolutions per minute	8.0 ~ 11 (RPM)		**8.1** ~ 11 (RPM)
	Minimum turbine spacing W-E	519 ~ 714 m		519 ~ **850** m
Design Envelope for Pin-Pile Foundation	Maximum distance between legs	40 m	No change	**55** m
	Maximum pile outer diameter	4.0 m		**8.0** m
	Maximum penetration depth of pin-pile	85 m		**120** m
	Maximum weight of jacket	1200 t		**3000** t
	Maximum pile weight	160 t		**800** t
	Maximum footprint of scour protection on seabed for each turbine	800 m^2		**6,600** m^2
Design Envelope for Suction Bucket Jacket (SBJ) Foundation	Maximum outer diameter of suction bucket	-	-	**25 m**
	Maximum suction bucket penetration depth			**25 m**
	Maximum weight of jacket			**3000 t**
	Maximum footprint of scour protection on seabed for each WTG			**8,000 m^2**

Table 3-3 Comparison between this Amendment, Previous Amendments and Original Content (Cont.)

<table>
<tr><th colspan="2">Item</th><th>Original Approved EIS Content</th><th>1st Amendment (Comparison Table)</th><th>This Amendment (1st DA)</th></tr>
<tr><td rowspan="6">Offshore Substation Design</td><td>Maximum footprint on the seabed</td><td>40 m x 40 m</td><td>No change</td><td><u>50 m x 50 m</u></td></tr>
<tr><td>Maximum size of the topside (L x W x H)</td><td>50 m x 40 m x 30 m
(including helipad but not the crane and antenna)</td><td>No change</td><td><u>60 m x 50 m x 40 m</u>
(including helipad but not the crane and antenna)</td></tr>
<tr><td>Maximum weight for topside</td><td>-</td><td>No change</td><td><u>4,000 t</u></td></tr>
<tr><td>Number of piles</td><td>12 piles (4-legged foundations, with 3 piles on each leg). Maximum pile diameter is 3.5m, pile length is subject to the soil condition at the OSS location.</td><td>No change</td><td><u>Maximum of</u> 12 piles. Maximum pile diameter is <u>4.0</u> m, pile length is subject to the soil condition at the OSS location.</td></tr>
<tr><td>Maximum penetration depth of pin-piles</td><td>85 m</td><td>No change</td><td><u>120 m</u></td></tr>
<tr><td>Maximum footprint of scour protection</td><td>-</td><td>-</td><td><u>8000 m^2</u></td></tr>
<tr><td>Offshore Transmission Cables</td><td>Voltage of offshore export cable</td><td>220kV</td><td>No change</td><td>220kV <u>or 275kV</u></td></tr>
<tr><td>Cable Landfall</td><td>Seawall Crossing Approach</td><td>Transition joint bay (TJB) is required at each landfall location closest to the connection between the marine cable and the onshore cable via Horizontal Directional Drilling (HDD).
The indicative figure of HDD method is provided in Figure 4.1.6-1.</td><td>No change</td><td>Transition joint bay (TJB) is required at each landfall location closest to the connection between the marine cable and the onshore cable via <u>trenchless approach</u>, such as Horizontal Directional Drilling (HDD) <u>or microtunneling.</u>
The indicative figure of trenchless approach is provided in Figure 4.1.6-1.</td></tr>
</table>

Table 3-3 Comparison between this Amendment, Previous Amendments and Original Content (Cont.)

Item		Original Approved EIS Content	1st Amendment (Comparison Table)	This Amendment (1st DA)
Onshore Transmission System	Onshore substation	Three candidate sites were chosen for the onshore substation in the Lungwei area of the Changhua Coastal Industrial Park. One of the sites will be selected as the proposed location for the substation. Onshore cable will connect the onshore substation to the ChungKong grid connection point. Onshore substation (including the control room, gas insulated switchgear (GIS) and relevant electromechanical facilities) is estimated to take up 23,800 m^2 of space.	No change	**The onshore substation will be shared between this Project and CHW22. One site in the Lungwei area of the Changhua Coastal Industrial Park will be selected for the onshore substation. Onshore cables will connect the onshore substation to the ChungKong grid connection point.** **Onshore substation (including the control room, gas insulated switchgear (GIS) and relevant electromechanical equipment) is estimated to require an area of 29,300 m^2.**
	Onshore cable	Voltage of the onshore cable from the transition joint bay to the onshore substation will be 220kV. The length of this portion of the onshore cable is estimated to be within 3.7km. The voltage of the onshore cable from the onshore substation to the ChungKong grid connection, will be 161kV. The length of this portion of the onshore cable is anticipated to be within 4.35km.	No change	**The onshore cable is anticipated to share the cable trench with CHW22.** Voltage of the onshore cable from the transition joint bay to the onshore substation will either be 220kV or **275kV**. The length of this portion of the onshore cable is estimated to be no more than **1.5km**. The voltage of the onshore cable from the onshore substation to the ChungKong grid connection point will either be 161kV or **345kV**. The length of this portion of the cable is estimated to be no more than 1.4km. **The proposed onshore cable will use the existing onshore cable trench from CHW02 where they overlap. The only items that requires additional excavation are part of transition joint bay, connection point of onshore cable and cable trench for around 700m.**
Maximum Surplus Earthwork		Maximum Surplus Earthwork 195,100 m^3 (compressed) Maximum Surplus Earthwork 234,120 m^3 (loose).	No change	Maximum Surplus Earthwork **95,220m^3** (compressed) Maximum Surplus Earthwork **115,000m^3** (loose).

Table 3-3 Comparison between this Amendment, Previous Amendments and Original Content (Cont.)

Item		Original Approved EIS Content	1st Amendment (Comparison Table)	This Amendment (1st DA)
Environmental protection measures	Construction Phase Offshore Environmental Protection Measure - Cetacean	Pin-pile jackets will be selected for as the foundation for the wind turbines used for this Project, as they are expected to produce less noise.	No change	Pin-pile or **<u>Suction Bucket Jacket</u>** will be selected for as the foundation for the wind turbines used for this Project, as they are expected to produce less noise.
		"to have a bigger detection area regarding cetacean activities, four PAM devices will be deployed at appropriate locations 750m from the piling location" and "underwater noise monitoring campaign will be carried out once at 750m from piling location during pile driving campaign."	No change	"to have a bigger detection area regarding cetacean activities, 4 PAM device will be deployed in proper locations 750m from **<u>the center of Jacket as the reference point</u>**" and "underwater noise monitoring campaign will be carried out once at 750m from the **center of jacket** during pile driving campaign."
		—	—	"157 dB SEL of single piling event, measured as 30 second average, is set as early warning level during the pile installation." As the noise monitoring shows that the early warning level is exceeded, proper responses (e.g. lower the hammer energy(kJ), decrease the frequency of piling) alongside enhanced mitigation measures such as increase the air supply of bubble curtain, if necessary, will be taken to make sure the noise level is lower than the limit described in EIA commitment.
		The best commercially available noise control method at the time of development application will be applied during pile driving to all of the wind turbine locations, to ensure the noise levels within the 750m warning zone is below SEL 160dB. Details of the noise mitigation measures to be used will be determined before the pile driving campaign commences, including consideration of the latest noise reduction technology available at that time, such as such as bubble curtain or balloon curtains.	No change	The best commercially available noise control method at the time of development application will be applied during pile driving to all of the wind turbine locations, to ensure the noise levels within the 750m warning zone is below SEL 160dB. Details of the noise mitigation measures to be used will be determined before the pile driving campaign commences, including the latest noise reduction technology available at that time, such as bubble curtain or balloon curtains. Additionally, the sound exposure level (SEL) of 25% of all foundations to be installed in the Project at 750m distance to the center of jacket shall be lower than 159dB.
		The project commits that the underwater noise exposure value (Sound Exposure Level, SEL) shall not exceed 160 decibels [(dB) re. 1μPa^{2}s] as the impact assessment threshold.	—	**95% of the underwater noise measurement data (SEL_{05}) shall not exceed 160dB** and **<u>SPLpeak shall not exceed 190dB</u>** at 750m **<u>to the center of jacket</u>** where the underwater noise monitoring is carried out.

Table 3-3 Comparison between this Amendment, Previous Amendments and Original Content (Cont.)

Item		Original Approved EIS Content	1st Amendment (Comparison Table)	This Amendment (1st DA)
Environmental protection measures	Construction phase-Marine water quality	—	—	**<u>Installation of scour protection will be carried out by fall-pipe vessel to alleviate the influence on marine water quality during construction.</u>**
		—	—	**<u>For turbines using SBJ in the Project, 1 turbine will be selected from each row (east-west direction) where its underwater environment around the foundation will be observed by using ROV, which is capable of transmitting images to the installation vessels on real time basis, during the installation of SBJ. This is meant to understand if there is disturbance to the seabed during SBJ installation and thus affect water quality in the surrounding area.</u>**
	Construction phase-Air quality	During the construction phase, a total of 100m roadway to the front and rear of the construction site will be swept and cleaned to mitigate dust fall from the passage of construction and transportation vehicles (except for days of precipitation).	No change	During the construction phase, a total of **<u>1km</u>** roadway to the front and rear of the construction site will be swept and cleaned to mitigate dust fall from the passage of construction and transportation vehicles (except for days of precipitation).
		All marine spread will use fuel with the minimum sulfur content available in Taiwan at the time.	No change	All marine spread will use fuel with the minimum sulfur content **<u>(<0.5%)</u>** available in Taiwan at the time.
		—	—	**<u>During construction, onshore construction equipment and vehicles will comply with Class 4 environmental standards (or above), and possess Grade A Self Management Label. The aforementioned requirements will be integrated into the contracts for the construction subcontractors.</u>**

Table 3-3 Comparison between this Amendment, Previous Amendments and Original Content (Cont.)

Item		Original Approved EIS Content	1st Amendment (Comparison Table)	This Amendment (1st DA)
Environmental protection measures	Operation phase-Marine ecology	—	—	**During underwater filming, the presence of marine reptiles will also be monitored.**
	Operation phase-Waste	—	—	**This Project has committed not to bury turbine blades during the decommissioning. In the future, the Project will participate blade recycling-related initiatives to monitor all possible recycling methods and adopt them where possible to improve the sustainability of wind turbines. These initiatives include finding common solutions through cooperating with other companies and organizations or participating in research and innovation projects focused on recycling blade materials.** **If a suitable solution is not found during the decommissioning, the Project has also committed to legitimately store blades temporarily rather than landfill.** **This commitment is incorporated as part of the mitigation measures that will be provided, at least 1 year before official decommissioning, to the competent authority for approval.**
Environmental Monitoring Plan	Pre-construction phase – air quality	—	—	**Based on the air quality monitor locations provided in the "Construction Environmental Monitoring Plan", make an additional event of survey for particulate matter (TSP 、 PM_{10} 、 $PM_{2.5}$), sulfur oxides (SO_2), nitrogen oxides (NO 、 NO_2), O_3.**
	Construction phase – air quality	Monitoring items: Wind direction, wind speed, particulate matter (TSP, PM_{10}, $PM_{2.5}$), SO_2, and nitrogen oxides (NO, NO_2).	No change	Monitoring items: Wind direction, wind speed, particulate matter (TSP, PM_{10}, $PM_{2.5}$), SO_2, nitrogen oxides (NO_X, NO, NO_2), and **O_3**.
	Construction phase – marine ecology	Underwater filming to monitor for fish gathering effect (monitor location: at the foundation of a one selected turbine)	No change	Underwater filming to monitor for fish gathering effect (monitor location: at the foundation of a one selected turbine **and one Offshore Substation)**.

Table 3-3 Comparison between this Amendment, Previous Amendments and Original Content (Cont.)

Item		Original Approved EIS Content	1st Amendment (Comparison Table)	This Amendment (1st DA)
Environmental Monitoring Plan	UNM (including PAM) for Pre-construction, construction and operation phases	—	—	**(1) For this project, the underwater acoustic survey team will deploy underwater measurement devices at the beginning of each quarter. If sea state allows, devices will be retrieved as soon as possible after 30 days of continuous monitoring.** **(2) If the underwater measurement devices are found to be lost during retrieval, a proof of survey execution have to be provided for clarification.** **(3) If sea state allows, a supplemental underwater noise survey will be conducted as soon as possible, to ensure that the data can be retrieved. Following deployment, once the survey instrument has measured a period of 24 hours, the instrument will be retrieved from each deployed location.** **(4) To ensure the safety of monitoring personnel and vessel, if sea state suddenly worsens, the vessel will return back to the harbor on standby.** **(5) If the contingency measure is conducted, the activity will be documented and explained.**
	Marine ecology for Pre-construction, construction and operation phases	Monitoring item: Cetacean survey	—	Cetacean **(incl. marine reptile observation)**
	Response measures for poor sea state that continue for extended periods during the offshore environmental monitoring	—	—	**During the offshore monitoring, the Central Weather Bureau's sea state system or common international weather forecast systems (incl. Windguru, Windy, ECMWF) will be used as reference. To consider safety for vessel and personnel, surveys will only be conducted during periods of wave height ≦1m for 24 continuous hours. If the time required for conducting the required number of surveys in the given month or quarter is not available, the remaining surveys for the that month or quarter will be suspended.**

Chapter 4 Rationale for Amendment to the Development Plan or Environmental Protection Measure

4.1 Rationale for Amendment to the Development Plan

The Project was awarded with grid capacity during the Bureau of Energy’s competitive price bidding round on 22nd June 2018. The plan was to have the Project connect to the ChungKong substation by 2025. In consideration that the larger turbine is becoming the more recent global trend, and that the actual construction activities will not be taking place for a period of time after the initial EIA process, the originally proposed plans and designs used in the original EIS will not be sufficient for latter construction activities. Therefore, this Differential Analysis (going forward referred to as “DA”) has been prepared to address each of the items during the construction activities that will need to be amended from the original EIS.

This amendment includes changes to name and address of the Developer, design details for the larger turbines, addition to the turbine foundation option, design of offshore substation, arrangement of the offshore transmission system, cable landfall, offshore substation design, the arrangement of onshore transmission system alongside variations on mitigation measures and environmental monitoring plan. Detailed explanation of each amendment item is further described in the following subsections.

4.1.1 Name and Address of the Developer

The name and address of the developer in the original EIS is provided by Table 4.1.1-1. Since the Developer has officially changed its name from a preparatory office to a company, the associated information is changed in this amendment. The revised name and address of the developer is provided as Table 4.1.1-2.

Table 4.1.1-1 Name and Address of the Developer before the Amendment

Name	Greater Changhua Northwest Offshore Wind Power Co., Ltd. Preparatory Office
Address of the Office	14F-1, No. 36, Songren Rd., Xinyi Dist., Taipei City

Table 4.1.1-2 Name and Address of the Developer after the Amendment

Name	Greater Changhua Northwest Offshore Wind Power Co., Ltd.
Address of the Office	11F-2, No. 37, Huashan Rd., Changhua City

4.1.2 Larger turbines

In the original EIS, the wind turbines proposed for the Project had single turbine capacity of between 8MW and 11MW. However, considering that the Project is expected to connect to the ChungKong substation in 2025, and that the recent current trend of offshore wind industry is moving towards erecting larger turbines, the Project is proposing to increase the maximum power capacity for wind turbines from 11MW to 16MW in order to follow the global trend. The design envelope for wind turbines before (11MW) and after (16MW) the amendment is shown in Table 4.1.2-1 and Table 4.1.2-2, respectively.

Before the amendment, if single turbine capacity of 11MW is selected, the maximum number of wind turbines that can be installed will be 54 units. The maximum rotor diameter of this unit will be 210m. The maximum lower tip height is 55m. The maximum upper tip height is 265m. Lastly, the maximum hub height of this unit is 160m.

Following the amendment, if single turbine capacity of 16MW is selected, the maximum number of wind turbines that can be installed will be 37 units. The maximum rotor diameter of this unit will be 250m. The maximum lower tip height will remain at 55m. The maximum upper tip height will be 305m. The maximum hub height of this unit will be 180m. Lastly, the maximum revolutions per minute will be 8.1rpm. Turbine layout is shown as Figure 4.1.2-1.

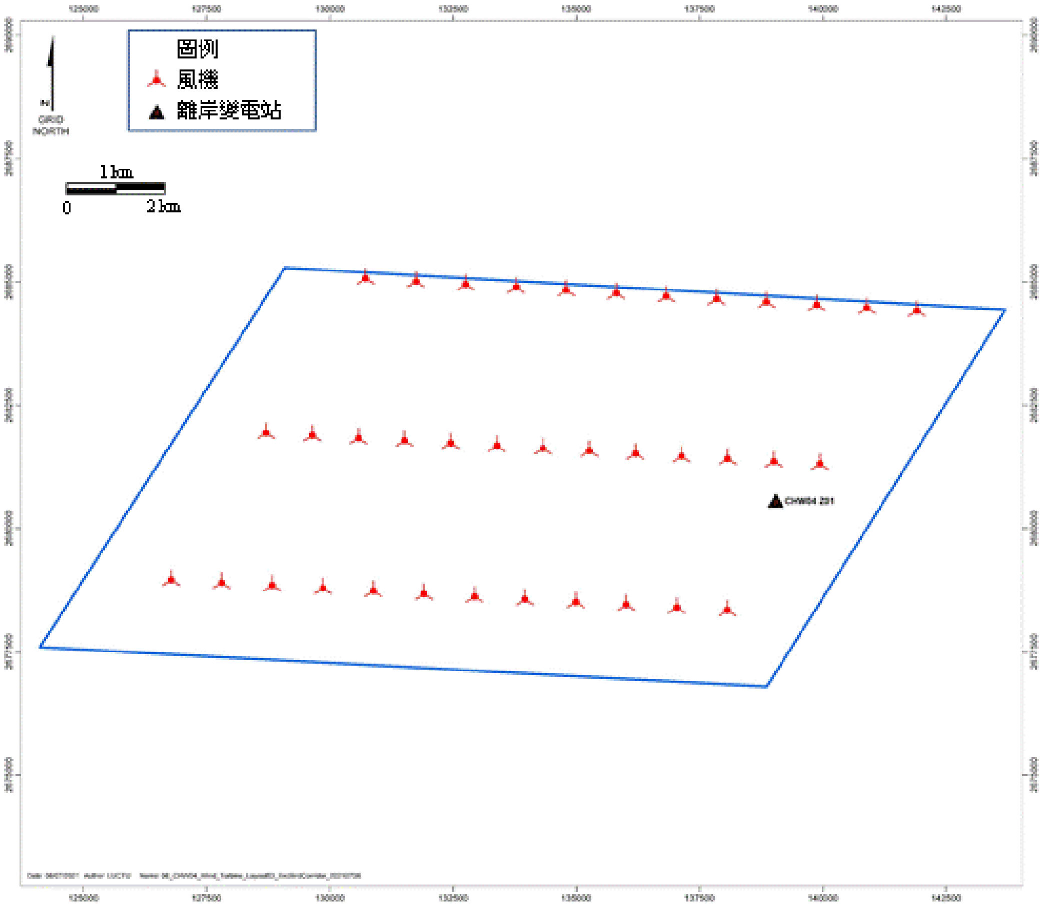
The original EIS stated that "the maximum total capacity of the wind turbines will not be greater than 598MW". In this amendment, the maximum total capacity of the wind turbines have not been changed, therefore the maximum total capacity will remain the same as that in the original EIS. The amendment proposed in this DA will only be the maximum single turbine capacity, which will increase from 11MW to 16MW, to follow the global trend of erecting larger turbines. Given the total capacity of the windfarm stays the same, a maximum of 37 units of 16MW wind turbines can be installed.

Table 4.1.2-1 Design Envelope for Wind Turbine before this Amendment

Components	Smallest Wind Turbine		Largest Wind Turbine	
	Min	Max	Min	Max
No. of wind turbines (#)	74		54	
Single turbine capacity (MW)	8.0		11.0	
Rotor diameter (m)	-	195		210
Lower tip height, LAT(m)	27.9(LAT) 25.0(MSL)	55	27.9 (LAT) 25.0 (MSL)	
Upper tip height, LAT (m)	-	250	-	265
Hub height, LAT(m)	-	153	-	160
Maximum revolutions per minute	-	11	-	8
Turbine spacing, E-W(m)	519 ~ 714			
Turbine spacing, N-S(m)	3,719 ~ 4,182			

Table 4.1.2-2 Design Envelope for Wind Turbine after this Amendment

Components	Smallest Wind Turbine		Largest Wind Turbine	
	Min	Max	Min	Max
No. of wind turbines (#)	74		**37**	
Single turbine capacity (MW)	8.0		**16.0**	
Rotor diameter (m)	-	195	-	**250**
Lower tip height, LAT(m)	27.9(LAT) 25.0(MSL)	55	27.9(LAT) 25.0(MSL)	55
Upper tip height, LAT (m)	-	250	-	**305**
Hubheight, LAT(m)	-	153	-	**180**
Maximum revolutions per minute	-	11	-	**8.1**
Turbine spacing, E-W(m)	519~**850**			
Turbine spacing, N-S(m)	3,719~4,182			



Note: 1. Actual wind farm layout is subject to final approval by the competent authorities

Figure 4.1.2-1 16MW Wind Turbine Layout

4.1.3 Turbine Foundation

In the original EIS, the design envelope for the pin-pile jacket was proposed with consideration of a maximum single turbine capacity of 8MW to 11MW. However, as mentioned earlier, the recent current trend of offshore wind industry is moving towards larger turbines, the maximum single turbine capacity is being proposed to increase to 16MW. In order to accommodate this increase in the maximum single turbine capacity, the maximum values for pin-pile jacket design envelope are proposed and summarized in Table 4.1.3-1.

Table 4.1.3-1 Design Envelope for Jacket Type Foundations in this Amendment

Foundation components	Estimated maximum values (8MW)	Estimated maximum values (11MW)	Note
No. of legs	4	4	
Distance between Legs (m)	40	55	
Pin-Pile outer diameter (m)	4.0	8.0	
Pin- Pile penetration depth (m)	85	120	
Jacket weight (t)	1,200	3,000	
Pin-Pile weight (t)	160	800	Each pile
Footprint of scour protection on seabed (m^2)	800	6,600	Each foundation

Furthermore, this amendment plans to add Suction Bucket Jacket(SBJ), as an option for turbine foundation concept for this Project, explanations are as follows:

SBJ foundation is a novel type of offshore wind power foundation. The foundation is primarily divided into two parts: the caisson and the jacket structure, as shown in Figure 4.1.3-1. The caisson consists of a cylindrical structure, where the opening is at the bottom, with its top sealed. The size and weight of the caisson may change dependent on depth and soil conditions. The SBJ structure will consist of either be a 3-legged or 4-legged steel truss structure. The top of the jacket consists of a transition piece that is used to connect with the turbine tower. The flange section of the top of the transition piece will be fastened to the turbine tower with nuts and bolts. Within the transition piece are components relevant to array cables, including components for suspension fastener, and switch board. Design envelope for SBJ foundation is shown in Table 4.1.3-2.

SBJ utilizes pressure differential between the inside and outside of the caisson structure to sink through the seabed. Typically, the caisson is a cylindrical structure designed with an open bottom and a sealed top, with the only exception of a small opening at the top for extraction of the water within the caisson. The opening will be connected to a decompression equipment via a monitoring system to ensure the decompression process can be safely conducted. When the caisson is placed on the seabed, the interior of the caisson becomes an enclosed space. Then, by operating the vacuum pump and the valve on top of each caisson, the seawater in the caisson is pumped out, so that the internal pressure of caisson is reduced. The pressure induced within the caisson relative to the external pressure is low, such that when the water pressure outside the caisson is greater than the internal pressure of the caisson, the pressure difference will make the caisson sink through the seabed.

The decompression system includes a quick-release valve connecting the caisson top cover, and a pressure-resistant hose connecting the caisson and the installation vessel. The decompression process is shown in Figure 4.1.3-2. The installation vessel will carry a vacuum, steel pressure tank, air compressors and other equipment. The connection of the quick-connect coupling during water extraction and disconnection of the coupler is kept isolated from the water outside the caisson, in order to ensure that the pumping pressure will not have direct contact with the outside seawater, but only connect with the top of the caisson. The vacuum hoses are sealed, such that the decompression equipment will not exchange fluid with the surrounding marine environment. In order to smooth suction operation, the pumping pipes connecting the installation vessel and the caisson are all lined with pressure resistance, and the average seepage velocity of the soil inside the caisson will be controlled to below 1×10^{-2}m/sec. This is to avoid buckling of the sleeve. Through out the installation, the flow, pressure, verticality of the caisson and other conditions will be monitored by the monitoring equipment on quick-connect coupling and the vacuum Since SBJ uses pressure difference to sink the caissons under the seabed, there is no need for pile driving during construction, and is expected to create almost no underwater noise. However, the caisson is typically more suitable for areas with soft clay layers and low-strength soil types, and less suitable for areas with more gravel or boulders on the seabed. The upper truss frame structure and the caisson foundation of the SBJ can be pre-welded onshore, and then transported offshore for installation. With this approach, the overall offshore construction time can be saved.

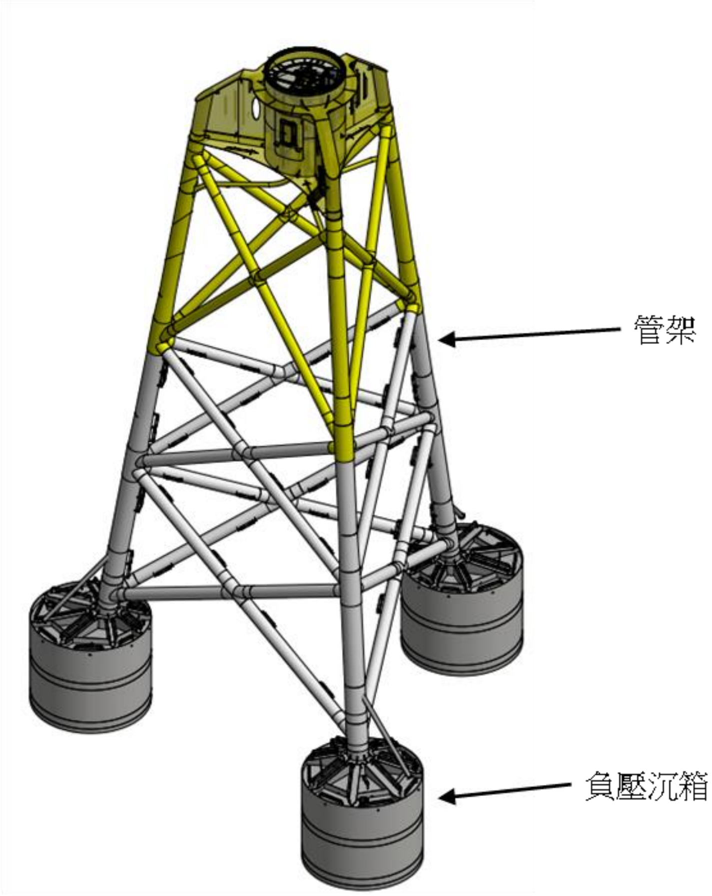
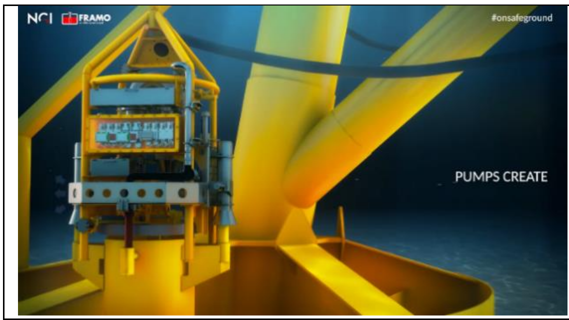


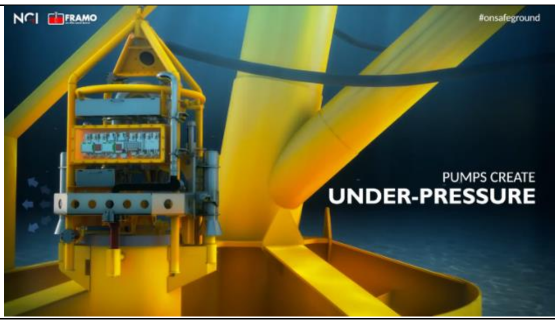
Figure 4.1.3-1 SBJ Foundation Concept

Table 4.1.3-2 Design envelope for SBJ Foundation of the Project

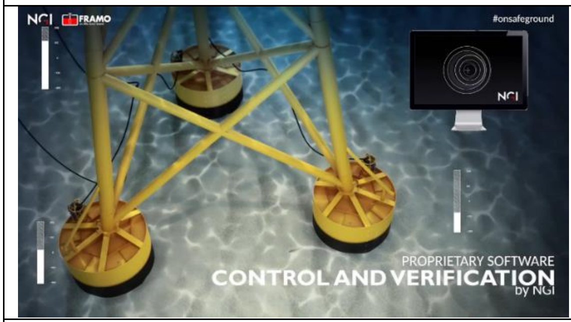
Foundation components	Estimated max values of foundation designs of the Project	Note
Suction bucket outer diameter (m)	**25**	
Suction bucket penetration depth (m)	**25**	
Jacket weight (t)	**3,000**	
Footprint of scour protection on seabed (m^2)	**8,000**	Each foundation



(a) Pumps are connected to the SBJ



(b) Pumps in operation



(c) Monitoring of SBJ installation

(d) Low noise installation

(e) Pumps are removed

(f) Pumps are retrieved

Figure 4.1.3-2 Process for the Pressure system

The installation process for the SBJ includes roughly the following four steps (as illustrated in Figure 4.1.3-3):

I. Transportation and crane lift: The welding for the jacket and the inspection of each component for the SBJ is conducted at the designated staging area in port. The foundation is transported to the installation location using an installation vessel. A crane is used to deploy the SBJ foundation into the water.

II. Positioning: Once the SBJ jacket is in the water, there may be lateral movement due to the currents and surficial waves. Therefore, constant positioning while slowly placing the foundation is vital, to ensure that the foundation is at the correct location on the seabed.

III. Self-weight penetration and suction operation: Once the SBJ is placed on the seabed, the foundation will slowly sink into the seabed due to its self-weight penetration. After confirming that the inside of the bucket is sealed, water is extracted from inside the bucket to allow the bucket to continue to sink towards the target penetration depth.

IV. Burial: Once the SBJ is at the target penetration depth, the pump can be removed, and scour protection can be installed.

All foundations will equipped with two layers of scour protection, including the Armor layer and the Filter layer. Each layer consists of different sizes of granules. Scour protection will be designed according to EN 13383-1:2002, and the width of the protection layer depends on the grading used. The slope for the layer is also to be designed at a suitable angle to ensure stability. Scour protection is illustrated in Figure 4.1.3-4 ~ Figure 4.1.3-5.

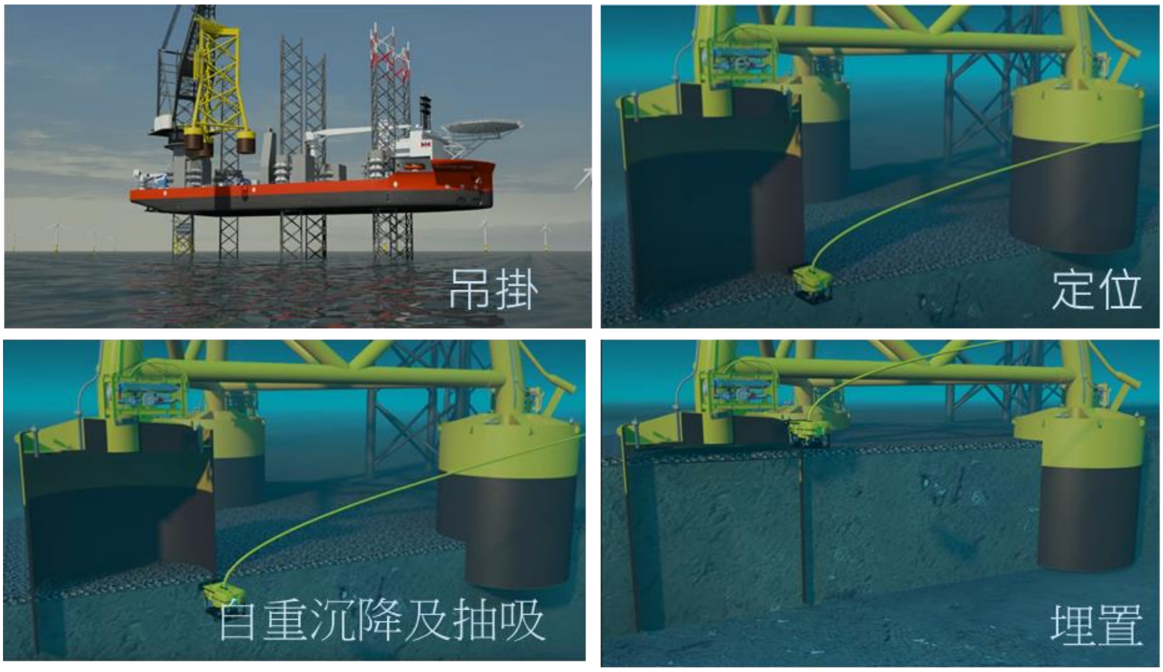


Figure 4.1.2-3 Conceptual Illustration of SBJ Installation Process

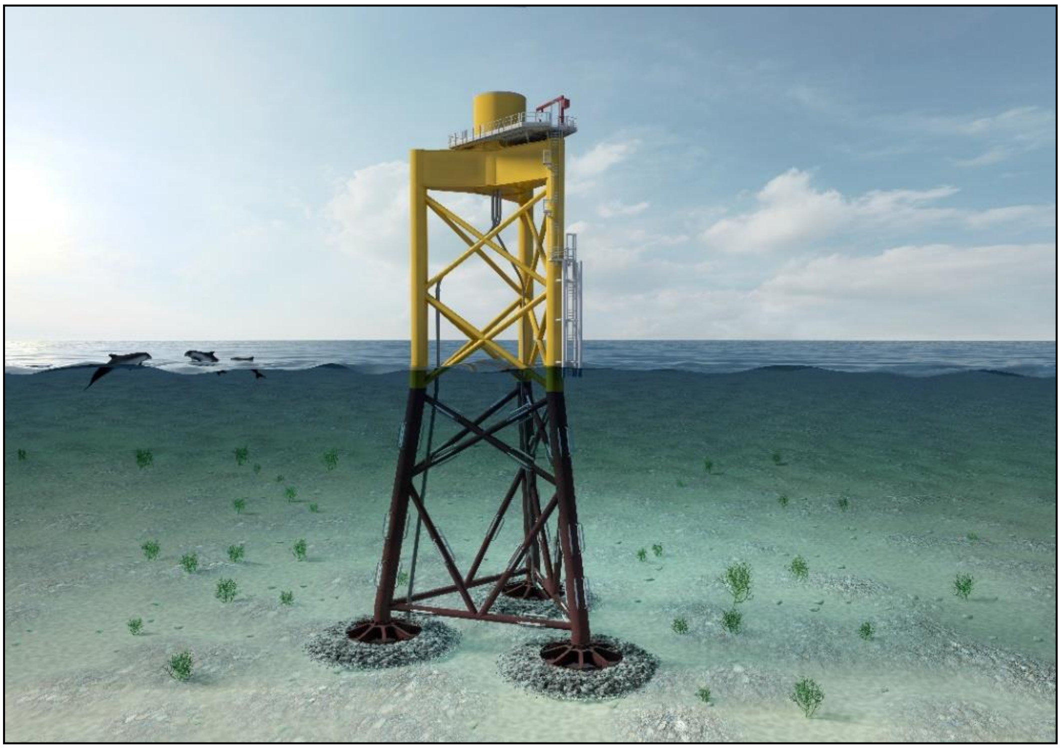


Figure 4.1.3-4 Concept of a SBJ Foundation

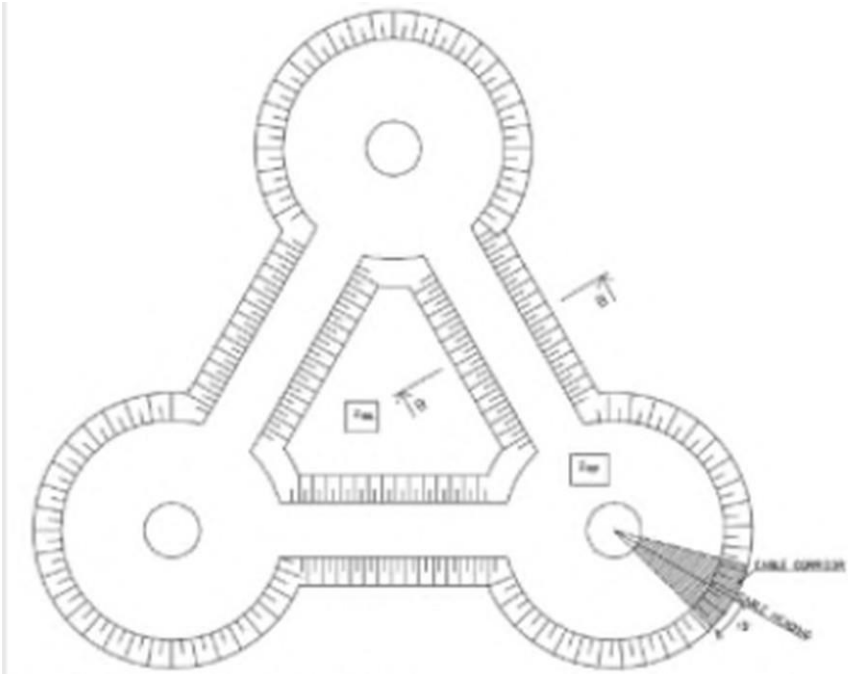


Figure 4.1.3-5 Scour Protection for WTG Foundation

4.1.4 OSS

According to the original EIS, an OSS will be installed at the offshore Project Site. The purpose of the OSS is to collect each of the array cables from each turbine and transform the voltage of the power generated to a higher voltage, which will then be exported to shore. The design envelope in the original EIS is summarized in Table 4.1.4-1.

This amendment adjusts the maximum size of the topside structure, the maximum seabed footprint, and increases the pin-pile diameter and penetration depths of the OSS pin-pile foundation in order to ensure structural safety. The design envelope of the OSS after the amendment is summarized in Table 4.1.4-2.

Table 4.1.4-1 Design Envelope of OSS before the Amendment

Item	OSS
Number of OSS	1
Type of Foundation	Four legged pin-pile foundation
Maximum seabed footprint (m)	40m x 40m
Maximum topside size (LxWxH)	50m x 40m x 30m*
Maximum Protrusion of the Helipad	20m
Pin-Pile Jacket	• Maximum of 12 pin piles (4-legged foundation, with 1 - 3 pin piles at each leg) • Max pin pile diameter 4 m • Pin pile length is subject to soil condition at the OSS location
Maximum pile penetration depth	85 m

* Excluding crane and antenna mast; including helideck

Table 4.1.4-2 Design Envelope of OSS after the Amendment

Item	OSS
Number of OSS	1
Type of pin-pile foundation	4-legged
Max. seabed footprint (m)	**50m x 50m**
Max. topside size (LxWxH)	**60m x 50m x 40m***
Max weight for topside (tons)	**4,000 t**
Maximum Protrusion of the Helipad	20m
Pin-Pile Jacket	• Max 12 pin piles (4-legged foundation, with 1 - 3 pin piles at each leg) • Max diameter 4 m • Pin pile length is subject to soil condition at the OSS location
Max. pin pile penetration depth	**120 m**
Max. footprint of scour protection on seabed (m^2)	**8,000 m^2**

* Excluding crane and antenna mast; including helideck

The structure of the offshore substation is mainly divided into three parts: topside structure, jacket, and pin-piles. The purpose of the topside structure is to accommodate various electrical and mechanical facilities. The design and planning of this space will be based on the electrical equipment and transformer equipment selected for this Project. It is being proposed that the pin-piles will be used to support the entire weight of the OSS. The pin-piles will support the pin-pile jacket, which then will support the topside structure. The schematic diagram of the structure and its scour protection is shown in Figure 4.1.4-1 to Figure 4.1.4-2.

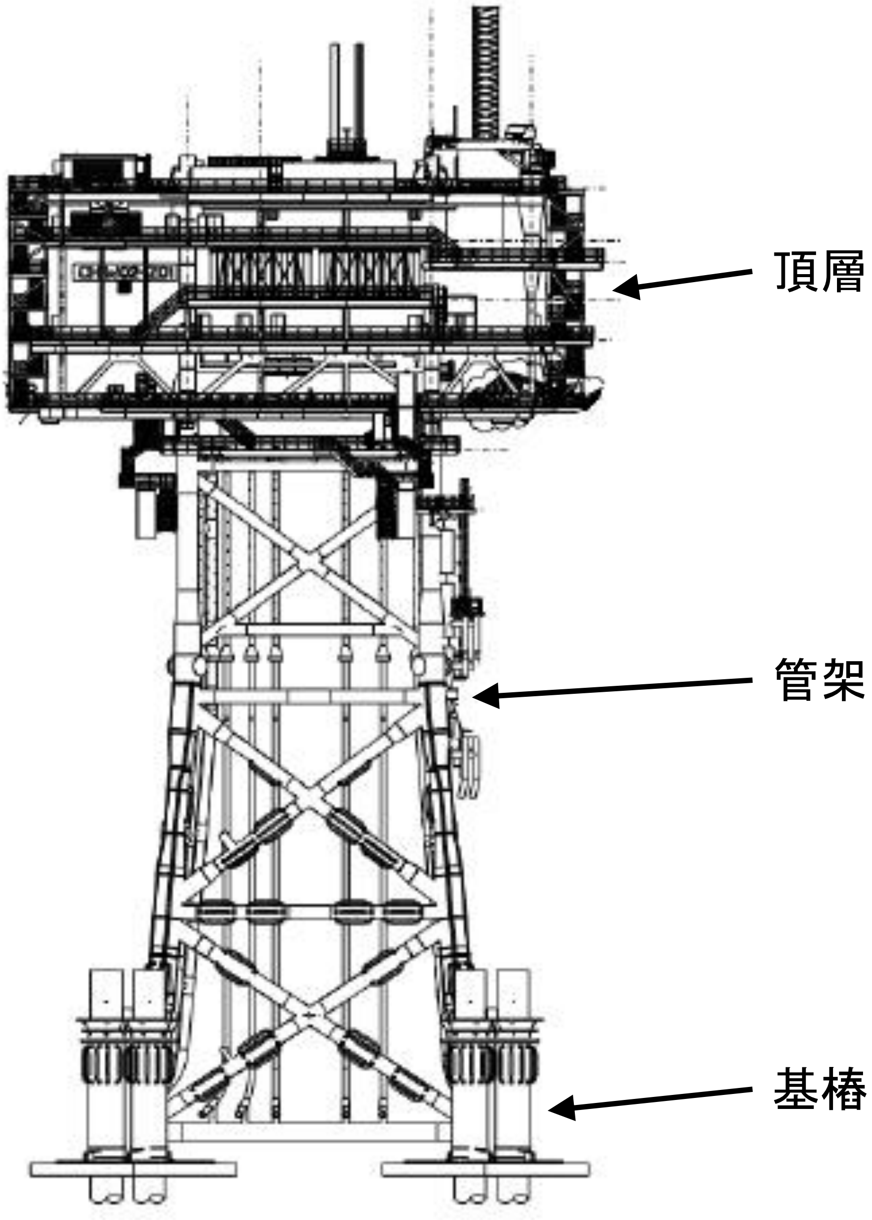


Figure 4.1.4-1 Illustrative OSS Structure in this Project

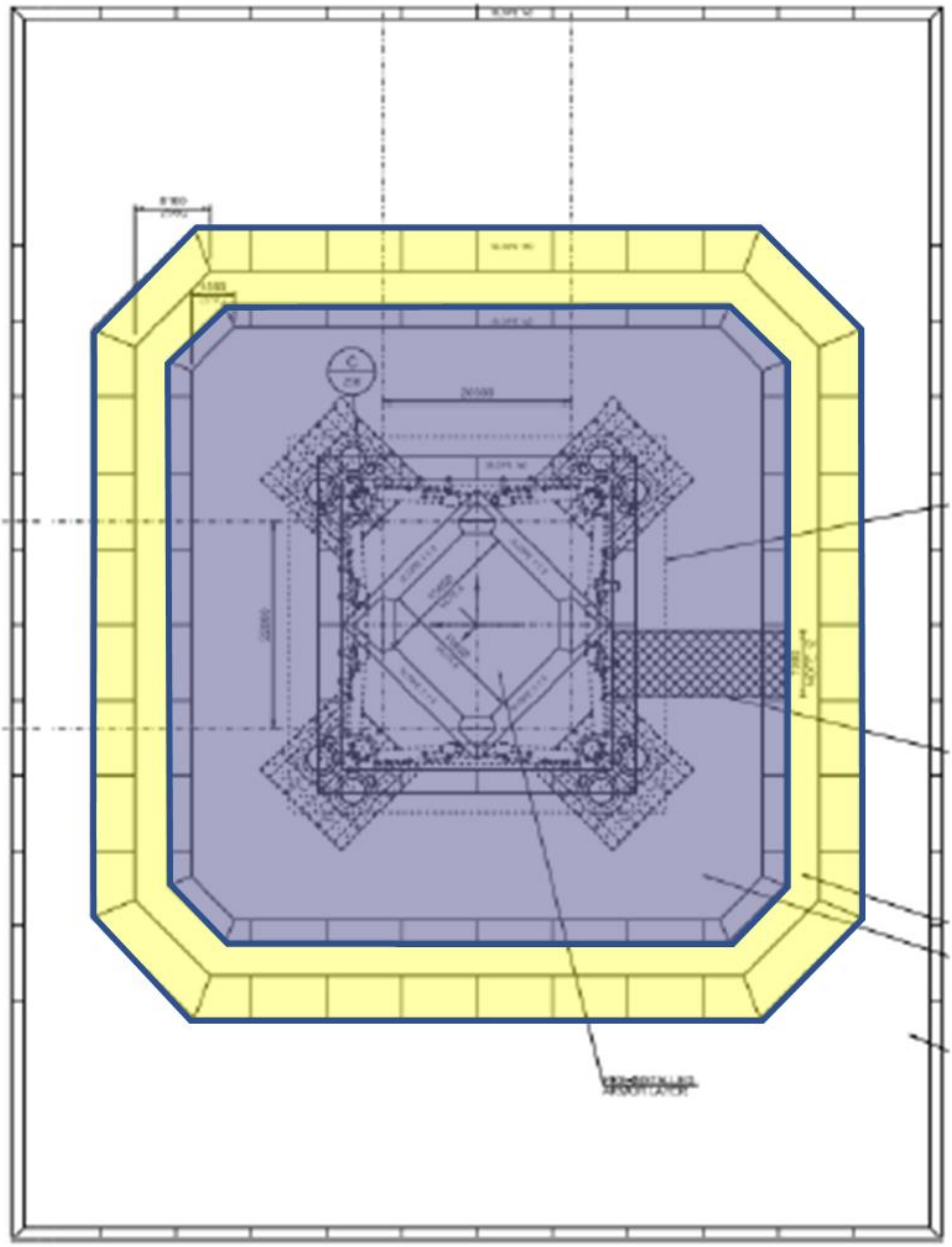


Figure 4.1.4-2 Illustrative scour protection of the OSS in this Project

4.1.5 Offshore Transmission Cables

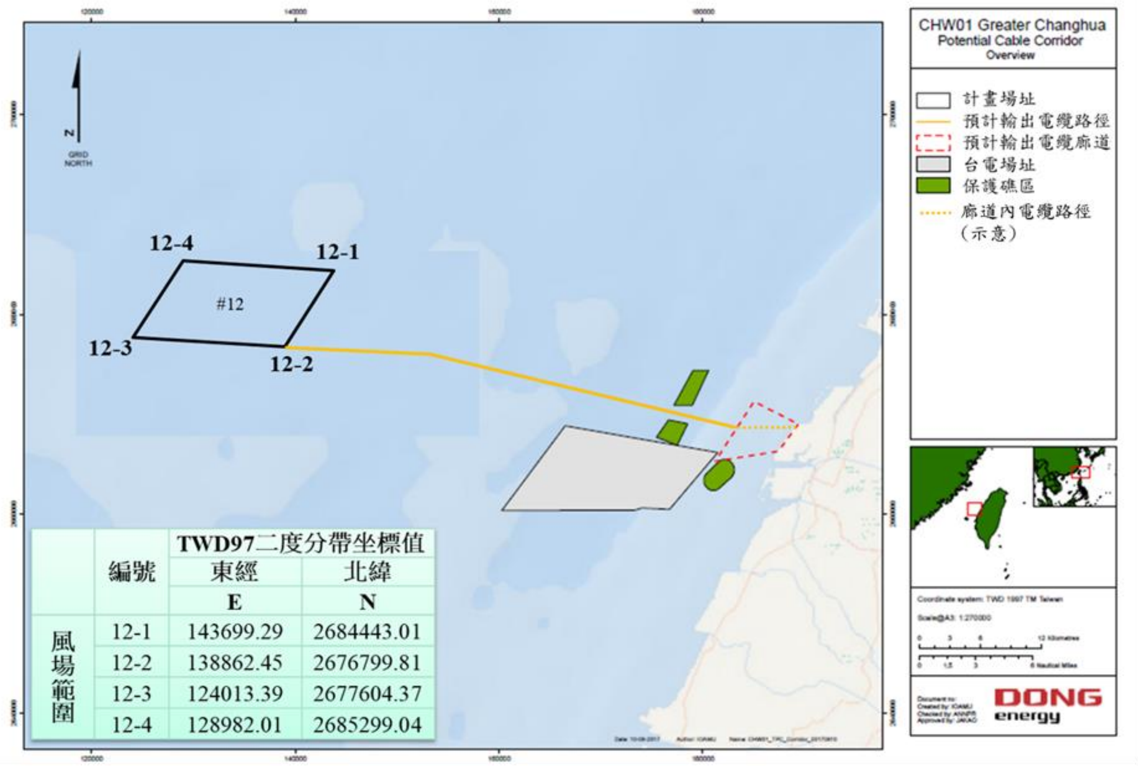
According to the original EIS, offshore transmission cables include array cables, interlink cables and export cables. In this amendment, the cable route has not been changed, thus the cable connection and landfall to the onshore infrastructure remain the same as those outlined in the original EIS. This amendment only made an addition to the existing selection of voltage for the export cable. The array and interlink cables remain the same as proposed in the original EIS. The amendment proposed is explained as follows:

I. Original EIS

Export cables are responsible for transmitting energy produced by the wind turbines from the offshore substation to the onshore substation. According to the original EIS, two 220kV submarine export cables will make landfall through the Northern Common Corridor.

II. This Amendment

This Project will still use two export cables. These cables will make landfall through the Northern Common Corridor, as proposed in the original EIS. However, the voltage for the export cable is proposing to be either 220kV or 275kV.



	編號	TWD97二度分帶坐標值	
		東經	北緯
		E	N
風場範圍	12-1	143699.29	2684443.01
	12-2	138862.45	2676799.81
	12-3	124013.39	2677604.37
	12-4	128982.01	2685299.04

註：依台電公司於106年8月14日公告之共同廊道進行規劃

Source: CHW04 Environmental Impact Statement (Approved)

Figure 4.1.5-1 Proposed Project Cable Route

4.1.6 Cable Landfall

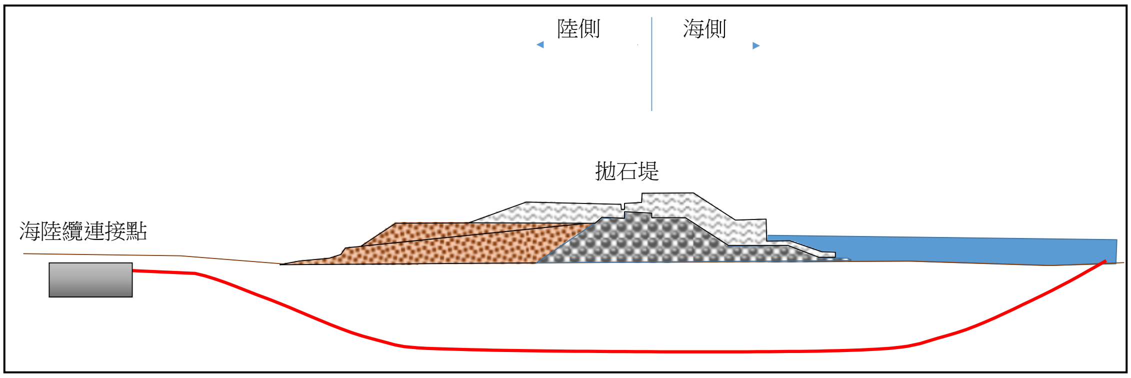
According to the original EIS, the seawall crossing approach to be used at the location of the cable landfall is proposed to be Horizontal Directional Drilling (HDD). However, the seawall crossing approach will only be finalized after reviewed and approved by the industry competent authority. In order to grant more flexibility to the Project, an additional option is proposed in this amendment as follows:

I. Original EIS

Transition joint bay (TJB) is required at each landfall location closest to the connection between the marine cable and the onshore cable via Horizontal Directional Drilling (HDD). The indicative figure of HDD method is provided in Figure 4.1.6-1.

II. This Amendment

Transition joint bay (TJB) is required at each landfall location closest to the connection between the marine cable and the onshore cable via **<u>trenchless approach</u>**, such as Horizontal Directional Drilling (HDD) **<u>or microtunneling.</u>** The indicative figure of trenchless approach is provided in Figure 4.1.6-1.



Source: CHW04 Environmental Impact Statement (EPA Approved Version)

Figure 4.1.6-1 Indicative figure of trenchless approach

When compared with typical open cut approach, microtunneling (a trenchless approach) can mitigate disturbance and impact on the nearshore marine ecology by preventing the establishment of a large-scale excavation and a large area of construction site on the nearshore seabed. The following briefly describes the microtunneling approach:

I. Work Shaft Installation

To ensure that the microtunnel boring machine (MTBM) can operate, it is proposed to start from the onshore side of the tunnel, where a work shaft will be secured using sheet piles. Sole plates and thrust blocks will also be installed in the work shaft to facilitate the operation of the MTBM.

II. Tunnel Excavation

Once the work shaft is in place, MTBM will be placed in the work shaft, which can be remote controlled. During tunnel boring, excavated soil will be transported to the surface and disposed of appropriately. During the boring process, tunnel liner segments are placed behind the MTBM. This process will be repeated over and over until the tunnel boring is complete.

III. MTBM Retrieval

Once the tunnel is complete, the MTBM can be retrieved from the offshore side of the tunnel. The tunnel will be sealed after the MTBM is removed. Afterwards, the MTBM will be loaded onto the deck of one of the marine spread and transported back to port.

IV. Completion and Restoration

Once the MTBM is retrieved, the export cable will be inserted into the tunnel, and the work shaft will be restored such that the onshore cable installation can continue. Generally, the work shaft will be temporary and will be installed only on the onshore portion, so it does not increase the scale of the offshore construction.

HDD and microtunnelling both utilize trenchless technology. Although these approaches are similar, microtunneling is more commonly utilized in Taiwan. Since either approach has yet to be approved by the industrial competent authority, this amendment will include both of the aforementioned trenchless technology as the two available trenchless options. The actual approach will be selected following the results of the industrial competent authority review.

4.1.7 Onshore Transmission System

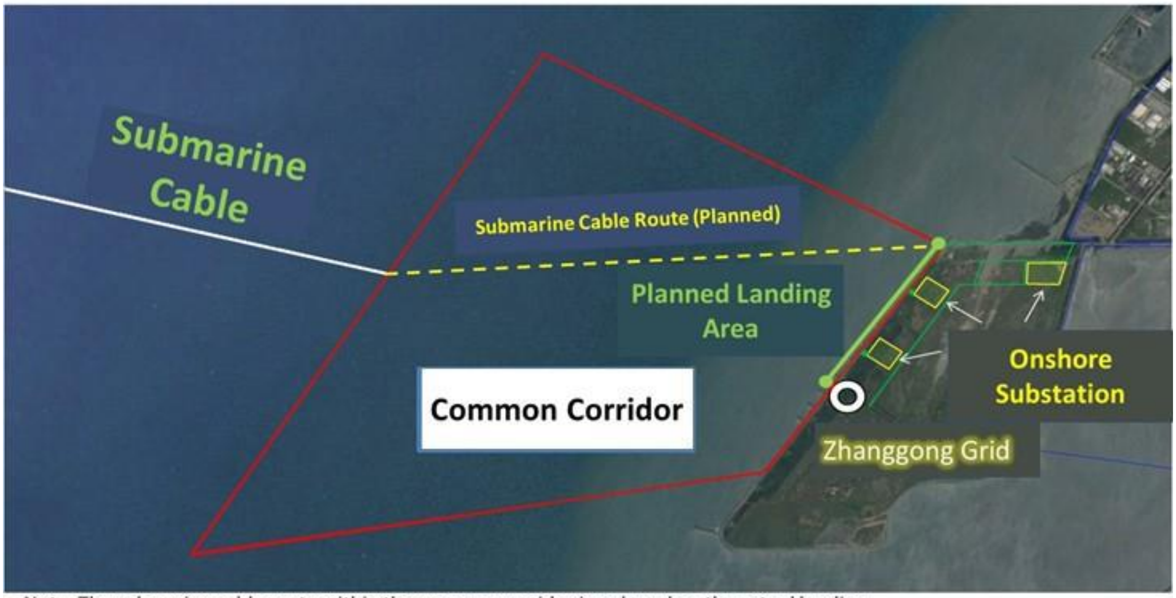
According to the original EIS, three sites were chosen for the onshore substation in the Lungwei area of the Changhua Coastal Industrial Park. One of the sites will be selected as the proposed location for the substation, as shown in Figure 4.1.7-1. This amendment will focus and clarify the proposed plans for the onshore transmission system.

Since the Greater Changhua Southwest Offshore Wind Farm is divided into two phases (first phase being CHW02, second phase being CHW22), the proposed schedule for grid connection of this Project is expected to correspond with the grid connection of CHW22. Therefore, considering the uniformity of grid connection operations and to reduce unnecessary construction activities, this Project proposes to share onshore cable route and onshore substation with CHW22.

The location of the onshore substation to be shared between this Project and CHW22 is shown in Figure 4.1.7-2. Preliminary plans for the onshore substation (including the control room, gas insulated switchgear (GIS) and relevant electromechanical equipment) is estimated to require an area of 29,300 m^2. The layout of the substation is shown as Figure 4.1.7-3. The future site of the proposed substation is currently vacant and vegetated, photographs of the proposed site is shown in Figure 4.1.7-4.

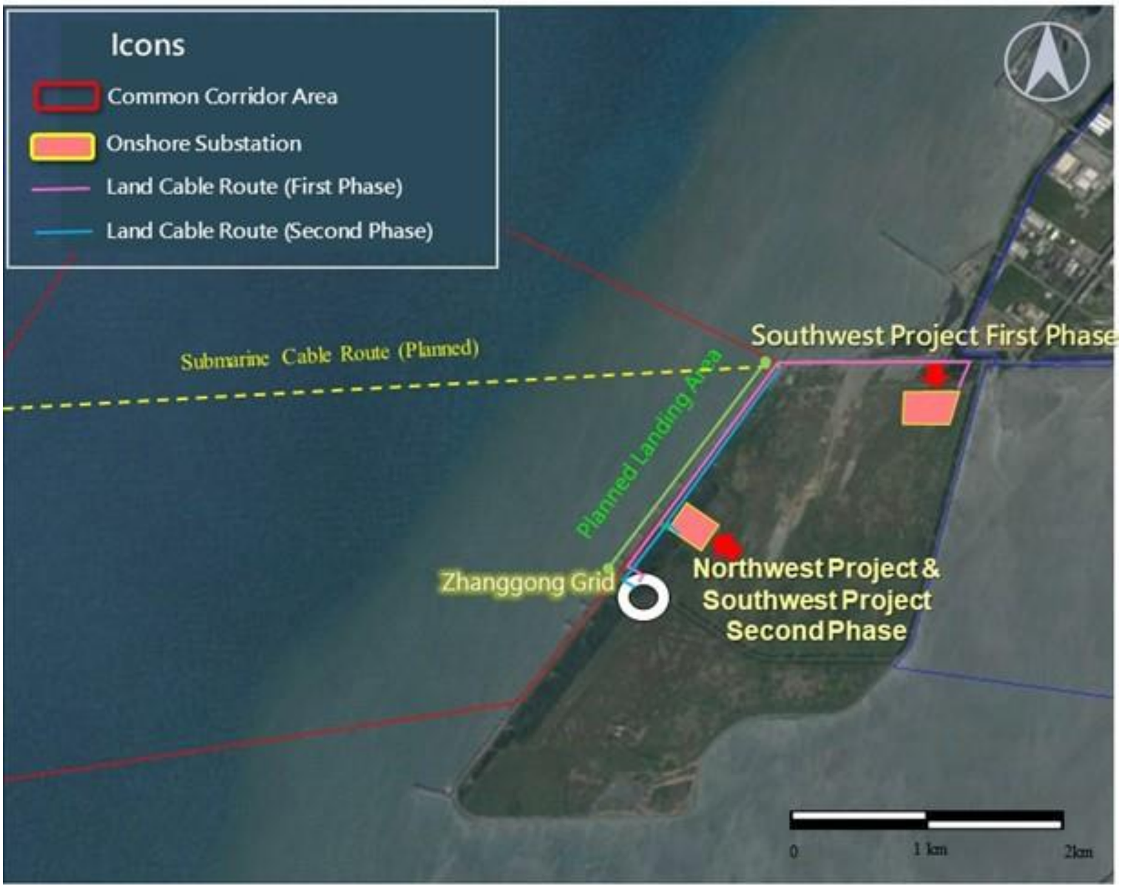
Since the voltage of offshore export cable is proposed to be either 220kV or 275kV, the future TJB connection to the onshore substation will be either 220kV or 275kV as well, to be in line with the voltage of the offshore export cable. The length of this portion of the onshore cable is estimated to be no more than 1.5 km. The voltage of the onshore cable from the onshore substation to the ChungKong grid connection point will either be 161kV or 345kV to be in line with the proposed ChungKong grid connection point. The length of this portion of the cable is estimated to be no more than 1.4km.

Moreover, since much of the proposed onshore cable route overlaps with the existing cable route of CHW02, and that there is adequate space in the existing trench of CHW02, it is proposed for the onshore cable trench for this Project to utilize the existing onshore cable trench to avoid unnecessary excavation and construction. The only items that require additional excavation for onshore cable are the TJB, connection point of onshore cable and the approximately 700-m long onshore cable trench.



Note: The submarine cable route within the common corridor is only a plan, the actual landing point will be according to TPC plans and relevant regulations by the Zhanggong Industrial Park

Figure 4.1.7-1 Locations of Landfall and Onshore Facilities in the Original EIS



Note: The marine cable route within the common corridor is only a plan, the actual landfall location will be dependent to TPC plans and relevant regulations by the Changhua Coastal Industrial Park

Figure 4.1.7-2 Locations of Onshore Facilities proposed by this Amendment

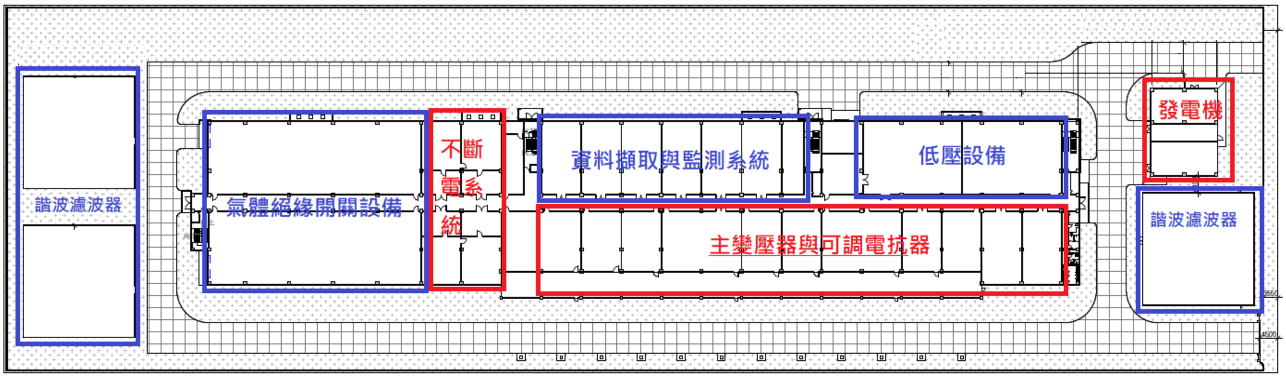


Figure 4.1.7-3 Configuration of the Onshore Substation used for this Project and CHW22

Figure 4.1.7-4 Future Site of the Proposed Onshore Substation for this Project and CHW22

4.1.8 Earthwork Volume

Only the construction of onshore transmission system and onshore substation is this Project is expected to generate surplus earthwork. According to the original EIS, the maximum surplus earthwork by the construction of onshore substation and onshore cable is approximately 234,000 m^3 (loose). The earthwork generated from the construction will be backfilled or paved within the industrial park in accordance with the regulation in the Changbin Industrial Park. Therefore, there will be no earthwork being exported outside the industrial park.

Since the common onshore cable route and the onshore substation is shared with CHW22, the surplus earthwork will be stated in the EIS for both this Project and CHW22. The description is as follows:

I. Onshore Substation

- i Excavation of non-foundation area: Maximum excavation area is approximately 18,300m^2. Maximum excavation depth is approximately 1 m below grade. Expected volume of soil generated from the excavation is 18,300 m^3 (compressed).
- ii Excavation of foundation area: Maximum excavation area is approximately 11,000m^2. Maximum excavation depth is approximately 6.45m below grade. Expected volume of soil generated is 70,950 m^3 (compressed).
- iii Backfill required: Approximately 9,220 m^3 (compressed).

II. Onshore Transmission System

- i TJB and connection with the onshore cable: Approximately 4,620m^3 (compressed).
- ii Onshore cable route: Additional cable route will be approximately 700m in length, 5m in width, and 5.5m in depth; Volume of earthwork is expected to be approximately 19,250m^3 (compressed).
- iii Backfill required: Approximately 8,680 m^3 (compressed).

III. Estimation of Total Earthwork

The total volume of earthwork (compressed) is estimated to be approximately 113,120m^3. The total backfill required (compressed) is approximately 17,900 m^3, therefore the total volume of soil (compressed) generated is approximately 95,220 m^3. Accounting for a bulking factor of 1.2 and rounding up to the closest thousand, the total volume of earthwork is 115,000 m^3 (loose).

IV. Difference of Surplus Earthwork before and after the Amendment

At the time of writing, the civil construction of CHW02 is almost completed. The actual volume of surplus earthwork generated from the construction is approximately 49,000 m^3, which had not exceeded the approved volume of 234,000 m^3 in the original EIS. In addition, the earthwork generated during the construction of the onshore substation for this Project and to be shared with CHW22 is estimated to be 115,000 m^3 (loose). In the Original EIS, this Project and CHW02 each estimated a surplus earthwork of 234,000 m^3, regardless of whether the surplus earthwork in this amendment is combined with those incurred during the construction of CHW02, the overall surplus earthwork will be well below the volume approved for the original EIS.

4.2 Amendments to the Environmental Protection Measures and Environmental Management Plan

I. I. Environmental Protection Measures

i Construction Phase Offshore Environmental Protection Measure - Cetacean

(a) Choose a foundation type that produces less noise

In response to adding SBJ foundation type, the text for the protection measure is revised, as shown below:

- Original text : "Pin-pile jackets will be selected for this Project, as they are expected to produce less noise"
- Amendment text: "**Pin-Pile Jacket or SBJ foundation** will be selected for this Project, as they are expected to produce less noise".

(b) Real-time monitoring

The original EIS states that "to have a bigger detection area regarding cetacean activities, four PAM devices will be deployed at appropriate locations 750m from the piling location" and "underwater noise monitoring campaign will be carried out once at 750m from piling location during pile driving campaign." The statement does not clarify the reference point of the 750m, so the statement is amended as follows:

"to have a bigger detection area regarding cetacean activities, 4 PAM device will be deployed in proper locations 750m from **the centre of Jacket as the reference point**" and "underwater noise monitoring campaign will be carried out once at 750m from the **centre of jacket** during pile driving campaign."

(c) Noise mitigation measures during the construction

In order to mitigate the impact on cetaceans induced by underwater noise during foundation installation, the underwater noise threshold for the Project has been revised, as shown below:

- Original text:

  "The project commits that the underwater noise exposure value (Sound Exposure Level, SEL) shall not exceed 160 decibels [(dB) re. 1$\mu Pa^2 s$] as the impact assessment threshold."

  "The best commercially available noise control method at the time of development will be applied during pile driving to all of the wind turbine locations, to ensure the noise levels at the 750m warning zone is below SEL 160dB. Details of the noise mitigation measures to be used will be determined before the pile driving campaign commences, including consideration of the latest noise reduction technology available at that time, such as bubble curtain or balloon curtains.”

- Amendment text:

“**95% of the underwater noise measurement data (SEL05) shall not exceed 160dB** and **SPLpeak shall not exceed 190dB** at 750m **to the center of jacket** where the underwater noise monitoring is carried out.”

“The best commercially available noise control method at the time of development will be applied during pile driving to all of the wind turbine locations, to ensure the noise levels at the 750m warning zone is below SEL 160dB. Details of the noise mitigation measures to be used will be determined before the pile driving campaign commences, including consideration of the latest noise reduction technology available at that time, such as bubble curtain or balloon curtains.

(d) Additionally, the sound exposure level (SEL) of 25% of all foundations to be installed at 750m distance to the center of jacket shall be lower than 159dB.”Real-time noise monitoring

In order to ensure underwater noise during the piling is controlled within the limits, real-time noise monitoring is revised: “**157 dB SEL of single piling event, measured as 30 second average, is set as early warning level during the pile installation.”** As the noise monitoring shows that the early warning level is exceeded, proper responses (e.g. lower the hammer energy(kJ), decrease the frequency of piling) alongside enhanced mitigation measures such as increase the air supply of bubble curtain, if necessary, will be taken to make sure the noise level is lower than the **limit** described in EIA commitment.”

ii 2. Construction Phase Offshore Environmental Protection Measure - Marine Water Quality

(a) To reduce the impact of seabed protection to the marine water quality, fall-pipe vessel will be retained for the construction phase. New statements are as follows: “**Installation of scour protection will be carried out by fall-pipe vessel to alleviate the influence on marine water quality during construction.**”

(b) Addition proposed wording for marine water quality monitoring during the construction phase: “For turbines using SBJ, one turbine location will be selected from each row (east-west direction) where its underwater environment around the foundation will be observed by using a Remotely Operated Vehicle (ROV), which is capable of transmitting images to the installation vessel in real-time, during the installation of SBJ. This is meant to understand if there is disturbance to the seabed during SBJ installation and thus affect water quality in the surrounding area.”

iii 3. Construction Phase Offshore and Onshore Environmental Protection Measure -Air Quality

(a) In order to reduce the impact of air pollutants on the environment during the construction phase, the length of roadway to be swept during the construction phase will be increased in this amendment. As shown below:

- Original text: “During the construction phase, a total of **100m** roadway to the front and rear of the construction site will be swept and cleaned to mitigate dust fall from the passage of construction and transportation vehicles (except for days of precipitation).”
- Amendment text: “During the construction phase, a total of **1km** roadway to the front and rear of the construction site will be swept and cleaned to mitigate dust fall from the passage of construction and transportation vehicles (except for days of precipitation).”

(b) In order to reduce the impact of exhaust produced by the marine spread on air quality during the construction phase, the description for the sulfur content of fuel consumed by the marine spread is revised. As follows:

- Original text: All marine spread will use fuel with the minimum sulfur content available in Taiwan at the time.
- Amendment text: All marine spread will use fuel with the minimum sulfur content **(<0.5%)** available in Taiwan at the time.

(c) In order to effectively reduce air pollutants emitted by onshore construction equipment and vehicles during the construction phase, an additional commitment is added: “During construction, onshore construction equipment and vehicles will comply with Class 4 environmental standards (or above), and possess Grade A Self Management Label. The aforementioned requirements will be integrated into the contracts for the construction subcontractors.”

iv Operation Phase Offshore Environmental Protection Measure – Marine Ecology

Amendment text: During underwater filming, the presence of marine reptiles will also be monitored.

v Operation Phase Environmental Impact Mitigation Measure- Waste

The main components for the WTG include the foundation, tower, hub, and turbine blades. All of the components are produced using steel except for the blade which is produced using use glass fiber and carbon fiber. The waste resulting from the decommissioned blades will not considered as hazardous and can be recycled but challenging. However, as the blades are designed to be lightweight and sturdy, they are difficult to dismantle. Currently, decommissioned turbine blades for wind farms are usually landfilled. The original EIS did not include any commitments in regard to the decommissioning of blades, and a commitment for handling decommissioned blades is added, "**<u>This Project has committed not to bury turbine blades during the decommissioning. In the future, the Project will participate blade recycling-related initiatives to monitor all possible recycling methods and adopt them where possible to improve the sustainability of wind turbines. These initiatives include finding common solutions through cooperating with other companies and organizations, or participating in research and innovation projects focused on recycling blade materials.</u>**

If a suitable solution is not found during the decommissioning, the Project has also committed to legitimately store blades temporarily rather than landfill. This commitment is incorporated as part of the mitigation measures that will be provided, at least 1 year before official decommissioning, to the competent authority for approval. "

II. Environmental Monitoring Plan

i Pre- Construction Phase Environmental Monitoring Plan

To clarify the baseline data for the air quality in the construction site, a pre-construction air quality survey will be carried out at the monitoring locations in addition to those to be conducted during the construction phase. Survey items will include wind direction, wind speed, particulate matter (TSP, PM_{10}, $PM_{2.5}$), SO_2, nitrogen oxides (NO, NO_2), O_3. The environmental monitoring plans during the construction phase before and after the amendment are as summarized in Table 4.2-1 and 4.2-2, respectively.

ii Construction Phase Environmental Monitoring Plan

(a) <u>Air Quality</u>

According to air quality data from the past 10 years collected by the EPA, the concentration of various air pollutants has decreased in each area of Taiwan as more and more air pollutant prevention measures have been implemented. The only pollutant that has not shown significant improvement is O_3. O_3 is a vital index pollutant. Therefore, O_3 has been added to the environmental monitoring plan during the construction phase. The environmental monitoring plans during the construction phase before and after the amendment are as shown in Table 4.2-3 to Table 4.2-4.

(b) <u>Marine Ecology</u>

In the original EIS, ROV is used to conduct underwater filming only at the foundation of turbines. To understand the effect of fish gathering at the foundation of OSS, this amendment has added underwater filming at one OSS location. The survey will be conducted before and after piling.

iii Marine Reptile Observation

In order to monitor whether marine reptiles appear in the Project site, “Marine Reptile Observation” is added to the environmental monitoring plan for cetaceans during the pre-construction, construction and operation phases. The environmental monitoring plans during the operation and construction phases before and after the amendment are as shown in Table 4.2-1 to Table 4.2-6.

iv Response measures regarding loss of PAM device and data during retrieval

Because the UNM/PAM device are installed at the sea site about 40 ~ 60 km away from shore for more than one month, the device or data retrieval may be lost from time to time due to natural or human factors (e.g., sand wave coverage, biological growth, interference from other vessels, etc.) In addition, the monitoring on the waters is restricted by sea states such as wind conditions and waves, and cannot be done immediately. Therefore, in order to effectively grasp the long-term monitoring data, a footnote on "Response measures regarding loss of PAM device and data during the retrieval" is added to the monitoring plan table in the pre-construction, construction and operation phases, as shown in Tables 4.2.2-2, 4.2.2-4 and 4.2.2-6.

v Response measures for poor sea state that continue for extended periods of time during the offshore environmental monitoring plan

Contingency measures for poor sea state that continue for extended period during the construction and operation phases are added to the environmental monitoring plan. The construction and operation environmental monitoring plans before and after the amendment are as shown in Table 4.2-1 to Table 4.2-4.

Table 4.2-1 Environmental Monitoring Plan during the Pre-construction Phase before the Amendment

Category	Items	Sites	Frequency
Marine ecology	Cetacean ecology survey	Project site	20 trips/year. 1 year before the construction
Underwater noise (including PAM)	Underwater noise 20 Hz-20kHz. Spectrogram, 1-Hz band, 1/3 Octave band analysis	2 stns within Wind Farm Area	4 quarter/year, 30 days per survey. (note)
Marine water quality	Water temperature, pH value, BOD, Salinity, Dissolved Oxygen, Ammonia-N, Nutrients, Suspended Solid, Chlorophyll a, Coliform group	12 stns in the area near the wind farm	Once every quarter
Bird ecology	Species, number, habiting and flying activity, flying routes, seasonal flock change etc. (including coastal birds and shore birds)	Vicinity of wind farm and coastal area near the landfall	Once per month from March to November and once between December and February. 10 survey trips annually.
	Bird radar survey (vertical and horizontal)	Project site	Quarterly 2 years before the construction (at least 5 days/times in spring, summer and fall; survey is subject to change in winter due to the weather. Each survey will cover daytime and nighttime)
	Bird satellite tracking	Coastal area of Changhua	Carry out in each season before the construction
Cultural heritage	Interpretation of underwater cultural assets	Drilling at turbine location	Archeologist will help with the interpretation (drilling at turbine location before the construction)
	Interpretation of cultural assets	Drilling at onshore substation location	Archeologist will help with the interpretation (drilling at 3 locations in minimum)

Note 1：The onshore monitoring (interpretation of cultural assets) starts before the beginning of the construction (expected to be Q1 2023), and the monitoring period will follow the associated requirements (expected to be from 2018 to Q1 2023).

Note 2：The offshore monitoring (marine ecology, UNM, marine water quality, bird ecology, underwater cultural interpretation) starts before the beginning of the offshore construction (expected to be 2025 Q1), and the monitoring period will follow the associated requirements (expected to be from 2023 Q1 to 2025 Q1).

Table 4.2-2 Environmental Monitoring Plan during the Pre-construction Phase After the Amendment

Category	Items	Sites	Frequency
Air Quality	**Monitoring items: Wind direction, wind speed, particulate matter (TSP, PM_{10}, $PM_{2.5}$), SO_2, nitrogen oxides (NO, NO_2), and O_3.**	**1. Wuqi Fishing Harbor 2.One station near onshore substation**	**Once before the construction**
Marine ecology	Cetacean ecology survey (**including marine reptiles**)	Project site	20 trips/year. 1 year before the construction
Underwater noise (including PAM)	Underwater noise 20 Hz-20kHz. Spectrogram, 1-Hz band, 1/3 Octave band analysis	2 stn. within Wind Farm Area	4 quarter/year, 30 days per survey. (note 3)
Marine water quality	Water temperature, pH value, BOD, Salinity, Dissolved Oxygen, Ammonia-N, Nutrients, Suspended Solid, Chlorophyll a, Coliform group	12 stations in the area near the wind farm	Once every quarter, conduct for one year before construction
Bird ecology	Species, number, habiting and flying activity, flying routes, seasonal flock change etc. (including coastal birds and shore birds)	Vicinity of wind farm and coastal area near the landfall	Once per month from March to November and once between December and February of the following year. 10 survey trips annually.
	Bird radar survey (vertical and horizontal)	Project site	Quarterly for 2 years before the construction (at least 5 days/times in spring, summer and fall; survey is subject to change due to the weather in winter. Each survey will include daytime and nighttime survey)
	Bird satellite tracking	Coastal area of Changhua	Once per season before construction, for a total of four seasons
Cultural heritage	Interpretation of underwater cultural assets	Drilling at turbine location	Professional archeologist will help with the interpretation (drilling at each turbine location before construction)
	Interpretation of cultural assets	Drilling at onshore substation location	Archeologist will help with the interpretation (drilling at 3 locations at a minimum)

Note 1：The onshore monitoring (onshore air quality and cultural assets) starts before the beginning of the terrestrial construction (onshore substation and onshore cable construction, expected to be Q1 2023), and the monitoring period will follow the associated requirements (expected to be from 2018 to Q1 2023).

Note 2：The offshore monitoring (marine ecology, UNM, marine water quality, bird ecology, underwater cultural interpretation) starts before the beginning of the offshore construction (expected to be 2025 Q1), and the monitoring period will follow the associated requirements (expected to be from 2023 Q1 to 2025 Q1).

Note 3:

(1) For this project, ideally the underwater acoustic survey team will deploy underwater measurement devices at the beginning of each quarter. If sea state allows, devices will be retrieved as soon as possible after 30 days of continuous monitoring.

(2) If the underwater measurement devices are found to be lost during retrieval, a proof of survey execution have to be provided for clarification.

(3) If sea state allows, a supplemental underwater noise survey will be conducted as soon as possible, to ensure that the data can be retrieved. Following deployment, once the survey instrument has measured a period of 24 hours, the instrument will be retrieved from each deployed location.

(4) To ensure the safety of monitoring personnel and vessel, if sea state suddenly worsens, the vessel will return back to the harbor on standby.

(5) If the contingency measure is conducted, the activity will be documented and explained.

Note 4: During the offshore monitoring phase, the Central Weather Bureau sea state system or common international weather forecast systems (incl. Windguru, Windy, ECMWF) will be used as reference, in consideration of safety for vessel and personnel. In principle, surveys will only be conducted during periods of wave height ≦1m for 24 continuous hours. If the time required for conducting the required amount of surveys in the given month or quarter is not available, the remaining surveys for the that month or quarter will be suspended.

Table 4.2-3 Environmental Monitoring Plan during the Construction Phase before the Amendment

Category		Items	Sites	Frequency
Onshore	Air quality	Monitoring items: Wind direction, wind speed, particulate matter (TSP, PM_{10}, $PM_{2.5}$), SO_2, and nitrogen oxides (NO, NO_2).	1. Wuqi Fishing Harbor 2.One station near onshore substation	Once every quarter
	Noise vibration	L_{eq} and day-night average vibration level in each time period (day, evening, night)	1. One station at sensitive area near onshore construction 2. One station at the entrance / exit of onshore construction site	Once for 24 continuous hours per quarter
	Terrestrial ecology	Ecology of terrestrial animal and plantation (According to EPA's technical regulation on animal/plant survey)	Onshore transmission cable system (including substation, onshore cable and vicinity)	Once every quarter
	Construction noise	1. Low frequency (measure L_{eq} at 20Hz-200Hz) 2. Normal frequency (measure L_{eq} and L_{max} at 20Hz-20kHz)	1. One station near the onshore substation 2. One station in close proximity of the onshore cable construction	Once every month
	Cultural heritage	Onshore archeological monitoring	Excavation extents	Monitored by professional archeologists during excavation
Offshore	Marine water quality	Water temperature, pH value, BOD, Salinity, Dissolved Oxygen, Ammonia-N, Nutrients, Suspended Solid, Chlorophyll a, Coliform group	12 stations in close proximity to the wind farm	Once every quarter
	Bird ecology	Species, number, habiting and flying activity, flying routes, seasonal flock change etc. (including coastal birds and shore birds)	Vicinity of wind farm and coastal area near the landfall	Once per month from March to November and once between December and February (of the following year). 10 survey trips annually.
	Marine ecology	1. Intertidal ecology	Within 50m on both sides of cable landfall	Once every quarter
		2. Plankton, Fish Egg and Larvae, Benthic Organisms	12 station spots near the wind turbines	
		3. Fish	3 survey lines	Once every quarter
		4. Cetacean	Project Site	20 trips each year (at least 1 trip each quarter)
		5. Underwater filming to observe fish gathering effect at bottom of turbines	1 selected wind turbine	Once before and after piling
	Underwater noise	Underwater noise 20 Hz-20kHz. Spectrogram, 1-Hz band, 1/3 Octave band analysis	4 locations 750m from turbine piling location	Once during piling of each turbine
			2 stn. within Project Site	4 quarter/year, 30 days per survey. (note)

Note

(1). Monitoring for construction noise will be conducted during construction for the onshore substation and onshore cable.

(2). Onshore monitoring items (air quality, noise and vibration, onshore ecology) will be conducted during the onshore construction phase.

(3). Offshore monitoring items (marine water quality, offshore bird, marine ecology, underwater noise) will be conducted during the offshore construction phase.

Table 4.2-4 Environmental Monitoring Plan during the Construction Phase after the Amendment

Category		Items	Sites	Frequency
Onshore	Air quality	Monitoring items: Wind direction, wind speed, particulate matter (TSP, PM_{10}, $PM_{2.5}$), SO_2, nitrogen oxides (NO, NO_2), and **<u>O_3</u>**.	1. Wuqi Fishing Harbor 2.One station near onshore substation	Once every quarter
	Noise vibration	L_{eq} and day-night average vibration level in each time period (day, evening, night)	1. One station at sensitive area near onshore construction 2. One station at the entrance / exit of onshore construction site	Once for 24 continuous hours per quarter
	Terrestrial ecology	Ecology of terrestrial animal and plantation (According to EPA's technical regulation on animal/plant survey)	Onshore transmission cable system (including booster station, onshore cable and vicinity)	Once every quarter
	Construction noise	1. Low frequency (measure L_{eq} at 20Hz-200Hz) 2. Normal frequency (measure L_{eq} and L_{max} at 20Hz-20kHz)	1. One station near the onshore substation 2. One station near the onshore cable	Once every month
	Cultural heritage	Onshore archeological monitoring	Excavation area	Monitored by professional archeologists during excavation
Offshore	Marine water quality	Water temperature, pH value, BOD, Salinity, Dissolved Oxygen, Ammonia-N, Nutrients, Suspended Solid, Chlorophyll a, Coliform group	12 stns near the wind farm	Once every quarter
		Suspended Solid	Choose 1 OSS and 3 WTG (1 WTG each row) and conduct monitoring 500m upstream and downstream	Once during construction of scour protection
	Bird ecology	Species, number, habiting and flying activity, flying routes, seasonal flock change etc. (including coastal birds and shore birds)	Vicinity of wind farm and coastal area near the landfall	Once per month from March to November and once between December and February. 10 survey trips annually.
	Marine ecology	1. Intertidal ecology	Within 50m of both sides of cable landfall	Once every quarter
		2. Plankton, Fish Egg and Larvae, Benthic Organisms	12 spots near wind turbines	
		3. Fish	3 survey lines	Once every quarter
		4. Cetacean **<u>(incl. marine reptile monitoring)</u>**	Wind Farm Area	20 trips each year (at least 1 trip each quarter)
		5. Underwater filming to observe fish gathering effect at bottom of turbines	2 selected wind turbine **<u>and 1 OSS</u>**	Once before and after piling
	Underwater noise	Underwater noise 20 Hz-20kHz. Spectrogram, 1-Hz band, 1/3 Octave band analysis	4 locations 750m from piling	Once during piling of each turbine
			2 stn. within Wind Farm Area	4 quarter/year, 30 days per survey. **<u>(note2)</u>**

Table 4.2-4 Environmental Monitoring Plan during the Construction Phase after the Amendment (Cont.)

Note 1 : (1). Monitoring for construction noise will be conducted during construction for the onshore substation and onshore cable. (2). Onshore monitoring items (air quality, noise and vibration, onshore ecology) will be conducted during the onshore construction phase. (3). Offshore monitoring items (marine water quality, offshore bird, marine ecology, underwater noise) will be conducted during the offshore construction phase. Note 2 : (1) For this project, ideally the underwater acoustic survey team will deploy underwater measurement devices at the beginning of each quarter. If sea state allows, devices will be retrieved as soon as possible after 30 days of continuous monitoring. (2) If the underwater measurement devices are found to be lost during retrieval, a proof of survey execution have to be provided for clarification. (3) If sea state allows, a supplemental underwater noise survey will be conducted as soon as possible, to ensure that the data can be retrieved. Following deployment, once the survey instrument has measured a period of 24 hours, the instrument will be retrieved from each deployed location. (4) To ensure the safety of monitoring personnel and vessel, if sea state suddenly worsens, the vessel will return back to the harbor on standby. (5) If the contingency measure is conducted, the activity will be documented and explained. Note 3:During the offshore monitoring phase, the Central Weather Bureau sea state system or common international weather forecast systems (incl. Windguru, Windy, ECMWF) will be used as reference, in consideration of safety for vessel and personnel. In principle, surveys will only be conducted during periods of wave height ≦1m for 24 continuous hours. If the time required for conducting the required amount of surveys in the given month or quarter is not available, the remaining surveys for the that month or quarter will be suspended.

Table 4.2-5 Environmental Monitoring Plan during the Operation Phase before the Amendment

Category	Items	Sites	Frequency
Bird ecology	Species, number, habiting and flying activity, flying routes, seasonal flock change etc. (including coastal birds and shore birds)	Vicinity of wind farm and coastal area near the landfall	Once a month between March-November, once between December – February (of following year), 10 times each year (For offshore bird surveys in winter, survey will be vessel-based or supplemented with equipment such as video recording device)
	Joint monitoring system for birds (install thermography, sonic microphone, and high efficiency radar, or "high-tech" monitoring systems of the time)	1 WTG location	Continuous monitoring
	Bird footage (Install filming equipment)	2 locations within Project Site	Continuous monitoring
Marine ecology	1. Plankton 2. Fish Egg and Larvae 3. Benthic Organisms	12 stations near wind turbines	Once every quarter
	4. Fish (incl. species distribution and abundance near WTG)	3 survey lines	Once every quarter
	5. Cetacean	Project Site	20 trips each year
	6. Underwater filming to observe fish gathering effect at bottom of turbines	2 selected wind turbines	Once every quarter during operation phase, for at least 6 years
Underwater noise	Underwater noise 20 Hz-20kHz. Spectrogram, 1-Hz band, 1/3 Octave band analysis	2 stn. within Project Site	4 quarter/year, 30 days per survey (note)
Fishery economy	Compile data relevant to fishery economy within the annual fishery report announced by the FA (Fishery environment, facility, productivity, and population)	Annual fishery report announced by the FA (Changhua County)	Once every year

Note :
Before terminating the monitoring during the operation phase, application need to be carried out in accordance with Article 37 of the Environmental Impact Assessment Act Enforcement Rules.

Table 4.2-6 Environmental Monitoring Plan during the Operation Phase after the Amendment

Category	Items	Sites	Frequency
Bird ecology	Species, number, habiting and flying activity, flying routes, seasonal flock change etc. (including coastal birds and shore birds)	Vicinity of wind farm and coastal area near the landfall	Once a month between March-November, once between December- February (of the following year), 10 times each year (For offshore bird surveys in winter, survey will be vessel-based or supplemented with equipment such as video recording device)
	Joint monitoring system for birds (install thermography, sonic microphone, and high efficiency radar, or better monitoring systems of the time)	1 WTG location	Continuous monitoring
	Bird footage (Install filming equipment)	2 locations within Project Site	Continuous monitoring
Marine ecology	1. Plankton 2. Fish Egg and Larvae 3. Benthic Organisms	12 stations near wind turbines	Once every quarter
	4. Fish (incl. species distribution and abundance near WTG)	3 survey lines	Once every quarter
	5. Cetacean <u>**(incl. marine reptile monitoring)**</u>	Project Site	20 trips each year
	6. Underwater filming to observe fish gathering effect at bottom of turbines	2 selected wind turbine	Once every quarter during operation phase, for at least 6 years
Underwater noise	Underwater noise 20 Hz-20kHz. Spectrogram, 1-Hz band, 1/3 Octave band analysis	2 stn. within Project Site	4 quarter/year, 30 days per survey <u>**(note2)**</u>
Fishery economy	Compile data relevant to fishery economy within the annual fishery report announced by the FA (Fishery environment, facility, productivity, and population)	Annual fishery report announced by the FA (Changhua County)	Once every year

Note 1 :Before terminating the monitoring during the operation phase, application need to be carried out in accordance with Article 37 of the Environmental Impact Assessment Act Enforcement Rules.

Note 2 :

<u>(1) For this project, ideally the underwater acoustic survey team will deploy underwater measurement devices at the beginning of each quarter. If sea state allows, devices will be retrieved as soon as possible after 30 days of continuous monitoring.</u>

<u>(2) If the underwater measurement devices are found to be lost during retrieval, a proof of survey execution have to be provided for clarification.</u>

<u>(3) If sea state allows, a supplemental underwater noise survey will be conducted as soon as possible, to ensure that the data can be retrieved. Following deployment, once the survey instrument has measured a period of 24 hours, the instrument will be retrieved from each deployed location.</u>

<u>(4) To ensure the safety of monitoring personnel and vessel, if sea state suddenly worsens, the vessel will return back to the harbor on standby.</u>

<u>(5) If the contingency measure is conducted, the activity will be documented and explained.</u>

<u>Note 3: During the offshore monitoring phase, the Central Weather Bureau sea state system or common international weather forecast systems (incl. Windguru, Windy, ECMWF) will be used as reference, in consideration of safety for vessel and personnel. In principle, surveys will only be conducted during periods of wave height ≦1m for 24 continuous hours. If the time required for conducting the required amount of surveys in the given month or quarter is not available, the remaining surveys for the that month or quarter will be suspended.</u>

4.3 Explanation of Differences for Development Activities Amendments

The explanations on this amendment and previous amendments are indicated as Table 4.3-1.

Table 4.3-1 Explanation of Differences for Development Activities Amendments

Items		Original Content	This Amendment	Explanation
Name of developer		Greater Changhua Northwest Offshore Wind Power Co., Ltd. Preparatory Office	Greater Changhua Northwest Offshore Wind Power Co., Ltd.	The company is officially established.
Office address		14F-1, No. 36, Songren Rd., Xinyi Dist., Taipei City	**11F-2, No. 37, Huashan Rd., Changhua City**	
Design Envelope for Wind Turbine (Largest Wind Turbines)	Single turbine capacity	8-11MW	8 ~ **16**MW	Max turbine capacity is increased from 11MW to 16MW, and design parameters for the largest turbines are provided accordingly.
	Maximum number of wind turbines	54~74	**37** ~ 74	
	Maximum rotor diameter	195-210 m	195~**250** m	
	Maximum total height/ (blade) upper tip height	250~265 m (LAT)	250 ~ **305** m (LAT)	
	Maximum hub height	153~160 m (LAT)	153 ~ **180** m (LAT)	
	Maximum revolutions per minute	8.0 -11(RPM)	**8.1** ~ 11 (RPM)	
	Minimum spacing between turbines W-E	519~714 m	519 ~ **850** m	
Design Envelope for Pin-Pile Foundations	Maximum distance between leg	40 m	**55** m	Max values for foundation designs are proposed in response to adjustments to max single turbine capacity.
	Maximum outer diameter of pin-pile	4.0 m	**8.0** m	
	Maximum penetration depth of pin-pile	85 m	**120** m	
	Maximum weight of jacket	1200 t	**3000** t	
	Maximum pile weight	160 t	**800** t	
	Maximum footprint of scour protection on seabed for each turbine	800 m^2	**6,600** m^2	

Table 4.3-1 Explanation of Differences for Development Activities Amendments (Cont.)

Items		Original EIS	This Amendment	Explanation
Design Envelope for Suction Bucket Jacket (SBJ) Foundation	Maximum outer diameter of suction bucket	-	**<u>25 m</u>**	Addition to the foundation type proposed for the Project and provide maximum design parameters
	Maximum penetration depth	-	**<u>25 m</u>**	
	Maximum weight of jacket	-	**<u>3000 t</u>**	
	Maximum footprint of scour protection	-	**<u>8,000 m^2</u>**	
Offshore Substation Design	Max. seabed footprint	40 m x 40 m	**<u>50 m x 50 m</u>**	
	Max. size of the topside (LxWxH)	50 m x 40 m x 30 m (including parking apron but not the crane and antenna)	**<u>60 m x 50 m x 40 m</u>** (including parking apron but not the crane and antenna)	In consideration of the current proposed Project approach and adjust design parameters, the maximum footprint of scour protection is added
	Max weight for topside	-	**<u>4,000 t</u>**	
	Number of pile (jacket)	12 piles in total (4-legged jackets, with 3 piles on each leg). Maximum pile diameter is 3.5m, pile length is subject to the soil condition at the OSS location.	Maximum of 12 piles (4-legged jackets, with 3 piles on each leg). Maximum pile diameter is **<u>4.0</u>**m, pile length is subject to the soil condition at the OSS location.	
	Penetration depth	85 m	**<u>120 m</u>**	
	Area of scour protection on seabed for each turbine (max value)	-	**<u>8,000 m^2</u>**	
Offshore Transmission Cables	Voltage	220kV	**220kV or 275kV**	The plan for offshore transmission cables is adjusted due to the amendment on the maximum single turbine capacity

Table 4.3-1 Explanation of Differences for Development Activities Amendments (Cont.)

Items		Original EIS	This Amendment	Explanation
Cable Landfall / Transition Joint Bay	Seawall Crossing Approach	Transition joint bay (TJB) is required at each landfall location closest to the connection between the marine cable and the onshore cable via Horizontal Directional Drilling (HDD). The indicative figure of HDD method is provided in Figure 4.1.6-1.	Transition joint bay (TJB) is required at each landfall location closest to the connection between the marine cable and the onshore cable via **trenchless approach**, such as Horizontal Directional Drilling (HDD) **or microtunneling.** The indicative figure of trenchless approach is provided in Figure 4.1.6-1.	The construction method will only be settled after being approved upon the review of the competent authorities. To grant more flexibility to the Project, a new option is proposed in this amendment
Onshore Transmission System	Onshore substation	Three candidate sites were chosen for the onshore substation in the Lungwei area of the Changhua Coastal Industrial Park. One of the sites will be selected as the proposed location for the substation. Onshore substation (including the control room, gas insulated switchgear (GIS) and relevant electromechanical facilities) is estimated to take up 23,800 m^2 of space.	**The onshore substation will be shared between this Project and CHW22. One site in the Lungwei area of the Changhua Coastal Industrial Park will be selected for the onshore substation. Onshore cables will connect the onshore substation to the ChungKong grid connection point.** **Onshore substation (including the control room, gas insulated switchgear (GIS) and relevant electromechanical equipment) is estimated to require an area of 29,300 m^2.**	The schedule for grid connection of CHW04 and CHW02 are identical. Therefore, considering the uniformity of grid connection operations and to reduce unnecessary construction work, the onshore substation will be shared by CHW04 and CHW22. In addition, the space required for the onshore substation is also adjusted accordingly.

Table 4.3-1 Explanation of Differences for Development Activities Amendments(Cont.)

Items		Original EIS	This Amendment	Explanation
Onshore Transmission System	Onshore cable	Voltage of the onshore cable from the transition joint bay to the onshore substation will be 220kV. The length of this portion of the onshore cable is estimated to be within 3.7km. The voltage of the onshore cable from the onshore substation to the ChungKong grid connection, will be 161kV. The length of this portion of the onshore cable is anticipated to be within 4.35km.	**The onshore cable is anticipated to share the cable trench with CHW22.** Voltage of the onshore cable from the transition joint bay to the onshore substation will either be 220kV or **275kV**. The length of this portion of the onshore cable is estimated to be no more than **1.5km**. The voltage of the onshore cable from the onshore substation to the ChungKong grid connection point will either be 161kV or **345kV**. The length of this portion of the cable is estimated to be no more than 1.4km. **The proposed onshore cable will use the existing onshore cable trench from CHW02 where they overlap. The only items that requires additional excavation are part of transition joint bay, connection point of onshore cable and cable trench for around 700m.**	The schedule for grid connection of this Project and CHW02 are identical. Therefore, considering the uniformity of grid connection operations and to reduce unnecessary construction work, the onshore cable route will be shared. At the same time, the onshore cable will use the existing cable route from CHW02 where they overlap in order to reduce excavation. Furthermore, to accommodate the plans for the voltage of export cables and ChungKong grid connection, options for onshore cable voltage are adjusted.
Maximum Surplus Earthwork		- Maximum Surplus Earthwork 195,100 m^3 (compressed) Maximum Surplus Earthwork 234,120 m^3 (loose).	Maximum Surplus Earthwork **95,220m^3** (compressed) Maximum Surplus Earthwork **115,000m^3** (loose).	The onshore construction is built jointly with CHW22, so the volume of soil from earthwork is re-examined. The volume will be stated in the EIS for CHW22 and CHW04.

Table 4.3-1 Explanation of Differences for Development Activities Amendments(Cont.)

Items		Original EIS	This Amendment	Explanation
Environmental protection measures	Construction Phase Offshore Environmental Protection Measure - Cetacean	Pin-pile jackets will be selected for as the foundation for the wind turbines used for this Project, as they are expected to produce less noise.	Pin-pile or **<u>Suction Bucket Jacket</u>** will be selected for as the foundation for the wind turbines used for this Project, as they are expected to produce less noise.	Furthermore, this amendment plans to add a type for the foundation structure, Suction Bucket Jackets (SBJ), as an option of this Project
		The best commercially available noise control method at the time of development will be applied during pile driving to all of the wind turbine locations, to ensure the noise levels at the 750m warning zone is below SEL 160dB. Details of the noise mitigation measures to be used will be determined before the pile driving campaign commences, including consideration of the latest noise reduction technology available at that time, such as bubble curtain or balloon curtains.	The best commercially available noise control method at the time of development will be applied during pile driving to all of the wind turbine locations, to ensure the noise levels at the 750m warning zone is below SEL 160dB. Details of the noise mitigation measures to be used will be determined before the pile driving campaign commences, including consideration of the latest noise reduction technology available at that time, such as bubble curtain or balloon curtains. **<u>Additionally, the sound exposure level (SEL) of 25% of all foundations to be installed at 750m distance to the center of jacket shall be lower than 159dB.</u>**	In order to further reduce the impact of the underwater noise generated by the foundation installation on the cetaceans, the original protection measures were adjusted, and the sound exposure value of a certain proportion of the foundation quantity was increased and the sound exposure value did not exceed 159dB.
		-	**157 dB SEL of single piling event, measured as 30 second average, is set as early warning level during the pile installation. <u>As the noise monitoring shows that the early warning level is exceeded, proper responses (e.g. lower the hammer energy(kJ), decrease the frequency of piling) alongside enhanced mitigation measures such as increase the air supply of bubble curtain, if necessary, will be taken to make sure the noise level is lower than the limit described in EIA commitment</u>**	Underwater noise is monitored in real time, and alert values and contingency measures are set to ensure that underwater noise can be controlled within the EIA commitment control value during piling.

Table 4.3-1 Explanation of Differences for Development Activities Amendments(Cont.)

Items		Original EIS	This Amendment	Explanations
Environmental protection measures	Construction Phase Offshore Environmental Protection Measure - Cetacean	The project commits that the underwater noise exposure value (Sound Exposure Level, SEL) shall not exceed 160 decibels [(dB) re. $1\mu Pa^2s$] as the impact assessment threshold.	**95% of the underwater noise measurement data (SEL_{05})** shall not exceed 160dB and **SPLpeak shall not exceed 190dB** at 750m to the **center of jacket** where the underwater noise monitoring is carried out.	In order to further reduce the impact of the underwater noise generated by the foundation installation on cetaceans, the description of the adjustment of the original underwater noise commitment control value.
	Construction Phase Offshore Environmental Protection Measure - Marine Water Quality	-	**Installation of scour protection will be carried out by fall-pipe vessel to alleviate the influence on marine water quality during construction.**	To mitigate the impact on water quality resulted from scour installation, a state-of-the-art fall pipe vessel will be chosen.
		-	**For turbines using SBJ, one turbine location will be selected from each row (east-west direction) where its underwater environment around the foundation will be observed by using a Remotely Operated Vehicle (ROV), which is capable of transmitting images to the installation vessel in real-time, during the installation of SBJ. This is meant to understand if there is disturbance to the seabed during SBJ installation and thus affect water quality in the surrounding area.**	In order to monitor the water quality changes in the sea area during the construction period
	Construction Phase Offshore and Onshore Environmental Protection Measure -Air Quality	During the construction phase, a total of 100m roadway to the front and rear of the construction site will be swept and cleaned to mitigate dust fall from the passage of construction and transportation vehicles (except for days of precipitation).	During the construction phase, a total of **1km** roadway to the front and rear of the construction site will be swept and cleaned to mitigate dust fall from the passage of construction and transportation vehicles (except for days of precipitation).	This plan will increase the length of street cleaning during the construction period in order to complete the offset of the particulate matter discharge during the construction period.
		All marine spread will use fuel with the minimum sulfur content available in Taiwan at the time.	All marine spread will use fuel with the minimum sulfur content **(<0.5%)** available in Taiwan at the time.	Clearly defined minimum Sulphur values.

Table 4.3-1 Explanation of Differences for Development Activities Amendments(Cont.)

Items		Original EIS	This Amendment	Explanations
Environmental protection measures	Construction Phase Offshore and Onshore Environmental Protection Measure - Air Quality	—	**During construction, onshore construction equipment and vehicles will comply with Class 4 environmental standards (or above), and possess Grade A Self Management Label. The aforementioned requirements will be integrated into the contracts for the construction subcontractors.**	In order to effectively reduce the emission of air pollutants from construction equipment and vehicles during construction.
Environmental protection measures	Operation Phase Offshore Environmental Protection Measure – Ecology	—	**During underwater filming, the presence of marine reptiles will also be monitored.**	Added countermeasures for observing marine reptiles to confirm whether there are marine reptiles within the wind area.
Environmental protection measures	Operation Phase Environmental Impact Mitigation Measure- Waste	—	**This Project has committed not to bury turbine blades during the decommissioning. In the future, the Project will participate blade recycling-related initiatives to monitor all possible recycling methods and adopt them where possible to improve the sustainability of wind turbines. These initiatives include finding common solutions through cooperating with other companies and organizations, or participating in research and innovation projects focused on recycling blade materials.** **If a suitable solution is not found during the decommissioning, the Project has also committed to legitimately store blades temporarily rather than landfill. This commitment is incorporated as part of the mitigation measures that will be provided, at least 1 year before official decommissioning, to the competent authority for approval.**	Commitment to properly dispose of decommissioned turbine blades.

Table 4.3-1 Explanation of Differences for Development Activities Amendments(Cont.)

Items		Original EIS	This Amendment	Explanations
Environmental Monitoring Plan	Air Quality during the pre-construction phase	—	1. **Monitoring items: Wind direction, wind speed, particulate matter (TSP, PM_{10}, $PM_{2.5}$), SO_2, nitrogen oxides (NO_X, NO, NO_2), and O_3.** 2. **Monitoring sites: 1. Wuqi Fishing Harbor 2. One station near onshore substation** 3. **Monitoring frequency: 1 survey before the construction phase**	To clarify the baseline data for the air quality in the construction site
	Air Quality during the construction	Monitoring items: Wind direction, wind speed, particulate matter (TSP, PM_{10}, $PM_{2.5}$), SO_2, and nitrogen oxides (NO, NO_2).	Monitoring items: Wind direction, wind speed, particulate matter (TSP, PM_{10}, $PM_{2.5}$), SO_2, nitrogen oxides (NO_X, NO, NO_2), and **O_3.**	O_3 has become an important indicator pollutant of poor air quality and is included in monitoring.
	Marine Ecology during the Construction Phase	Carried out underwater filming to monitor the fish gather effect at 1 turbine location	Carried out underwater filming using an ROV to monitor the fish gather effect at 1 turbine location and **one OSS location.**	To observe the fish gathering effect at the foundation of OSS
	UNM (including PAM) for Pre-construction, construction and operation phases	—	Notes added: **(1) For this project, the underwater acoustic survey team will deploy underwater measurement devices at the beginning of each quarter. If sea state allows, devices will be retrieved as soon as possible after 30 days of continuous monitoring.** **(2) If the underwater measurement devices are found to be lost during retrieval, a proof of survey execution have to be provided for clarification.** **(3) If sea state allows, a supplemental underwater noise survey will be conducted as soon as possible, to ensure that the data can be retrieved. Following deployment, once the survey instrument has measured a period of 24 hours, the instrument will be retrieved from each deployed location.** **(4) To ensure the safety of monitoring personnel and vessel, if sea state suddenly worsens, the vessel will return back to the harbor on standby.** **(5) If the contingency measure is conducted, the activity will be documented and explained.**	To effectively manage the long-term monitoring data, “Response measures regarding loss of PAM device and data during the retrieval” is added as notes for the UNM in pre-construction, construction and operation phase

Table 4.3-1 Explanation of Differences for Development Activities Amendments(Cont.)

Items		Original EIS	This Amendment	Explanations
Environmental Monitoring Plan	Marine ecology for Pre-construction, construction and operation phases	Cetacean	Cetacean **(incl. marine reptile observation)**	In order to observe whether marine reptiles appear in the Project area, "monitoring on marine reptile" is added to the environmental monitoring plan for cetaceans during the construction and operation phases.
	Response measures for poor sea state that continue for extended periods of time during the offshore environmental monitoring plan	—	**During the offshore monitoring phase, the CWB sea state system or common international weather forecast systems (incl. Windguru, Windy, ECMWF) will be used as reference, in consideration of safety for vessel and personnel. In principle, surveys will only be conducted during periods of wave height ≦1m for 24 continuous hours. If the time required for conducting the required amount of surveys in the given month or quarter is not available, the remaining surveys for the that month or quarter will be suspended.**	Response measures considering the safety of survey vessel and personnel during offshore survey period are added.

Chapter 5 Amendment Does Not Engage with Items in Paragraph 1, Article 38

This amendment does not engage with Article 38 of the Environmental Impact Assessment Enforcement Rules. Further explanation is provided as Table 5- 1:

Table 5-1 Review of Article 38 in Environmental Impact Assessment Enforcement Rules in Respect of this Project

Article 38 of the Enforcement Rules	Detailed Explanation
1. Productivity, scale or route extends more than 10% variation	In this amendment, maximum single turbine capacity is adjusted, new turbine foundation option is added, cable landing approach, onshore transmission system and offshore substation design details are adjusted. Therefore, conditions stated here (Productivity, scale or route extends more than 10%) will not occur.
2. Variation on land use is engaged in protecting zone in the original project, buffer zone, or areas that will be severely changed or damaged due to the development.	In this amendment, maximum single turbine capacity is adjusted, new turbine foundation option is added, cable landing approach and onshore transmission system are adjusted. Area of the wind farm is not adjusted, and the wind farm is still within the No.14 potential site in "Application Operation Guideline for Site Selection of Offshore Wind Farms." No amendment to land use has occurred.
3. Reducing processing levels or efficiency of the environmental protection measures.	In this amendment, maximum single turbine capacity is adjusted, new turbine foundation option is added, cable landing approach and onshore transmission system are adjusted. Processing levels or efficiency of the environmental protection measures are not reduced.
4.Variation of the plan may increase the impact on living, nature, social environment or protected subjects.	In this amendment, maximum single turbine capacity is adjusted, new turbine foundation option is added, cable landing approach, and onshore transmission system are adjusted. Therefore, this amendment will not bring greater impact on living, nature, social environment or protected subjects in the affected area.
5.Placing unfavorable influence on the quality of the environment.	In this amendment, maximum single turbine capacity is adjusted, new turbine foundation option is added, cable landing approach, and onshore transmission system are adjusted. Therefore, no further unfavorable impacts will be brought to the quality of the environment.
6. Other events identified by the competent authority	This Project is associated with the development of wind power, and the turbines are operated by natural wind power. In this amendment, maximum single turbine capacity is adjusted, new turbine foundation option is added, cable landfall approach & onshore transmission system are adjusted. There is no unfavorable event identified by the competent authority.

Chapter 6 Environmental Differential Analysis after Amendment on Development or Environmental Mitigation Measure

The amendment includes design of bigger turbines, design of turbine foundations, the arrangement of the submarine cable route, and onshore transmission system. The environmental factors that may be affected by the amendment, including air quality, noise and vibration, underwater noise simulation, electromagnetic field, turbine foundation scouring and change of coastal terrain, hydrology and water quality, marine ecology and bird collision, are investigated in this assessment.

The analysis of the differences in the environmental factors before and after the amendment are listed in Table 6-1. For noise and vibration, underwater noise, turbine foundation scouring and change of coastal terrain, hydrology and water quality, and marine ecology during construction stage, the impact is slightly different. For electromagnetic field, turbine foundation scouring, change of coastal terrain, marine ecology and bird collision during O&M stage, the impact is slightly different. No difference is spotted for the rest of the items before and after the amendment. Surveys and assessment results for each environmental factor are explained as follows.

Table 6-1 Analysis of Differences in Environmental Factors before/after Amendment

Affected Range / Environmental Factor	Periphery of Site	
	Construction	Construction
Air Quality	No difference	No difference
Noise & Vibration	**Slight difference**	No difference
Underwater Noise Simulation	**Slight difference**	No difference
Electromagnetic Field	No difference	**Slight difference**
Turbine Foundation Scouring and Change of Coastal Terrain	**Slight difference**	**Slight difference**
Hydrology and Water Quality	**Slight difference**	No difference
Marine Ecology	**Slight difference**	**Slight difference**
Bird Collision Assessment	No difference	**Slight difference**
Terrestrial Ecology	No difference	No difference
Structural Safety of Turbine	No difference	No difference

6.1 Air Quality

The plans for onshore transmission facilities are revised, and bigger turbines are proposed in this amendment, and this might impact air quality during onshore construction. Therefore, the following are explanations for the difference in impact before and after amendment. This is conducted according to environmental background surveys and differential analysis results in this amendment.

6.1.1 Current Environmental Conditions

I. Environmental Background Surveys

Environmental monitoring results for air quality in this Project is as shown in Table 6.1.1-1, and monitoring locations are as shown in Figure 6.1.1-1. 8 surveys for air quality have been conducted between June 2019 and March 2021, the monitoring results are as shown in Table 6.1.1-1, and monitoring results are all in compliance with Air Quality Standards.

II. Supplemental Survey Results for this Amendment

For this Project, air quality surveys were conducted around the onshore construction site according to regulations in "Operational Regulations for Environmental Impact Assessments for Development Activities". 2 supplemental surveys for background air quality were conducted between July 31st-August 1st, 2020, and between November 9th – 10th, 2020, respectively. 1 survey spot is located in the Lukang Industrial Park and monitoring locations are as shown in Figure 6.1.1-1. Monitoring results are as shown in Table 6.1.1-2, and results from each air quality item complies with Air Quality Standards, which indicates that the air quality conditions near the site is good.

Figure 6.1.1-1 Supplemental Survey Locations for Air Quality

Table 6.1.1-1 Air Quality Monitoring Result

Survey Items \ Monitoring Station / Survey Dates (Month/Day)		Lunwei Industrial Park								Air Quality Standards
		2019/ 6/26-27	2019/ 9/18-19	2019/ 12/10-11	2020/ 3/12-13	2020/ 6/16-17	2020/ 9/17-18	2020/ 12/22-23	2021/ 3/23-24	
SO_2 (ppm)	Hour Average Value	0.001	0.001	0.001	0.007	0.001	0.002	0.001	0.001	0.075
	Day Average Value	0.001	0.001	0.001	0.002	0.001	0.001	0.001	0.001	–
NOx(ppm)	Hour Average Value	0.019	0.013	0.033	0.023	0.016	0.056	0.022	0.042	–
	Day Average Value	0.011	0.009	0.013	0.012	0.010	0.023	0.008	0.017	–
NO_2 (ppm)	Hour Average Value	0.011	0.011	0.030	0.019	0.012	0.033	0.017	0.031	0.1
	Day Average Value	0.008	0.007	0.011	0.009	0.006	0.016	0.006	0.013	–
NO (ppm)	Hour Average Value	0.010	0.003	0.005	0.008	0.008	0.023	0.009	0.016	–
	Day Average Value	0.003	0.002	0.002	0.005	0.003	0.008	0.002	0.009	–
TSP($\mu g/m^3$)	Value of 24 Hours	44	137	93	108	70	90	64	77	–
PM_{10}($\mu g/m^3$)	Day Average Value	22	76	48	61	33	44	33	31	100
$PM_{2.5}$($\mu g/m^3$)	Value of 24 Hours	8	27	32	25	12	20	14	14	35
Wind Speed (m/s)	Day Average Value	2.4	7.7	2.7	1.6	2.9	1.6	2.0	1.0	–
Wind Direction (Deg)	Most Frequent	ESE	EN	E	S	WS	ES	EN	ES	–
Temperature (°C)	Day Average Value	28.3	27.3	19.5	20.6	29.7	30.4	20.5	18.0	–
Relative Humidity (%)	Day Average Value	82	65	80	80	73	72	81	89	–

Source: Greater Changhua Southwest Wind Power Project- Environmental Monitoring Plan
Air quality standards are from "Air Quality Standards" announced in September 18th, 2020 (EPA # 1010038913).

Table 6.1.1-1 Air Quality Monitoring Results (Cont.)

Survey Items \ Monitoring Station / Survey Dates (Month/Day)		Wuqi Fishing Port								Air Quality Standards
		2019/ 6/27-28	2019/ 9/19-20	2019/ 12/11-12	2020/ 3/13-14	2020/ 6/17-18	2020/ 9/25-26	2020/ 12/23-24	2021/ 3/24-25	
SO_2 (ppm)	Hour Average Value	0.002	0.001	0.001	0.001	0.001	0.002	0.001	0.001	0.075
	Day Average Value	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	—
NOx(ppm)	Hour Average Value	0.076	0.011	0.016	0.011	0.029	0.027	0.013	0.036	—
	Day Average Value	0.022	0.005	0.008	0.007	0.015	0.010	0.006	0.011	—
NO_2 (ppm)	Hour Average Value	0.071	0.009	0.006	0.008	0.022	0.015	0.010	0.024	0.1
	Day Average Value	0.017	0.003	0.002	0.005	0.009	0.008	0.005	0.008	—
NO (ppm)	Hour Average Value	0.011	0.005	0.006	0.004	0.011	0.011	0.004	0.011	—
	Day Average Value	0.005	0.002	0.002	0.002	0.006	0.003	0.001	0.004	—
TSP($\mu g/m^3$)	Value of 24 Hours	53	97	65	59	56	50	50	55	—
PM_{10}($\mu g/m^3$)	Day Average Value	29	48	37	33	30	28	26	29	100
$PM_{2.5}$($\mu g/m^3$)	Value of 24 Hours	15	19	21	12	6	10	9	15	35
Wind Speed (m/s)	Day Average Value	2.3	3.9	2.6	2.7	1.8	2.3	1.3	2.4	—
Wind Direction (Deg)	Most Frequent	SE	E	ENE	WSS	WNW	ENE	ESE	ENE	—
Temperature (℃)	Day Average Value	28.5	25.5	19.2	19.6	29.8	26.7	18.9	18.0	—
Relative Humidity (%)	Day Average Value	77	74	67	79	76	69	84	68	—

Source: Greater Changhua Southwest Wind Power Project- Environmental Monitoring Plan
Air quality standards are from “Air Quality Standards” announced in September 18th, 2020 (EPA # 1010038913).

Table 6.1.1-2 Supplemental Survey Results for Background Air Quality

Survey Items \ Monitoring Station / Survey Dates (Month/Day)		Lukang Industrial Park		Air Quality Standards
		2020/7/31-8/1	2020/11/9-10	
SO_2 (ppm)	Hour Average Value	0.002	0.002	0.075
	Day Average Value	<0.0007	0.001	—
NOx (ppm)	Hour Average Value	0.012	0.018	—
	Day Average Value	0.005	0.009	—
NO_2 (ppm)	Hour Average Value	0.010	0.017	0.1
	Day Average Value	0.004	0.008	—
NO (ppm)	Hour Average Value	0.004	0.002	—
	Day Average Value	0.002	0.001	—
CO (ppm)	Hour Average Value	0.7	0.2	35
	Average Max Value Every 8 Hours	0.2	0.2	9
O_3 (ppm)	Hour Average Value	0.117	0.046	0.12
	Average Max Value Every 8 Hours	0.065	0.041	0.06
TSP (μg/m^3)	Value of 24 Hours	99	71	—
PM_{10} (μg/m^3)	Day Average Value	56	34	100
$PM_{2.5}$ (μg/m^3)	Value of 24 Hours	17	14	35
Wind Speed (m/s)	Day Average Value	1.3	4.2	—
Wind Direction (Deg)	Most Frequent	292.5	67.5	—
Temperature (°C)	Day Average Value	30.8	21.5	—
Relative Humidity (%)	Day Average Value	71	69	—
Fallout Amount (g/m^2/month)	Monthly Value	14.8	11.0	—
Lead (μg/m^3)	Value of 24 Hours	N.D.	N.D.	0.15 (Moving Average Value Every 3 Months)

Source: Monitoring work for this survey is commissioned to Envimac Technology and Consultants Co., Ltd. (EPA #012A).
Air quality standards are from "Air Quality Standards" announced in September 18th, 2020 (EPA # 1010038913).

6.1.2 Differential Analysis for the Amendment

I. Onshore Construction

For the Project, a site has been chosen for the onshore substation located in the Lungwei Area, Changhua Coastal Industrial Park. In this amendment, the onshore cable will mainly use the existing onshore cable trench from CHW02 in order to connect to the onshore substation and ChungKong grid connection point. Therefore, the main impact of the onshore construction on the environmentally sensitive receptors originates from new construction for the onshore substation in CHW22 and construction for a small portion of the onshore cable. There will be relatively less construction activities compared to the original EIS.

II. Air Pollutant Emissions in the Construction Area- Construction for the Onshore Substation inCHW22

i Fugitive Dust in Bare Land at the Construction Site

(a) Emission Factor for Particulate Matter

According to Table B2 “Source of Pollution in Taiwan in 2019 (Base Year)- Emission Factor for Source of Fugitive Particulate Matter” in the most recently announced “Emission Factor from Area Source TEDS ver.11.0” promulgated by the EPA, the referenced total emission factor for total suspended particles generated by the construction in the development (industrial) area is 0.944 MT/HA/month (3.64×10^{-5} g/m^2/s).

Similarly, after watering is conducted for the bare land, areal source of particulate pollutant can be reduced by 50 %, to 1.82×10^{-5} g/m^2/s.

(b) Bare Lands in the Construction Area

The construction area for the onshore substation is around 29,300 m^2. The base land assessment covers the whole construction area.

ii Air Pollutant Emissions by Construction Machinery

The exhaust emission factor for construction machinery that may be used during the construction is referenced from AP-42 data by the EPA of the U.S. In addition, starting from July 1st, 2020, the max standard for sulfur content of gasoline is 10 ppm(mg/kg), according to the “Amendment to the Standards for the Composition of Mobile Pollution Source Fuels” (EPA#1090019185) announced by the EPA on March 20th, 2020. Therefore, the emission factor for SO_2 is revised, and compiled in Table 6.1.2-1. Furthermore, content from “Taiwan Emission Data System (TEDS)” is referenced as construction machinery mainly uses diesel fuel. The main exhaust emission from construction machinery is TSP which is mainly PM_{10}. As such, PM_{10} is 100% of TSP, while $PM_{2.5}$ is 92% of TSP. The emission factor for each pollutant is compiled in Table 6.1.2-2. The estimates for the emission factor of pollutants during each construction item is as explained below:

Construction items for the onshore substation include land leveling, architectural engineering, and electrical and mechanical engineering. Relatively more construction machinery will be used during land leveling, thus, emission of air pollutants will also be more prevalent. As such, a conservative assessment for the impact on air quality for land leveling during construction is conducted. Estimate of emission for air pollutants is as shown in Table 6.1.2-3.

able 6.1.2-1 Emission Factor of Air Pollutants for Construction Machinery using Diesel Fuel

Construction Machinery	Emission of Air Pollutant (g/hr/vehicle)				
	TSP	PM_{10}	$PM_{2.5}$	SOx	NOx
Excavator	184.0	184.0	169.3	4.77	1740.7
Bulldozer	75.0	75.0	69.0	3.59	575.8
Motor grader	22.7	22.7	20.9	0.69	392.9
Payloader	77.9	77.9	71.7	1.88	858.2
Dump truck	77.9	77.9	71.7	0.38	858.2
Sprinkler	77.9	77.9	71.7	0.38	858.2
Crane	50.7	50.7	46.6	1.42	570.7
Agitator Truck	61.5	61.5	56.6	0.19	575.8
Air compressor	63.2	63.2	58.1	1.47	767.3
Miscellaneous	63.2	63.2	58.1	1.47	767.3

Note: According to the “Amendment to the Standards for the Composition of Mobile Pollution Source Fuels” (EPA#1090019185) announced by the EPA on March 20th, 2020, standards for diesel fuel used by vehicles, including sulfur content (10ppmw), will be stricter starting from July 1st, 2020. As such, the estimated emission for this Project is revised, considering the emission factor from “U.S.EPA AP-42 Emission Factor” (1985) is based on 0.22% for sulfur content.

Table 6.1.2-2 Emission of Air Pollutants by Onshore Construction Machinery

Construction Machinery	Max No. Used Simultaneously	Emission Factor (g/h/vehicle)				
		TSP	PM_{10}	$PM_{2.5}$	SOx	NOx
Construction for Onshore Substation						
Bulldozer	2	75	75.0	69.0	3.59	575.8
Dump truck	7	77.9	77.9	71.7	0.38	859.2
Excavator	4	184	184.0	169.3	4.77	1740.7
Caterpillar Crane	2	50.7	50.7	46.6	1.42	570.7
Electric Tower Crane	1	50.7	50.7	46.6	1.42	570.7
Caterpillar Crane	3	61.5	61.5	56.6	0.19	575.8
Total Emission (g/s)		0.4911	0.4911	0.4518	0.0094	4.8802
Emission Rate of Area Source ($g/s/m^2$)		1.68×10^{-5}	1.68×10^{-5}	1.54×10^{-5}	3.20×10^{-7}	1.67×10^{-4}

Table 6.1.2-3 Total Emission of Air Pollutants in Onshore Construction

Construction Item		Emission ($g/m^2/s$)				
		TSP	PM_{10}	$PM_{2.5}$	SO_X	NO_X
Construction for Onshore Substation	Bare Land	1.82×10^{-4}	1.01×10^{-4}	2.02×10^{-5}	—	—
	Construction Machinery	1.68×10^{-5}	1.68×10^{-5}	1.54×10^{-5}	3.20×10^{-7}	1.67×10^{-4}
	Total	1.99×10^{-4}	1.18×10^{-4}	3.57×10^{-5}	3.20×10^{-7}	1.67×10^{-4}

III. Air pollution assessment in the construction area

The ISCST3 model recommended by the U.S. EPA was applied in this Project to evaluate the amount of air pollution from exposed construction sources and equipment. The meteorological data were from the ISC standard meteorological data downloaded from the EPA's model support center. The meteorological data were from the ground station in Wuqi station and the radiosonde station in Bangqiao Stations. The control parameters in the simulations are listed as Table 6.1.2-4:

Table 6.1.2-4 Control Parameters in Module ISCST3

Construction site	Onshore substation	Range (TWD97)	X (start)	180000	X (end)	200000
			Y(start)	2661000	Y (end)	2676000
		Allocation of the endurance points	Grid coordinate: 41× 31			
			Polar grid: 500× 500			
			Discrete points: 2			
Control parameter		Type of township	■ Town		□ Urban	
		Vertical profile coefficients	■ Default		□ Customized	
		Type of plume	■ Final plume height			
			□ plume rise coefficients			
		Vertical temperature gradient	■ Default		□ Customized	
		Terrain correction	□ used		■Not used	
		Chimney Specifications	□used		■Not used	
		Buoyancy Dispersion	■used		□Not used	
		Calm wind treatment	■ Use the treatment in the module			
			□ Do not use the treatment in the module			

i Ozone Limiting Method (OLM)

For this Project, simulation results for NOx is transformed into increase in NO_2 according to "Regulations for Using Gaussian model ISCSTS3 for Simulation of Allowable Pollutant Increase Limits" from "Support Center for Air Quality Models" and is conducted using the Ozone Limiting Method (OLM). In addition, measured ozone values are from monitoring data of the Xianxi air quality monitoring station (2019), the formula for transformation is as follows:

$[NO_2]_{\text{Revised Concentration}} = (0.1) \times [NO_x]_{\text{Simulation of Concentration Value}} + X$

$X = \{(0.9) \times [NO_x]_{\text{Simulation of Concentration Value}}$, or $(46/48) \times [O_3]_{\text{Background Concentration Value}}\}$, the lower value of the two will be chosen.

ii Simulation Results for Air Quality

The ISCST3 model is used to simulate conservative conditions, when each item is simultaneously undergoing construction. The results from diffusion of pollutants for each simulated item is as shown in Table 6.1.2-5 and Figure 6.1.2-1 to Figure 6.1.2-2.

Increase in value of 24 hours for TSP is 40.23μg/m^3, and max increase in annual average is 7.86 μg/m^3; after diffusion, the increase in value of 24 hours for TSP is 1.78μg/m^3, and max increase in annual average is 0.38 μg/m^3 at sensitive receptor, Zhangbin Show Chwan Memorial Hospital; after diffusion, increase in value of 24 hours for TSP is 0.40μg/m^3, and max increase in annual average is 0.03 μg/m^3 at sensitive receptor, Xianxi Service Center.

Max increase in day average value for PM_{10} is 23.84μg/m^3, and max increase in annual average is 4.66 μg/m^3; after diffusion, increase in value of 24 hours for PM_{10} is 1.05μg/m^3, and max increase in annual average is 0.22 μg/m^3 at sensitive receptor, Zhangbin Show Chwan Memorial Hospital; after diffusion, increase in value of 24 hours for PM_{10} is 0.24μg/m^3, and max increase in annual average is 0.02 μg/m^3 at sensitive receptor, Xianxi Service Center.

Max increase in day average value for $PM_{2.5}$ is 7.22μg/m^3, and max increase in annual average value is 1.41 μg/m^3; after diffusion, increase in value of 24 hours for $PM_{2.5}$ is 0.32 μg/m^3, and max increase in annual average value is 0.07 μg/m^3 at sensitive receptor, Zhangbin Show Chwan Memorial Hospital; after diffusion, increase in value of 24 hours for $PM_{2.5}$ is 0.07μg/m^3, and max increase in annual average value is 0.01μg/m^3 at sensitive receptor, Xianxi Service Center. Increase in $PM_{2.5}$ combined with background concentration is in compliance with Air Quality Standards.

During construction, max increase in hour average value for SO_2 is 0.31 ppb, max increase in day average value is 0.02 ppb, and annual average value is 0.01 ppb; after diffusion, max increase in hour average value for SO_2 is 0.01 ppb, max increase in day average value is 0.001 ppb, and max increase in annual average value is 0.0002ppb at sensitive receptor, Zhangbin Show Chwan Memorial Hospital; after diffusion, max increase in hour average value for SO_2 is 0.01 ppb, max increase in day average value is 0.0003 ppb, and max increase in annual average value is 0.00002 ppb at sensitive receptor, Xianxi Service Center. Increase in SO_2 combined with background concentration is in compliance with Air Quality Standards.

During construction, max increase in hour average value for NO_2 is 76.97 ppb, and max increase in annual average value is 3.13 ppb; after diffusion, max increase in hour average value for NO_2 is 9.79 ppb, and max increase in annual average value is 0.17 ppb at sensitive receptor, Zhangbin Show Chwan Memorial Hospital; after diffusion, max increase in hour average value for NO_2 is 3.35 ppb, and max increase in annual average value is 0.02 ppb at sensitive receptor, Xianxi Service Center. Increase in NO_2 combined with background concentration is in compliance with Air Quality Standards.

iii Assessment of the Project before and after the Amendment

The comparison of air quality simulations before and after the amendment is shown as Table 6.1.2-6. The difference between the estimated max increment of pollutants and the original EIA result is not significant.

Table 6.1.2-5 Simulation Results for Air Pollutant during Onshore Construction

Air Pollutant	Location	Simulated Item	Coordinates for Simulated Max Value (TWD97)	Background Value【Note】	Total	Air Quality Standards
TSP(μg/m³)	Max Concentration at Ground Level	Value of 24 Hours	40.23 188500,2667500	137	177.23	—
		Annual Average Value	7.86 189000,2666500	—	—	—
	Zhangbin Show Chwan Memorial Hospital	Value of 24 Hours	1.78	137	138.78	—
		Annual Average Value	0.38	—	—	—
	Xianxi Service Center	Value of 24 Hours	0.40	137	137.40	—
		Annual Average Value	0.03	—	—	—
PM10(μg/m³)	Max Concentration at Ground Level	Value of 24 Hours	23.84 188500,2667500	76	99.84	100
		Annual Average Value	4.66 189000,2667000	—	—	50
	Zhangbin Show Chwan Memorial Hospital	Value of 24 Hours	1.05	76	77.05	100
		Annual Average Value	0.22	—	—	50
	Xianxi Service Center	Value of 24 Hours	0.24	76	76.24	100
		Annual Average Value	0.02	—	—	50
PM2.5(μg/m³)	Max Concentration at Ground Level	Value of 24 Hours	7.22 188500,2667500	32	39.22	35
		Annual Average Value	1.41 189000,2667000	—	—	15
	Zhangbin Show Chwan Memorial Hospital	Value of 24 Hours	0.32	32	32.32	35
		Annual Average Value	0.07	—	—	15
	Xianxi Service Center	Value of 24 Hours	0.07	32	32.07	35
		Annual Average Value	0.01	—	—	15

Table 6.1.2-5 Simulation Results for Air Pollutant during Onshore Construction

Air Pollutant	Location	Simulated Item	Coordinates for Simulated Max Value (TWD97)	Background Value【Note】	Total	Air Quality Standards
SO_2(ppb)	Max Concentration at Ground Level	Max Hour Average Value	0.31 188500,2667500	7	7.31	75
		Day Average Value	0.02 188500,2667500	2	2.02	—
		Annual Average Value	0.01 189000,2667000	—	—	20
	Zhangbin Show Chwan Memorial Hospital	Max Hour Average Value	0.01	7	7.01	75
		Day Average Value	0.00(0.001)	2	2.00	—
		Annual Average Value	0.00(0.0002)	—	—	20
	Xianxi Service Center	Max Hour Average Value	0.01	7	7.01	75
		Day Average Value	0.00(0.0003)	2	2.00	—
		Annual Average Value	0.00(0.00002)	—	—	20
NO_2(ppb)	Max Concentration at Ground Level	Max Hour Average Value	76.97 189000,2667500	33	109.97	100
		Annual Average Value	3.13 189000,2667000	17	20.13	30
	Zhangbin Show Chwan Memorial Hospital	Max Hour Average Value	9.79	33	42.79	100
		Annual Average Value	0.17	17	17.17	30
	Xianxi Service Center	Max Hour Average Value	3.35	33	36.35	100
		Annual Average Value	0.02	17	17.02	30

Note: Measured max values from supplemental survey results for background air quality were used for max background concentration at ground level, and background concentration at environmental sensitive spots for simulations. (Details are as shown in Table 6.1.1-2)

Figure 6.1.2-1 Simulation of Max Increase in Value of 24 Hours for TSP during Onshore Construction

Figure 6.1.2-2 Simulation of Increase in Annual Average Value for TSP during Onshore Construction

Table 6.1.2-6 Comparison of Air Quality Simulation Before and After the Amendment

Pollutant/sensitive points		Max. concentration at ground level	Zhangbin Show Chwan Memorial Hospital	Xianxi Service Center
Daily average of TSP(μg/m^3)	Before	42.96	—	1.20
	After	40.23	1.78	0.40
Daily average of PM_{10} (μg/m^3)	Before	25.82	—	0.73
	After	23.84	1.05	0.24
Daily average of $PM_{2.5}$ (μg/m^3)	Before	8.53	—	0.27
	After	7.22	0.32	0.07
Hourly average of SO_2 (ppb)	Before	0.44	—	0.01
	After	0.31	0.01	0.01
Hourly average of NO_2 (ppb)	Before	86.62	—	12.44
	After	76.97	9.79	3.35

Note: "Before" refers to the simulation results of air quality at the Lungwei onshore substation during the construction phase in the EIA stage.

IV. Offshore Construction

This amendment will increase the single capacity of turbines while maintaining the original total capacity. As less turbines will be installed, it is expected that the construction period will be shortened, and the overall environmental impact will be smaller than the impact assessed in the EIA stage.

Simulation of air pollution emissions from construction vessels has been carried out in the EIS stage. The offshore construction includes OSS construction, submarine cable installation, turbine foundation installation, installation of turbine components and test runs. The type and amount of vessels for each construction is different. In the EIS stage, the plan is to carry out all constructions in the OWF area at the same time, and the maximum number of vessels operating in a single day would be 31. The simulation results (using ISCST3) of the air pollutant dispersion in the conservative scenario when the maximum vessels are in the site is shown as Table 6.1.2-7.

Table 6.1.2-7 Simulation of Air Pollution in Offshore Vessel Operations

Air pollutants	Location	Simulated item	Coordinate where the max. volume is located (TWD97)
TSP (μg/m^3)	Max Concentration at Ground Level (onshore)	24 hr value	0.01 [192800,2667700]
		Annual average	0.0008 [192300,2667700]
	Zhangbin Show Chwan Memorial Hospital	24 hr value	0.01
		Annual average	0.0007
	Xianxi Service Center	24 hr value	0.01
		Annual average	0.0007
PM_{10} (μg/m^3)	Max Concentration at Ground Level (onshore)	24 hr value	0.01 [192800,2667700]
		Annual average	0.0008 [192300,2667700]
	Zhangbin Show Chwan Memorial Hospital	24 hr value	0.01
		Annual average	0.0007
	Xianxi Service Center	24 hr value	0.01
		Annual average	0.0007
$PM_{2.5}$ (μg/m^3)	Max Concentration at Ground Level (onshore)	24 hr value	0.01 [192800,2667700]
		Annual average	0.0006 [192300,2667700]
	Zhangbin Show Chwan Memorial Hospital	24 hr value	0.01
		Annual average	0.0006
	Xianxi Service Center	24 hr value	0.01
		Annual average	0.0006
SO_2 (ppb)	Max Concentration at Ground Level (onshore)	Max. hourly value	3.18 [192800,2667700]
		24 hr value	0.13 [192800,2667700]
		Annual average	0.01 [192300,2667700]
	Zhangbin Show Chwan Memorial Hospital	Max. hourly value	2.31
		24 hr value	0.10
		Annual average	0.01
	Xianxi Service Center	Max. hourly value	2.01
		24 hr value	0.10
		Annual average	0.01
NO_2 (ppb)	Max Concentration at Ground Level (onshore)	Max. hourly value	0.26 [192800,2667700]
		Annual average	0.01 [192800,2667700]
	Zhangbin Show Chwan Memorial Hospital	Max. hourly value	0.19
		Annual average	0.00(0.0006)
	Xianxi Service Center	Max. hourly value	0.16
		Annual average	0.00(0.0006)

Source: EIS of Greater Changhua Northwest Offshore Wind Power Project

6.2 Noise and Vibration

The onshore substation for this Project is shared with CHW22 (the planned site is as shown in Figure 6.2.1-1), and the onshore cable will use existing onshore cable trench. Only a portion of the onshore cable will require additional construction, which means overall construction activity may be reduced. However, as noise and vibration may still be generated during the construction, difference in impact before and after amendment is as explained below using results from environmental background surveys and supplemental surveys.

Figure 6.2.1-1 Survey Locations for Noise and Vibration

6.2.1 Current Environmental Conditions

I. Environmental Background Surveys

For this Project, noise and vibration survey results are collected from "Greater Changhua Northwest Wind Farm Environmental Monitoring Project" and "Greater Changhua Southwest Wind Farm Environmental Monitoring Project". The monitoring station is located in a sensitive spot (Xianxi Service Center) near the onshore construction. According to noise control zone categorizations announced by the EPA, Executive Yuan, the monitoring station is within a Fourth

II. Type of Noise Control Zone near roads wider than 8m.

Environmental survey results for "Greater Changhua Northwest Wind Farm Environmental Monitoring Project" and "Greater Changhua Southwest Wind Farm Environmental Monitoring Project" from June 2019 to March 2021 are as shown in Table 6.2.1-1 and Table 6.2.1-2. The noise and vibration from monitoring stations are in compliance with Standards of Ambient Noise as well as control standards of Second Type of Zone from Japan Vibration Regulations

Table 6.2.1-1 Noise Survey Results from Environmental Background Survey

Unit: dB (A)

Monitoring Station	Date of Measurement	L_{Day}	L_{Night}	$L_{Midnight}$
Xianxi Service Center	2019.08.12-13	56.1	50.2	50.6
	2019.09.24-25	54.8	49.2	48.6
	2019.12.12-13	56.6	53.2	51.3
	2020.03.17-18	54.6	49.2	49.8
	2020.06.17-18	54.6	49.2	49.8
	2020.09.14-15	54.3	49.5	47.5
	2020.12.02-03	60.7	50.3	53.4
	2021.03.22-23	57.0	52.6	50.7
Third or Fourth Type of Noise Control Zone near roads wider than 8m		76	75	72

Note: According to Article 2, Point 5 in "Standards of Ambient Noise" announced by the EPA, Executive Yuan on January 21st, 2010 (EPA Official Letter #0990006225D) the time periods are as categorized: "Daytime is between 6:00am to 8:00pm, Nighttime is between 8:00pm to 10:00pm, and Midnight is between 10:00pm and 6:00am of the next day"
Source: Monitoring work for this survey is commissioned to Envimac Technology and Consultants Co., Ltd. (EPA #012A).

Table 6.2.1-2 Vibration Survey Results from Environmental Background Survey

Unit: dB (A)

Monitoring Station	Date of Measurement	L_{Day}	$L_{Midnight}$
Xianxi Service Center	2019.08.12-13	45.1	40.8
	2019.09.24-25	43.7	35.3
	2019.12.12-13	40.1	32.0
	2020.03.17-18	44.6	34.5
	2020.06.17-18	44.3	37.5
	2020.09.14-15	45.2	38.0
	2020.12.02-03	43.2	35.2
	2021.03.22-23	43.1	34.9
Control standards of Second Type of Zone for reference from Tokyo, Japan Vibration Regulations		70	65

Note: Control standards from Tokyo, Japan Vibration Regulations are used. First type of zone: quiet areas for residents; second type of zone: areas for industrial and commercial use while also maintaining a living environment for residents. Daytime is between 7:00am to 9:00pm; nighttime is between 9:00pm to 7:00am of the next day.
Source: Monitoring work for this survey is commissioned to Envimac Technology and Consultants Co., Ltd. (EPA #012A).

III. Supplemental Survey Results

i Noise

Ambient noise and vibration monitoring for 24 continuous hrs during weekend and non-weekend were conducted at the planned site (Zhangbin Industrial Park) for the onshore substation inCHW22. According to noise control zone categorizations announced by the EPA, Executive Yuan, Fourth Type of Noise Control Zone near roads wider than 8m are required to comply with ambient noise standards (L_{day}=76 dB(A), L_{night}=75 dB(A) and $L_{midnight}$=72 dB(A)).

Survey results for July and November, 2020 are as shown in Table 6.2.1-3 and the equivalent noise levels during each period complied with the corresponding ambient noise standards.

ii Vibration

Ambient noise and vibration monitoring for 24 continuous hrs during weekend and non-weekend were conducted at the planned site (Changhua Coastal Industrial Park) for the onshore substation in CHW22. Vibration monitoring results referred to control standards of Second Type of Zone from Japan Vibration Regulations (Lv_{10} day=70 dB and Lv_{10} night=65 dB).

Survey results for July and November, 2020 are as shown in Table 6.2.1-3 and complied with control standards of Second Type of Zone from Japan Vibration Regulations (Lv_{10} day=70 dB and Lv_{10} night=65 dB).

iii Low Frequency Noise

On August 5th, 2013 the EPA announced an “Amendment to Noise Control Standards” (EPA #1020065143). According to Article 8 of the standards, low frequency noise from wind turbines is under noise control standards for areas and facilities announced by other competent authorities.

Low frequency ambient noise monitoring for 24 continuous hours during weekend and non-weekend at the onshore substation has been conducted, monitoring results are as shown in Table 6.2.1-5. The results indicate each time period in both weekend and weekday comply with low frequency noise control standards for Wind Turbines - Class 4.

Table 6.2.1-3 Noise Survey Results from Supplemental Surveys

Monitoring Station	Date of Measurement	L_{Day}	L_{Night}	$L_{Midnight}$
Planned site for onshore substation CHW22 (Changhua Coastal Industrial Park)	2020.07.27(Weekday)	51.2	38.1	45.0
	2020.07.26(Weekend)	51.2	38.9	41.2
	2020.11.13(Weekday)	60.3	59.2	55.6
	2020.11.14(Weekend)	54.5	54.4	53.4
Third or Fourth Type of Noise Control Zone near roads wider than 8m		76	76	72

Note. Noise standards are according to "Standards of Ambient Noise" announced by the EPA, Executive Yuan on January 21st, 2010 (EPA #0990006225D).

Table 6.2.1-4 Vibration Survey Results from Supplemental Surveys

Unit: dB

Monitoring Station	Date of Measurement	L_{Day}	L_{Night}
Planned site for onshore substationin CHW22 (Changhua Coastal Industrial Park)	2020.07.27(Weekday)	32.7	30.0
	2020.07.26(Weekend)	30.7	30.0
	2020.11.13(Weekday)	36.8	34.5
	2020.11.14(Weekend)	36.5	34.1
Control standards of Second Type of Zone for reference from Tokyo, Japan Vibration Regulations		70	65

Note: Control standards from Japan Vibration Regulations are referenced, first type of zone is equal to first type and second type of zone from domestic noise control zones; second type of zone is equal to third type and fourth type of zone from domestic noise control zones.

Table 6.2.1-5 Low Frequency Noise Survey Results from Supplemental Surveys

Unit: dB

Monitoring Station	Date of Measurement	$L_{Day, LF}$	$L_{Night, LF}$	$L_{Midnight, LF}$
Planned site for onshore substation in CHW22 (Changhua Coastal Industrial Park)	2021.01.29(Weekday)	37.8	31.2	33.9
	2021.01.30(Weekend)	34.9	33.2	26.5
Low Frequency Noise Control Standards for Wind Turbines – Class 4		47	47	44

Note: Noise control standards are from Amendment to Noise Control Standards" implemented in August 5th, 2013.
Source: Monitoring work for this survey is commissioned to Envimac Technology and Consultants Co., Ltd. (EPA #012A).

6.2.2 Differential Analysis for the Amendment

This Project uses “SoundPLAN” noise computer model developed by German company Braunstein+Berndt GMBH for predictions and analysis. The advantage to this model is its ability to simultaneously include different types of noise sources, including point source, line source and plane source, and their corresponding combined noise levels. In addition to estimating the noise level of each sensitive spot, the model may also estimate the noise contours within and outside the entire Project area. After combining the predicted noise levels with the background levels at each receptor, the degree of impact may be determined according to noise impact assessment procedure (Figure 6.2.2-1) recommended by the EPA. This amendment includes adding an onshore substation. Therefore, simulation and assessment are conducted for noise and vibration during construction of the onshore substation as well as for noise and vibration of traffic during construction.

I. Noise

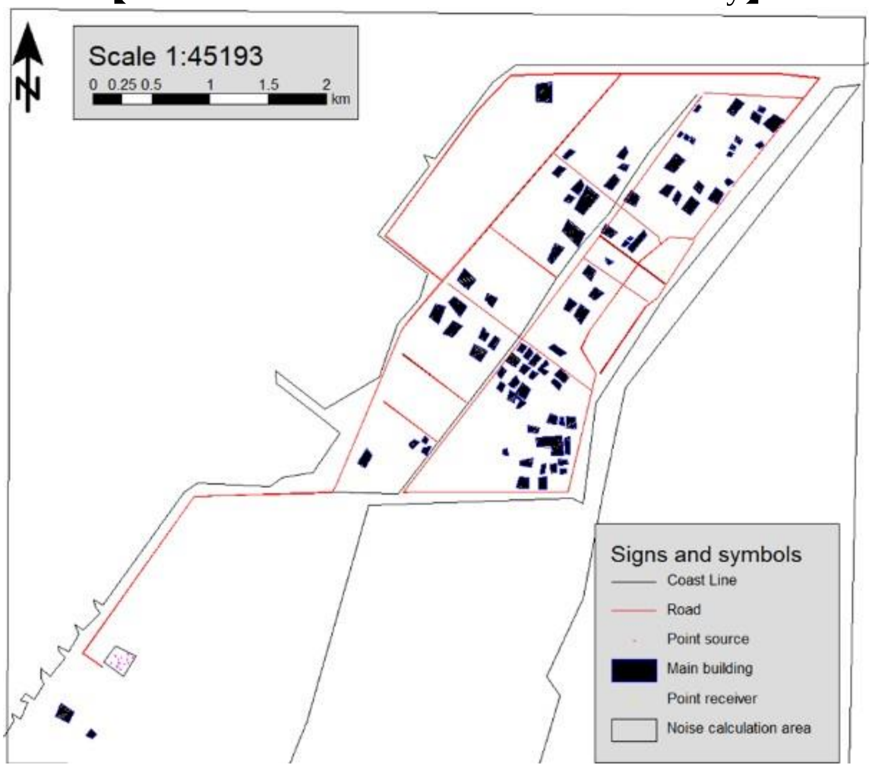
i Construction for Onshore Substationin CHW22

The main onshore construction during CHW22 mainly involves the onshore substation. The amount and types of machinery as well as corresponding noise levels are as shown in Table 6.2.2-1. During the construction phase, construction noise around the perimeter of the construction area for the Project is approximately 66.6dB (A), which is in compliance with daytime noise levels (80dB(A)) from Fourth Type Construction Noise Control Standards.

After attenuation, noise level at the Xianxi service center generated from the construction noise of the onshore substation in the second phase is 0dB(A). After combining construction noise with the measured background value (60.7dB(A)), L_{Day} combined noise level is predicted to be 60.7dB(A), as shown in Table 6.2.2-2. This is in compliance with Fourth Type Ambient Noise Standards. Increase in noise is 0dB(A) (0-5) and this amendment has no impact or negligible impact.

Table 6.2.2-1 Impact Assessment of Construction Noise during Each Main Construction Phase

【Allocation of the Main Construction Machinery】



Substation and Onshore Construction

Item	Construction Machinery	Max No. Used Simultaneously	Sound Power Level dB (A)	Distance between Noise Source and Perimeter* (m)	Combined Noise Level of Machinery Simultaneously in Use	Combined Noise Level during Construction
Onshore Substation (Zhangbin Industrial Park)	Bulldozer	2	110	150	57.7	66.6
	Excavator	4	111	150	61.7	
	Agitator Truck	3	108	150	57.5	
	Caterpillar Crane	2	107	150	54.7	
	Electric Tower Crane	1	95	150	39.7	
	Dump Truck	7	109	150	62.2	

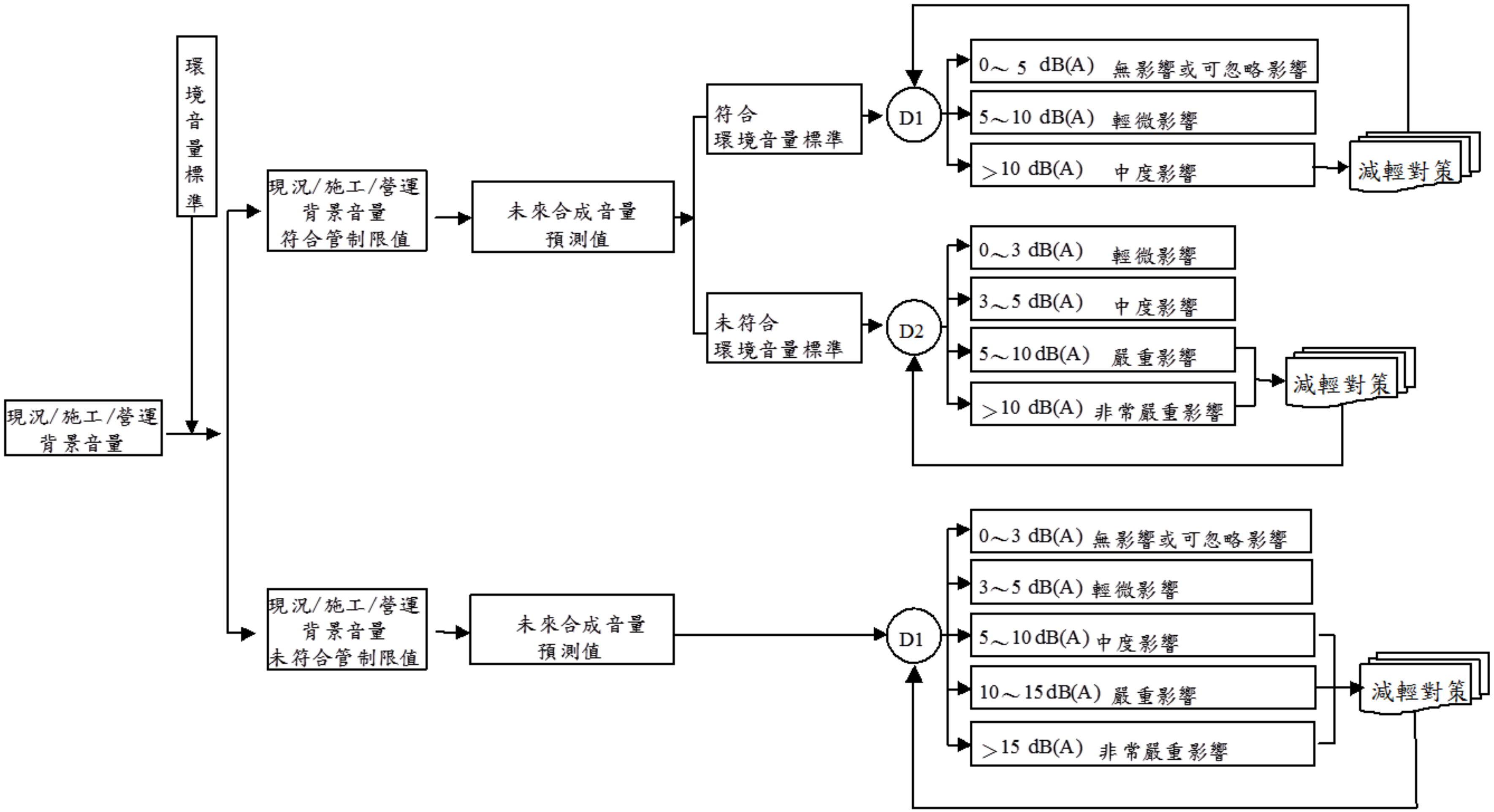
Table 6.2.2-2 Outputs from Simulations and Assessment Results for Construction Noise (L_{Day})

Unit: dB(A)

Item / Receptor	Current Background Ambient Noise Level	Background Noise Level during Construction [1]	Max Construction Noise during Construction [2]	Combined Noise Level during Construction [3]	Increase in Noise [4]	Noise Control Zone Category	Standard for Ambient Noise Level	Impact Level [5]
Xianxi Service Center	60.7	60.7	0	60.7	0	Fourth Type of Control Zone	75	No impact or negligible impact

Note:

1. The "Background Noise Level during Construction" are assumed to be the same as "Current Background Ambient Noise Level".
2. : "Max Construction Noise during Construction" is estimated by combining the construction noise levels of all machinery that may be simultaneously in use. Therefore, simulation and analysis of construction noise is conducted using the largest level of impact during construction.
3. : "Combined Noise Level during Construction"= "Background Noise Level during Construction" ⊕ "Max Construction Noise during Construction". ⊕ indicates adding the 2 values according to principles for calculating noise.
4. : "Increase in Noise" = "Combined Noise Level during Construction"- "Background Noise Level during Construction" (used when "Combined Noise Level during Construction" complies with "Standards of Ambient Noise"); "Additional Noise" = "Combined Noise Level during Construction"- "Standards of Ambient Noise" (used when "Combined Noise Level during Construction" does not comply with "Standards of Ambient Noise").
5. : Standards for assessment of impact level is as shown in Figure 6.2.2-1.



註：1. D1 未來合成音量預測值與現況/施工/營運背景音量之噪音增量
2. D2 未來合成音量預測值與環境音量標準之噪音增量
3. 等級劃分參考國內噪音法規、美國環保署環境影響評估準則歸類、噪音學原理及控制(蘇德勝著)。
4. 資料來源：黃乾全，「環境影響評估專業人員培訓講習會講義噪音與振動評估」，行政院環境保護署，民國87年1月。

Figure 6.2.2-1 Assessment Procedure for Noise Impact Level

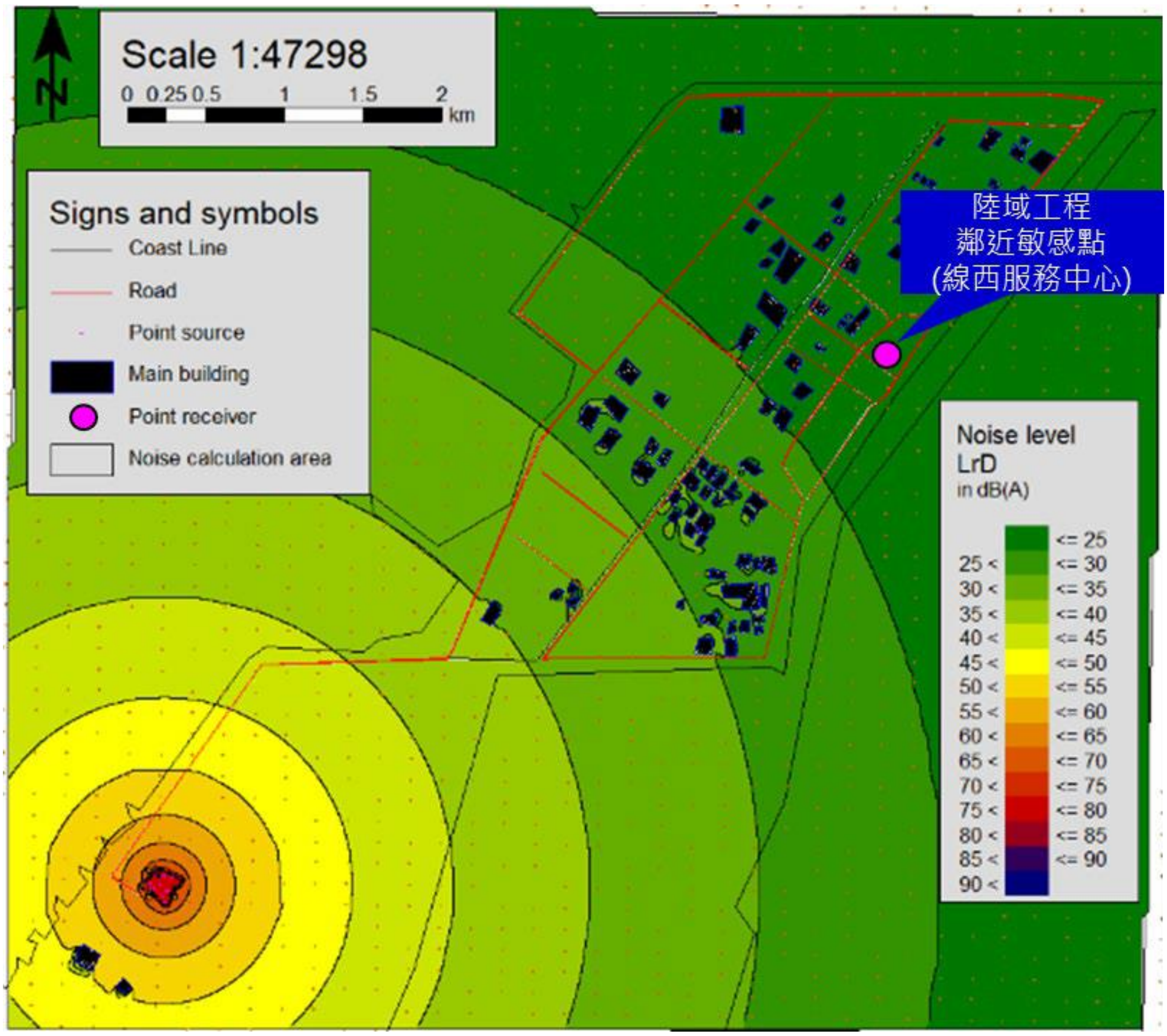


Figure 6.2.2-2 Simulation of Noise Impact during Construction

ii Noise from Construction Vehicles

Construction vehicles during transportation will mainly travel in a north-south trajectory using the Anxi Road. A portion of earthwork produced during excavation for the onshore substation will be backfilled onsite, and surplus earthwork will be transported to the industrial park for handling. The frequency for vehicles transporting earthwork is 4 vehicles per hour (either direction), as according to the original EIS.

Results from simulation and assessment using the model is as shown in Table 6.2.2-3. Noise contour is as shown in Figure 6.2.2-2. After attenuation, L_{Day} at the onshore substation from construction vehicles is 45.8dB(A), and after combining with measured background values(60.3 dB (A)), the estimated combined level for L_{Day} is 60.5 dB(A). Noise increase is 0.2 dB(A) (0-5 dB), and complies with regulations for Third or Fourth Type of Noise Control Zone near roads wider than 8m. According to assessment procedure for noise impact level, this amendment has no impact or negligible impact. After attenuation, L_{Day} at the sensitive spot near onshore construction (Xianxi Service Center) from construction vehicles is 49.1dB(A), and after combining with measured background values (60.7dB (A)), the estimated combined level for L_{Day} is 61.0dB(A). Noise increase is 0.3 dB(A) (0-5 dB) and complies with standard for Fourth Type of Noise Control Zone, 75 dB(A). According to assessment procedure for noise impact level, this amendment has no impact or negligible impact.

Table 6.2.2-3 Outputs from Simulations and Assessment Results for Construction Vehicles

Unit: dB(A)

Item / Receptor	Current Background Ambient Noise Level	Background Noise Level Without Construction Vehicles [1]	Traffic Noise from Construction Vehicles	Combined Noise Level Including Construction Vehicles [2]	Increase in Noise [3]	Noise Control Zone Category	Standard for Ambient Noise Level	Impact Level [4]
Sensitive Spot near Onshore Construction (Xianxi Service Center)	60.7	60.7	49.1	61.0	0.3	Fourth Type of Control Zone	75	No impact or negligible impact
Onshore Substation (Changbi Industrial Park)	60.3	60.3	45.8	60.5	0.2	Third or Fourth Type of Noise Control Zone near roads wider than 8m	76	No impact or negligible impact

Note:

(1) The "Background Noise Level Without Vehicles" is assumed to be the same as "Current Background Ambient Noise Level".

(2) : "Combined Noise Level Including Construction Vehicles"= "Background Noise Level Without Vehicles" ⊕"Traffic Noise from Construction Vehicles". ⊕indicates adding the 2 values according to principles for calculating noise.

(3) : "Increase in Noise" = "Combined Noise Level Including Construction Vehicles"- "Background Noise Level Without Vehicles" (used when "Combined Noise Level Including Construction Vehicles" complies with "Standards of Ambient Noise")

(4) : Standards for assessment of impact level is as shown in Figure 6.2.2-1.

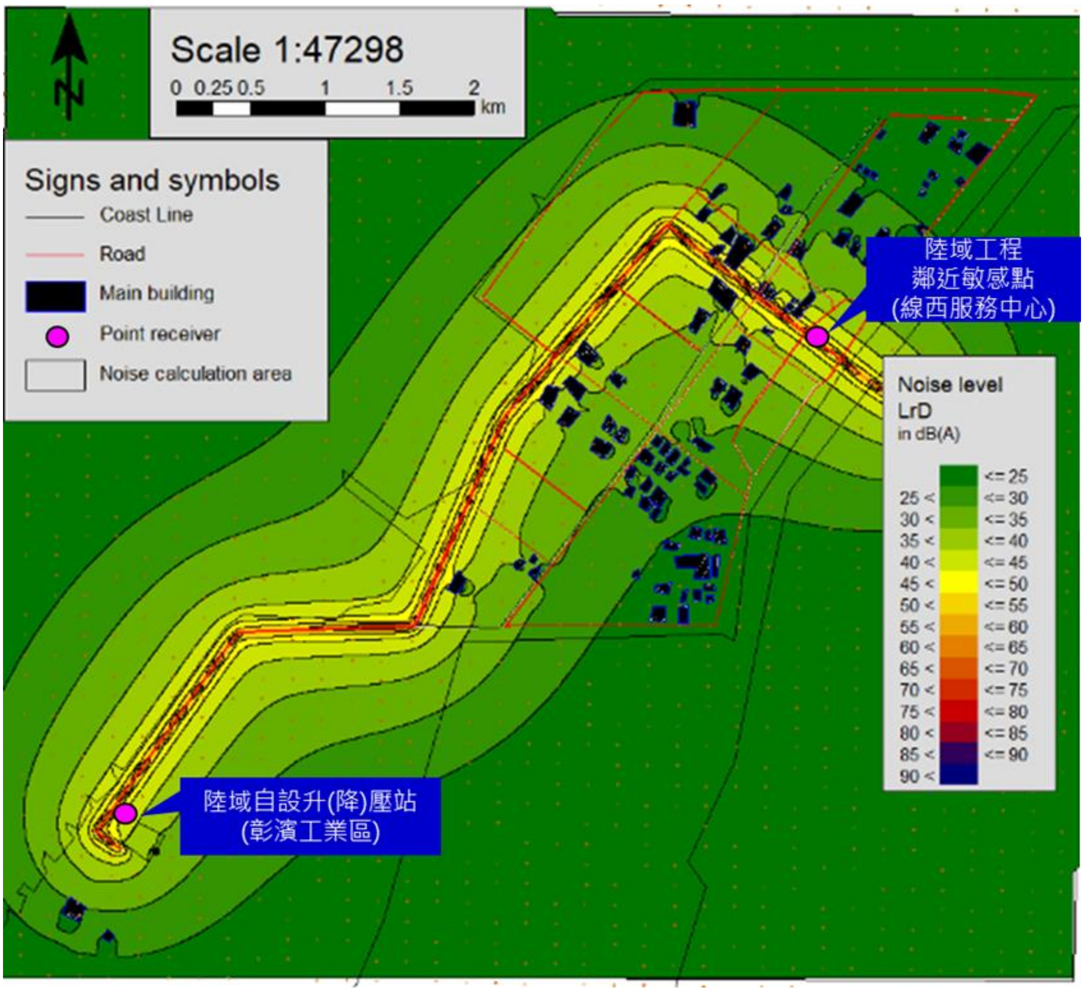


Figure 6.2.2-3 Simulation of Noise Impact during Transportation of Construction Vehicles

II. Vibration

Assessment and analysis for vibration impact is conducted according to "Technical Regulation for Ambient Vibration Assessment Model". Vibration impact of construction machinery is conducted according to "Appendix 5: Instruction Manual for Vibration Prediction Models of Factories and Site of Operations"; and vibration impact of traffic is conducted according to "Appendix 4: Instruction Manual for Traffic Vibration Models from Japanese Ministry of Construction".

Vibration generated from development activity will cause varying degrees of impact on nearby buildings and the lives of residents. Impacts, when severe, may cause cracks in buildings and impact physiology and sleep, as shown in Table 6.2.2-4. According to the table, vibration below 55dB will not be felt (the human body will feel vibration with levels higher than 55dB). For comparison with vibration impact assessments in this chapter, the vibration control standards of Japan Vibration Regulations are used as reference (Table 6.2.2-5).

Table 6.2.2-4 Analysis of Vibration Impact on Buildings and the Environment for Everyday Life

Impact Assessment	(Japan Meteorological Agency)	(Ejima Jun, Japan-Measures for Ground Vibration)	Japanese Industrial Standards (JIS)	
Vibration Level	Earthquake Levels	Impact to Buildings	Physiological Impact	Impact to Sleep
Below 55dB	Intensity○–none	—	Frequent microgravity	—
55-65dB	Intensity I– faint	No damage- weak vibration	Start to feel vibrations	No impact to sleep
65-75dB	Intensity II–slight	No damage- medium vibration	—	Impact to light sleep
75-85dB	Intensity III–weak	Cracks in paint- strong vibration	Workers in factories for 8 hrs. start to feel uncomfortable	Impact to deep sleep
85-95dB	Intensity IV–medium	Cracks in wall- very strong vibration	Physiological impact start occurring to human bodies	Impact to deep sleep
95-105 dB	Intensity V–strong	Structural damage- violent vibration	Significant physiological impact	—
105-110	Intensity VI–violent	—	—	—
Above 110dB	Intensity VII–intense	—	—	—

Table 6.2.2-5 Vibration Standards of Japan Vibration Regulations

Unit: dB

Zones	Time Period	
	Daytime	Nighttime
First Type of Zone	65	60
Second Type of Zone	70	65

Note:

1. Excerpt from "Six Codes for the Environment" announced by General Affairs, Environmental Agency, Japan, 2001
2. First type of zone: quiet areas for residents.
   Second type of zone: areas for industrial and commercial use while also maintaining a living environment for residents.
3. Daytime: 5:00am (or 6:00, 7:00, 8:00)-7:00pm (or 8:00, 9:00, 10:00).
   Nighttime: 7:00pm (or 8:00, 9:00, 10:00)- 5:00am (or 6:00, 7:00, 8:00) of the following day.

i Vibration Impact during Construction

Vibration during construction is mainly generated from construction machinery and the traffic. Machinery that produces larger vibration include excavator, piling machinery, etc. Traffic vibration is generated by construction trucks transporting heavy components, earthwork and materials. The following impact assessment of max vibration during construction is divided between the 2 vibration sources.

III. Vibration Impact of Construction Machinery

Construction items that often generate vibration during construction include items that create ground borne vibrations that travel short distances such as piling, compaction and excavation. These items are often the main factors for vibration during development activities.

Noise and vibration assessment are conducted for the same construction machinery, vibration assessment work for construction machinery is conducted according to the following basis. According to “Technical Guidelines for Management and Monitoring of Highway Construction Environment” (Taiwan Area National Expressway Engineering Bureau, MOTC, 1992, as compiled in Table 6.2.2-6); and “Appendix 5: Instruction Manual for Vibration Prediction Models of Factories and Site of Operations” from “Technical Regulation for Ambient Vibration Assessment Model” announced by EPA, Executive Yuan on January 9th, 2013, as shown in Table 6.2.2-7.

i Models

$$L_{V10} = L_0 - 20\log(r / r_0)^n - 8.68\alpha(r - r_0)$$

L_{V10}: Vibration level (predicted levels) that is r(m) from the vibration source

L_0: Vibration level (predicted levels) that is r_0(m) from the vibration source

n: Combination of propagation of physical wave fields in half-space free surface, n=2

r: Distance between prediction point and center line of viaduct columns r_0: Distance between reference point and center line of columns

α: Internal attenuation at site (clay: 0.01-0.02, silt: 0.02-0.03)

ii Prediction Results

The distance between the onshore substation in the second phase and the sensitive spot, Xianxi Service Center, is around 5,800m, as shown in Table 6.2.2-7. The combined vibration level of all construction machinery is reduced to 0dB after just 200m, and Xianxi Service Center is even further away, thus, combined vibration level after attenuation is also reduced to 0dB. 0dB will not be felt by the human body (the human body can only feel vibrations with levels higher than 55dB). Under normal construction conditions, this amendment will have no impact on the sensitive spot.

Table 6.2.2-6 Measured Vibration Levels of Construction Machinery

Construction Machinery	Measured Vibration Level at 10m Distance
Excavator	54-71 dB
Bulldozer	68-74 dB
Motor grader	63-67 dB
Road roller	62-71 dB
Vibratory roller	65-71 dB
Pneumatic-tire roller	62-66 dB
Reverse circulation drill	64-72 dB
Drilling machine	53-61 dB
Dump truck	54-58 dB
Tow truck	54-58 dB
Crane	53-57 dB
Concrete pump truck	55-60 dB
Agitator truck	54-58 dB
Concrete vibrator	64-71 dB
Asphalt paver	53-57 dB
Blasting Equipment	97-101 dB
Air compressor	48-52 dB

Note; Reference value: 10^{-5}m/sec^2
Source: "Technical Guidelines for Management and Monitoring of Highway Construction Environment" (Taiwan Area National Expressway Engineering Bureau, MOTC, 1992)

Table 6.2.2-7 Assessment for Vibration Levels of Construction Machinery

Item	Construction Machinery	Quantity	L_0 (single)	L_0 (combined)	L_{v10} (combined) at 200m distance
Onshore substation in second phase	Bulldozer	2	74	77.0	0
	Excavator	4	71	77.0	0
	Agitator truck	3	58	62.8	0
	Dump truck 11t	7	58	66.5	0
	Caterpillar Crane	2	57	60.0	0
	Electric Tower Crane	1	57	57.0	0
Total				80.4	0

Note: For this assessment n=2, α=0.02, r_0=10m, and unit for vibration: dB.

1. Vibration Impact of Traffic

Due to the wide variety of transmission mediums, it is difficult to create a theoretical formula that can be widely used when predicting the vibration created by transportation via trucks. Therefore, predictions are conducted using the empirical rule, and predictions are conducted using "Appendix 4: Instruction Manual for Traffic Vibration Models of Japanese Ministry of Construction" from Technical Regulation for Ambient Vibration

Assessment Model", the results are as shown in Table 6.2.2-8.

A. Model Explanations

Predicted vibration level L_{V10}(dB) at reference point

$$L_{V10} = 65\log(\log Q^*) + 6\log V + 4\log M + 35 + \alpha_\sigma + \alpha_f$$

L_{V10}: Upper value (predicted level) (dB) of 80% range for vibration level

Q^*: The equivalent traffic volume (vehicle/500sec/lane) in each lane

$$Q^* = \frac{500}{3600} \cdot \frac{1}{M} \cdot (Q_1 + 12Q_2)$$

every 500 seconds is calculated using the following formula

Q_1: Traffic volume of light-duty vehicle per hour (vehicle/hr) Q_2: Traffic volume of heavy-duty vehicle per hour (vehicle/hr) M: Combined number of lanes in either direction

V: Average running speed(km/hr)

α_σ: Correction value(dB) according to flatness of road surface.

α_σ=14logσ: when on asphalt pavement, σ≧1mm 18logσ: when on concrete pavement, σ≧1mm 0：σ≦1mm

In this equation, σ: standard deviation (mm) for bumps in the road when a 3m profile meter is used.

α_f: Correction value (dB) for dominant frequency onsite.

α_f = -20logf ：f≧8

-18 ：8＞f≧4

-24+10logf：4<f

f: Dominant frequency onsite (Hz)

B. Prediction Results

There is an average of 4 vehicles per hour (either direction) for transportation vehicles during construction. After assessment, background vibration will increase by 3.2dB due to transportation vibration during construction, and the combined vibration level is 48.4dB. This level is in compliance with requirements from Second Type of Zone in Japan Vibration Regulation (70dB), therefore impact along the lane of transportation is estimated to be slight.

Table 6.2.2-8 Outputs from Simulation Results for Transportation Vehicle Vibration

Unit: dB

Item / Receptor	Current Background Ambient Vibration Level	Background Vibration Level during Construction [1]	Vibration of Transportation Vehicles during Construction	Combined Vibration with Transportation Vehicles during Construction [2]	Increase in Vibration [3]	Standard for Ambient Vibration Level [4]
Xianxi Service Center	45.2	45.2	45.6	48.4	3.2	70

Note:

(1) The "Background Vibration Level during Construction" is assumed to be the same as "Current Background Ambient Vibration Level".

(2) "Combined Vibration with Transportation Vehicles during Construction"= "Background Vibration Level during Construction" ⊕ "Vibration of Transportation Vehicles during Construction". ⊕ indicates adding the 2 values according to principles for calculating noise.

(3) "Increase in Vibration" = "Combined Vibration with Transportation Vehicles during Construction"- "Background Vibration Level during Construction"

(4) "Standard for Ambient Vibration Level" is referenced from Japan Vibration Regulations.

I. Operation Phase

1. Description of Noise Source

During the operation phase of wind turbines, the main source of noise will be produced by the blades of the wind turbine in operation. On August 5th, 2013 the EPA announced an "Amendment to Noise Control Standards" (EPA #1020065143). According to Article 8 of the standards, full frequency and low frequency noise from wind turbines is under noise control standards for areas and facilities announced by other competent authorities. For this Project, impact assessment and simulation of full frequency and low frequency noise produced by wind turbines during operation is conducted.

2. Spectrum Data for Noise Source

Actual measurements of wind turbines with 8MW or more is conducted according to wind turbine noise monitoring regulations (IEC 61400-11) of the International Electrotechnical Commission (IEC). The results indicate sound power levels gradually trend towards max levels when wind speed is 8m/s rather than increasing linearly with wind speed. Similar to the original EIS, wind speed of 10m/s is used for the basis of measurements in this amendment.

3. Assessment Method

For this Project, actual measurements of full frequency and low frequency noise is used in the SoundPLAN model as point source. This is to understand the possible impact of noise during turbine operation. Actual measurements of noise during wind speed of 10m/s in each frequency was conducted during the EIS phase according to IEC 61400-11 regulations and will be put into SoundPLAN model as point source. The SoundPlan simulation is conducted with 54 turbines, and the results will show noise levels at the receptor produced by all turbines simultaneously in operation. The simulated noise level and actual measurements are then combined to produce the predicted noise levels at the location. The predicted noise level will then be compared to the noise standards for each time period as shown in “The Standards of Ambient Noise” (full frequency) and noise control standards (low frequency).

4. Model Prediction Results

Descriptions for low frequency and full frequency noise sources during operation phase of Greater Changhua Northwest wind farm is as follows:

(1) Full frequency noise of wind turbines (20Hz-20kHz)

Actual measurements of noise during wind speed of 10m/s in each frequency (for full frequencies) was conducted during the EIS phase by the turbine manufacturer according to IEC 61400-11 regulations and will be input into SoundPLAN model as point source. Simulation results are as shown in Table 6.2.2-9 and Figure 6.2.2-4. For the Greater Changhua Northwest wind farm, results for full frequency noise levels of all turbines simultaneously in operation after attenuation at the nearest receptor is 0.0dB(A), and the increase in noise in each time period is 0.0dB(A). This indicates full frequency noise produced during the operation phase has no impact or negligible impact on nearby sensitive receptors.

(2) Low frequency noise of wind turbines (20Hz-200Hz)

Actual measurements of noise during wind speed of 10m/s in each frequency (for low frequencies) was conducted during the EIS phase by the turbine manufacturer according to IEC 61400-11 regulations and will be input into SoundPLAN model as point source. Simulation results are as shown in Table 6.2.2-9 and Figure 6.2.2-4. For the Project wind farm, results for low frequency noise levels of all turbines simultaneously in operation at the nearest receptor is 0.0dB(A) after attenuation, and the increase in noise in each time period is 0.0dB(A). This indicates low frequency noise produced during the operation phase has no impact or negligible impact on nearby sensitive receptors.

Table 6.2.2-9 Simulation Results from Assessment Model for Full Frequency Noise of Wind Turbines during Operation Phase of Greater Changhua Northwest wind farm

Unit: dB(A)

Item / Receptor	Time Period	Current Background Noise Level (Full Frequency)	Background Noise Level without Wind Turbine (Full Frequency)	Noise Level of Wind Turbine (Full Frequency)	Combined Noise Level with Wind Turbine	Increase in Noise	Noise Control Zone Category	Standard for Ambient Noise Level	Impact Level
Onshore Substation (Changhua Coastal Industrial Park)	Day	60.3	60.3	0.0	60.3	0.0	Fourth Type of Control Zone	75	No impact or negligible impact
	Night	59.2	59.2	0.0	59.2	0.0	Fourth Type of Control Zone	70	No impact or negligible impact
	Evening	55.6	55.6	0.0	55.6	0.0	Fourth Type of Control Zone	65	No impact or negligible impact

Note:

1. : The "Background Noise Level without Wind Turbine" is assumed to be the same as "Current Background Noise Level".
2. : Background noise level at sensitive receptors are from actual measurements
3. : "Combined Noise Level with Wind Turbine"= "Background Noise Level without Wind Turbine" ⊕ "Noise Level of Wind Turbine". ⊕ indicates adding the 2 values according to principles for calculating noise.

[3]: "Increase in Noise" = "Combined Noise Level with Wind Turbine"- "Background Noise Level without Wind Turbine"

Table 6.2.2-10 Simulation Results from Assessment Model for Low Frequency Noise of Wind Turbines during Operation Phase of Greater Changhua Northwest wind farm

Unit: dB(A)

Item / Receptor	Time Period	Current Background Noise Level (Low Frequency)	Background Noise Level without Wind Turbine (Low Frequency)	Noise Level of Wind Turbine (Low Frequency)	Combined Noise Level with Wind Turbine	Increase in Noise	Noise Control Zone Category	Standard for Ambient Noise Level	Impact Level
Onshore Substation (Changhua Coastal Industrial Park)	Day	37.8	37.8	0.0	60.3	0.0	Fourth Type of Control Zone	47	No impact or negligible impact
	Night	33.2	33.2	0.0	59.5	0.0	Fourth Type of Control Zone	47	No impact or negligible impact
	Evening	33.9	33.9	0.0	55.6	0.0	Fourth Type of Control Zone	44	No impact or negligible impact

Note:

1. : The "Background Noise Level without Wind Turbine" is assumed to be the same as "Current Background Noise Level".
2. : Background noise level at sensitive receptors are from actual measurements
3. : "Combined Noise Level with Wind Turbine"= "Background Noise Level without Wind Turbine" ⊕ "Noise Level of Wind Turbine". ⊕ indicates adding the 2 values according to principles for calculating noise.
4. : "Increase in Noise" = "Combined Noise Level with Wind Turbine"- "Background Noise Level without Wind Turbine"

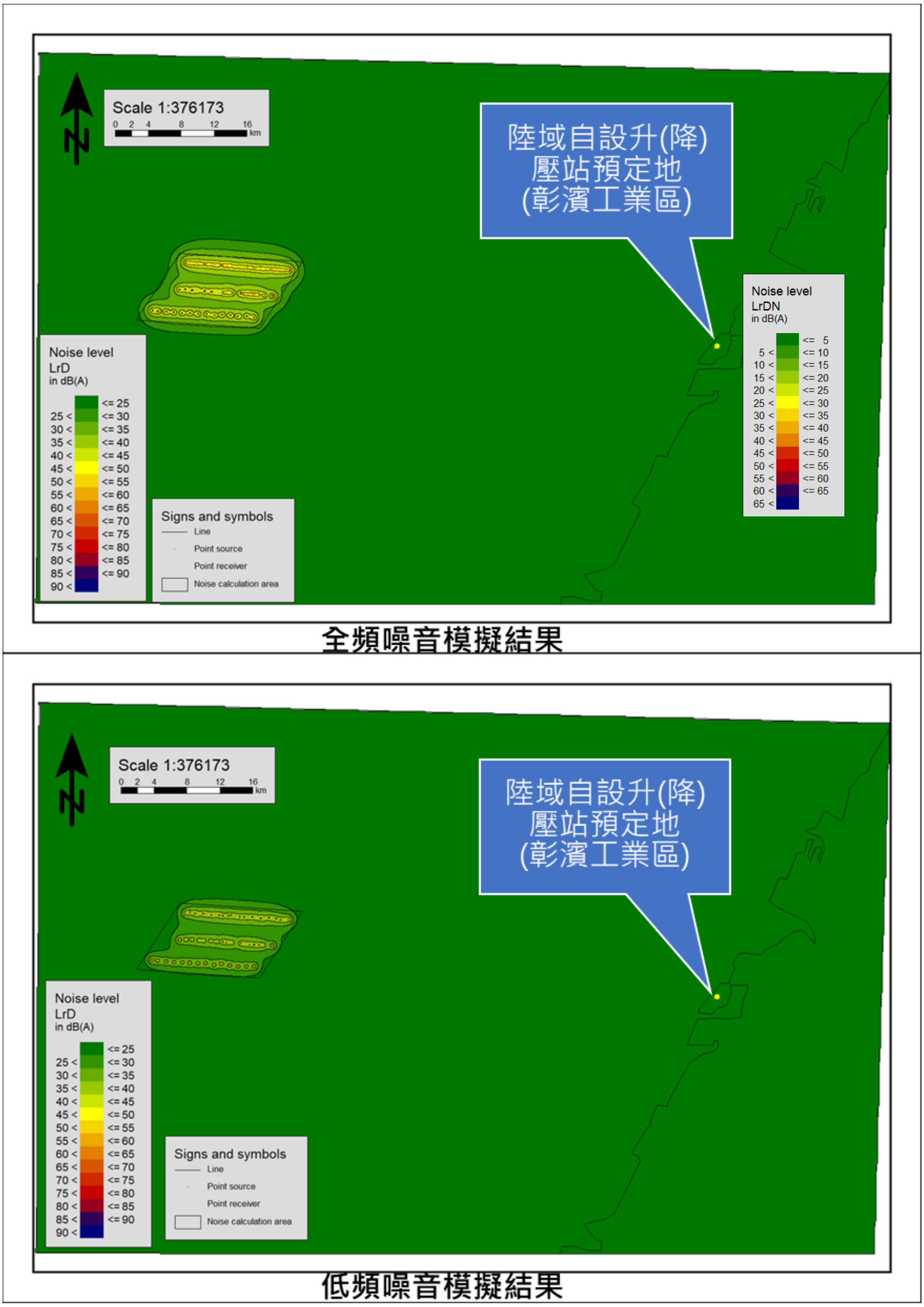


Figure 6.2.2-4 Simulation of Noise Impact of Wind Turbine during Operation Phase of Greater Changhua Northwest Wind Farm

6.3 Differential Impact Assessment for Underwater Noise in this Amendment

This amendment includes the adjustment of the design parameters of jacket foundation, SBJ foundation and OSS foundation. Considering that SBJ foundation does not require pile striking, and underwater noise will not be derived. The impact level of underwater noise is “no impact.” Therefore, simulation and estimate for underwater noise during piling will be conducted only for the parameters of jacket foundation and OSS foundation. Simulation of underwater noise includes simulating sound source and propagation model. First, Finite Element Method (FEM) is used to simulate sound source, and then Range- dependent Acoustic Model (RAM) is used to estimate SEL at 750m from the piling location. Environmental and pile parameters are as shown in Table 6.3-1. Results from the simulation are used to assess the degree of impact on marine ecology during construction, as well as used as reference for devising mitigation methods.

I. Simulation Method

As noise measurements during piling needs to consider operational limits and safety concerns, it is impossible to measure sound pressure from the source during piling of the foundation. Therefore, Finite Element Method (FEM) is used to simulate the noise produced in piling; and RAM (Range-dependent Acoustic Model) is used for simulating propagation of piling noise. The processes for simulations are summarized as follows:

1. Finite Element Method, FEM

Finite element method and Structure-Acoustic Coupling are used for simulating sound source. Its overall structure is as shown in Figure 6.3.1. The model mainly consists of pile, sea water and sediment layer.

For this research, Structure-Acoustic Coupling and Axial Symmetrical Model is used; a pressure release boundary condition is used for the sea surface; the energy of hammer strikes are applied on top of the pile; impact piling is considered an instant/temporary strike, F(t); and exponential attenuation is applied to approximate the real conditions for piling. The results of the calculations will produce a distribution of sound pressure along the water depth 1m away from the pile wall, which can be used to represent the strength of the linear sound source for propagation models. The feasibility and reasonableness of this method has been proven by comparing the simulation method with measured piling data.

Analysis from drilling conducted by the developer is referenced for sediment parameters; and hydrology database of MOST is referenced for outputs including temperature, depth and salinity which is used to calculate sound speed in sea water. Parameters for sediment and marine water layers are as shown in Figure 6.3-2 and Figure 6.3-3. There are 2 types of sediments to consider, solids which includes shear waves and fluids which doesn’t include shear waves. In order to simulate the friction and resistance from the sediments when piling, the effect of shear waves still need to be considered even in sediment conditions without shear waves. Thus, the equivalent absorption coefficient of compressive wave and shear wave is used to simulate energy loss.

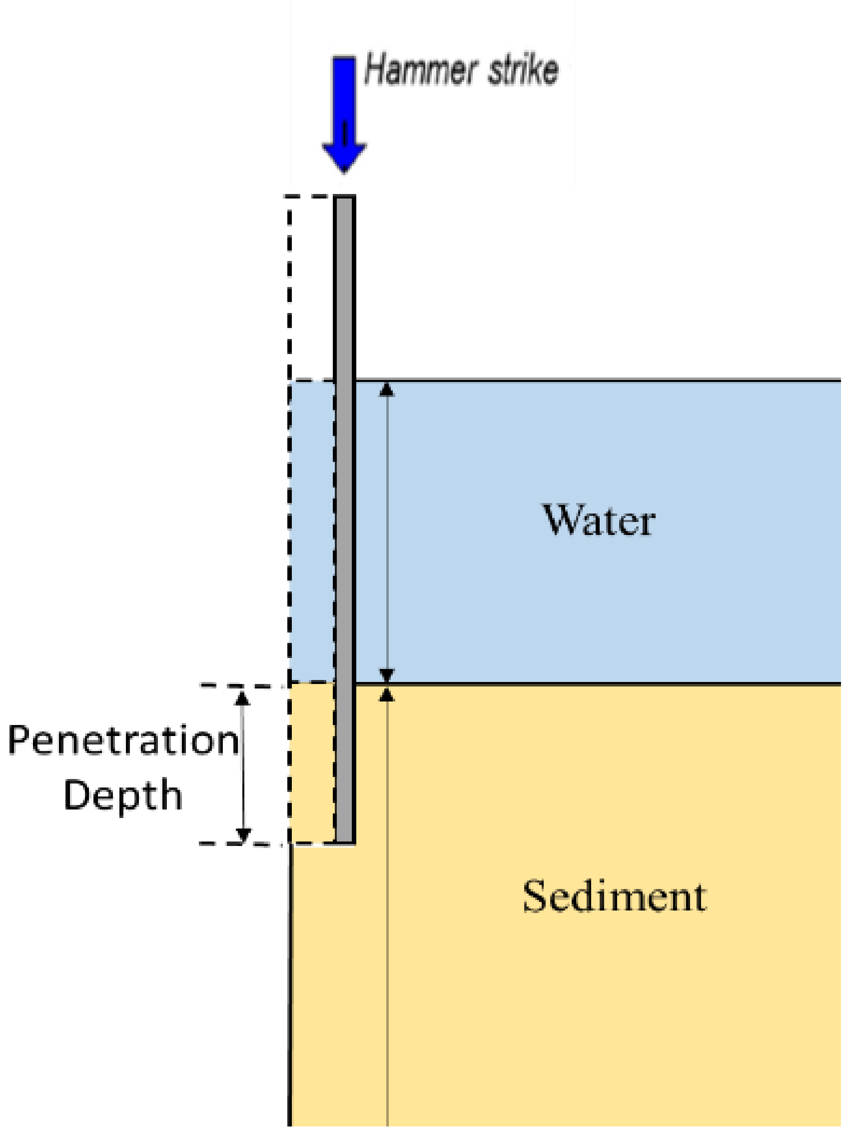


Figure 6.3-1 FEM Model Structure for Piling Noise

Table 6.3-1 Finite Element Parameters for Simulations

Parameter		Values	Unit
Piles	Young's modulus	210	GPa
	Poisson's ratio	0.3	
	Density	7850	kg/m^3
	Pile diameter	8(Jacket), 4(OSS)	m
	Pile length	130(Jacket), 140(OSS)	m
	Pile wall thickness	0.12(Jacket), 0.08(OSS)	m
Sediment	Speed of sound	1598-1674	m/s
	Density	1988-2069	kg/m^3
Other	Frequencies	10 to 1000	Hz
	Max grid dimensions	0.375 (l min / 4)	m

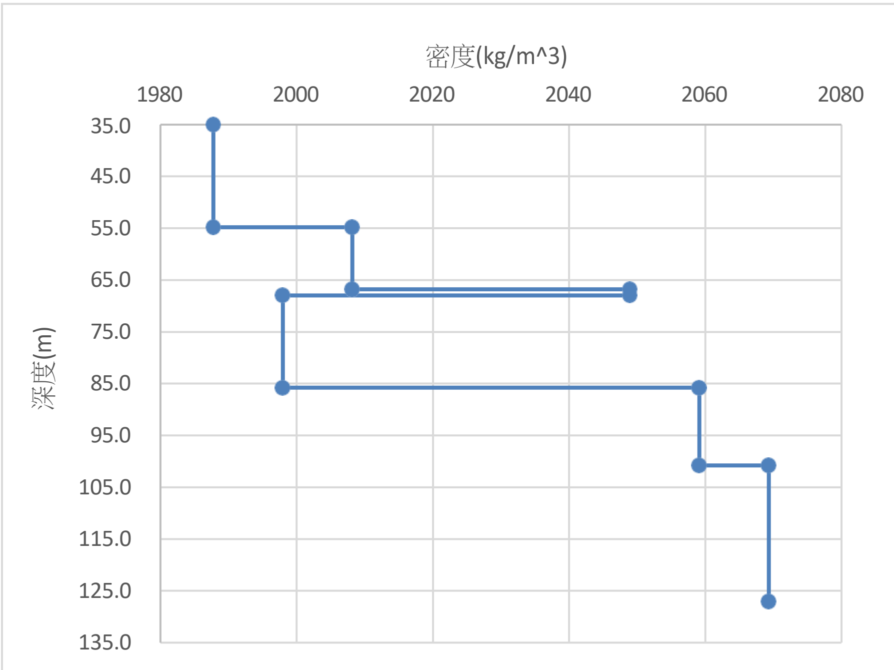


Figure 6.3-2 Density Distribution of Wind Farm Sediment Profile

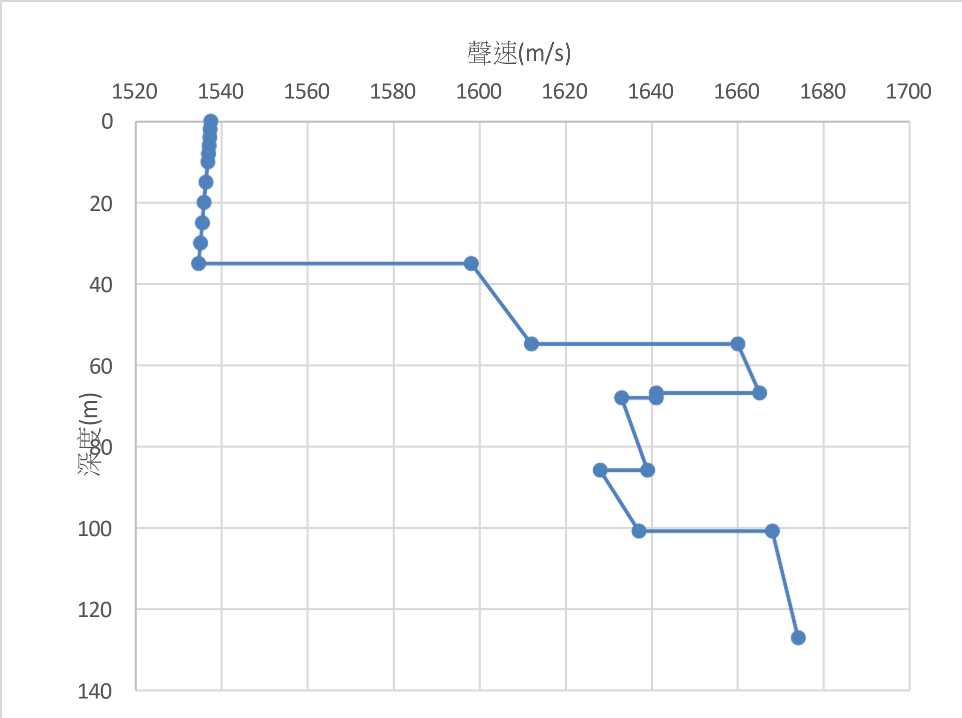


Figure 6.3-3 Density Distribution of Speed of Sound in Wind Farm Water Layers and Seabed Sediment Profile

2. Range-dependent Acoustic Model, RAM

A parabolic equation (PE) for acoustic propagation is used to calculate the underwater acoustic energy transfer in a marine environment. For this wave equation, a cylindrical coordinate system is applied (r: distance, θ: angle, z: depth) and assuming that marine environment is linearly symmetric, the acoustic field is not impacted by θ. Therefore, the equation can be simplified into a two-dimensional equation. This PE approximation method can be applied for a range dependent marine environment which includes marine environments with complex hydrology.

For this wind farm, the RAM method is used to calculate transmission loss in surrounding marine areas of the piling location. The frequency parameters for this simulation will be between 80 Hz-400 Hz, as the piling energy for wind turbines is usually between 80Hz-400Hz. The simulation will calculate the transmission loss within 1km radius of the piling location and the sound exposure level (SEL) is also calculated by combining the strength of the sound source. The simulation process is as shown in Figure 6.3-4.

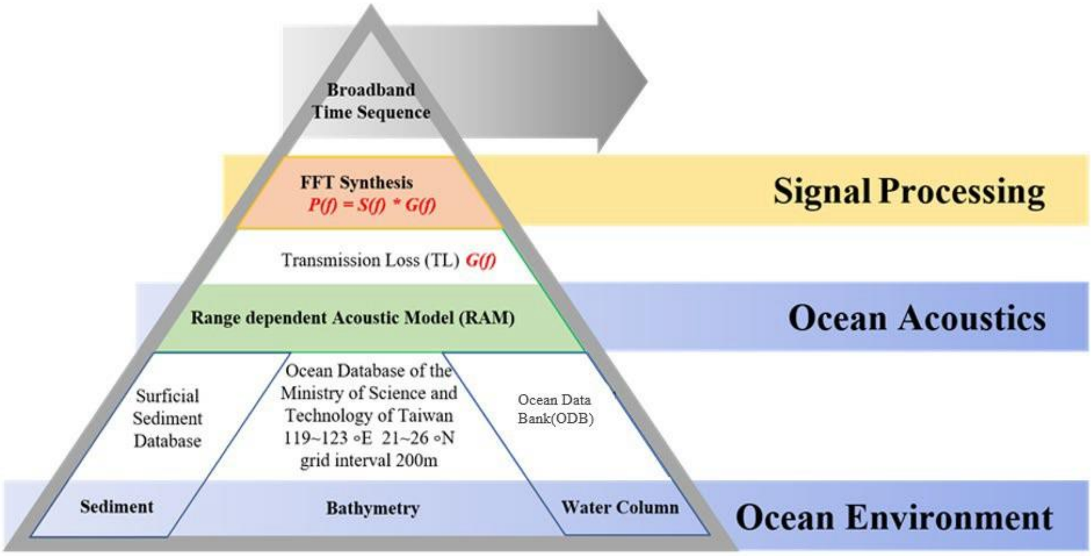


Figure 6.3-4 RAM Simulation Process

Table 6.3-2 Wind Farm Sediment Parameters

Seabed Depth(m)	Speed of Sound(m/s)	Density(kg/m^3)
0-19.8	1598-1660	1988-2008
19.8-31.8	1612-1665	1988-2049
31.8-33.0	1633-1665	1988-2049
33.0-50.8	1628-1641	1998-2059
50.8-65.8	1628-1668	1998-2069
65.8-92.0	1637-1674	2059-2069

Table 6.3-3 Environmental and Pile Design Parameters for Simulations

	Values	**Unit**
Local Water Depth	33(WTG NO.20), 36(OSS), 37(WTG NO.38)	m
Month	July	-
Distance of Calculations	1	km
Degree of Calculations	8 Directions	-
Grid	Horizontal calculation grid 10m Horizontal output grid 50 m Vertical calculation grid 1 m Vertical output grid 1 m	m

3. Sound Exposure Level (SEL) Method for Calculations

As shown in formula (1), multiple pressure levels, $P_{ijk}(r, z_k, f_j, z_i)$, are calculated by multiplying the frequency spectrum, $S_{ij}(f_j)$, and Green's Function, $G_{ijk}(r, z_k, f_j, z_i)$. The sound source depth is z_i, frequency is f_j, reception depth is z_k, and horizontal distance of reception is r.

$$P_{ijk}(r, z_k, f_j, z_i) = S_{ij}|_{f_j, z_i} \cdot G_{ijk}(r, z_k, f_j, z_i) \quad (1)$$

Within the formula:

i = 1, 2, …, I (data points for the depth of different point sources)

j = 1, 2, …, J (data points for frequency)

k = 1, 2, …, K(data points for reception depth) I= (Zmax)i/dzi

J = 80Hz to 400Hz

K = (Zmax)k /dzk

The aforementioned $(Z_{max})_i$ represents the depth from sea surface to seabed for the sound source; and $(Z_{max})_k$ represents the depth from sea surface to seabed for reception (r). The sum of multiple sound pressures in a single frequency band for reception at 750m distance, as shown in formula (2), is calculated by adding multiple sound pressures from the point sources of different depths from formula (1). The sound exposure level at 750m from piling is calculated, as shown in formula (3), by calculating the squared absolute value of the sum from multiple sound pressures in the relevant frequency band, then multiplying the bandwidth of each frequency band, Δf_j, and finally accumulating the frequency band.

$$P_{jk} = \Sigma_i P_{ijk}$$

$$SEL_k = 10 \log (\Sigma_j \, |P_{jk}|^2 * \Delta f_j)$$

Δf_j represents the bandwidth of each frequency band between 80Hz and 400Hz.

II. Simulation Results

The sound pressure within a frequency domain output by the aforementioned finite element analysis is used as multiple point sources. 1 sound source from every 1m in water depth is used, and by combining the energy of sound sources from various depths with transmission losses of each frequency, the SEL at 750m from the piling location is calculated. The simulation locations are as shown in Table 6.3-

4.

The underwater noise simulation results vary due to the different penetration depths of the pile. Therefore, simulations are conducted with scenarios for each penetration depth. The results (Table 6.3.5 to Table 6.3.7) indicate when the penetration depth for the underwater foundations of the WTG and OSS is at 10m, the simulation results for underwater noise at 750m is higher compared to other penetration depths. As such, the following discussion for this amendment is conducted considering the max impact, at 10m penetration depth.

The FEM noise source spectrogram for simulations of 10m penetration depth is shown in Figure 6.3-8 to Figure 6.3-10. The SEL distribution in each water layer at 750m is as shown in Figure 6.3-11; the SEL distribution at half water depth is as shown in Figure 6.3-12; the simulation results for the WTG and OSS foundation are as shown in Table 6.3-8 to Table 6.3-10. After simulations, max SEL for WTG jacket type foundations is 175.0dB and 175.1 dB at 2 separate locations, and max SEL for OSS foundation is 170.8dB.

Table 6.3-4 Data of Locations

Item	WTG no.38 jacket type foundation	WTG no.20 jacket type foundation	OSS
Coordinates	24°12’18.15"N, 119°53’56.34"E	24°12’35.56"N, 119°47’2.68"E	24°14’5.99"N, 119°54’13.98"E
Water Depth	37m	33m	36m
Distance	1km	1km	1km
Pile Diameter	8m	8m	4m
Pile Length	130m	130m	140m
Pile Wall Thickness	0.12m	0.12m	0.08m

Table 6.3-5 SEL 750m from the Piling Site in Different Depth at Turbine No. 38

Penetration depth	10	20	30	40	50	60	70	80	90	100	110	120
SEL	175.0	172.5	172.7	172.2	172.2	173.0	173.5	174.3	174.9	174.7	172.9	168.8

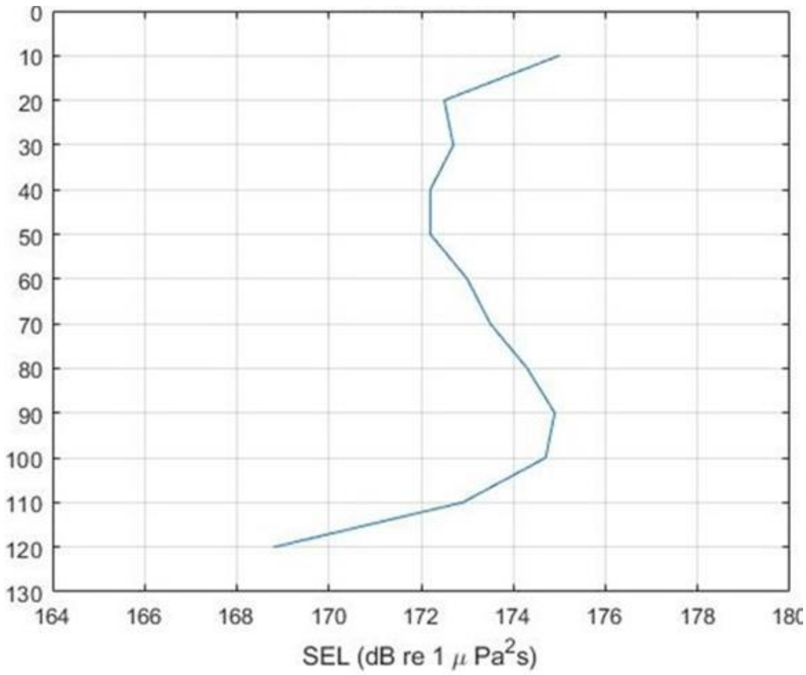


Figure 6.3-5 SEL Profile at Turbine No. 19

Table 6.3-6 SEL 750m from the Piling Location at WTG No. 20 in Different Penetration Depth

Penetration Depth	10	20	30	40	50	60	70	80	90	100	110	120
SEL	175.1	172.2	171.9	171.8	172.0	172.5	173.1	173.7	174.5	174.8	173.4	169.2

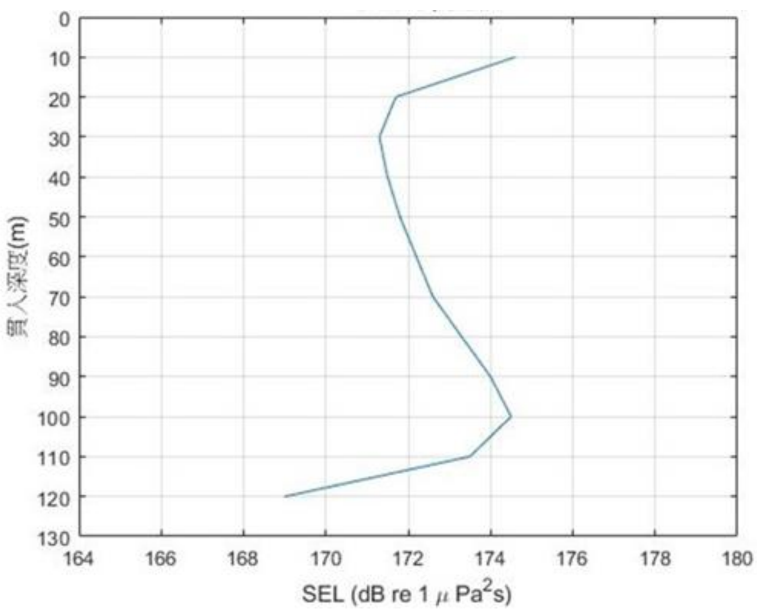


Figure 6.3-6 SEL Profile at Turbine No. 20

Table 6.3-7 SEL 750m from the Piling Location at OSS in Different Penetration Depth

Penetration Depth	10	20	30	40	50	60	70	80	90	100	110	120
SEL	170.8	167.1	167.8	167.6	168.2	168.7	169.2	170.0	170.8	170.6	170.6	169.5

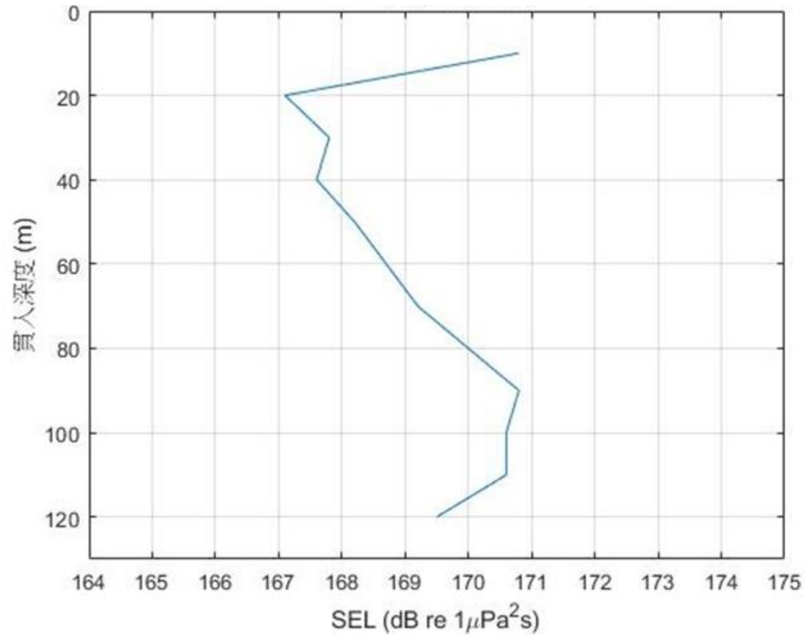


Figure 6.3-7 SEL Profile at OSS

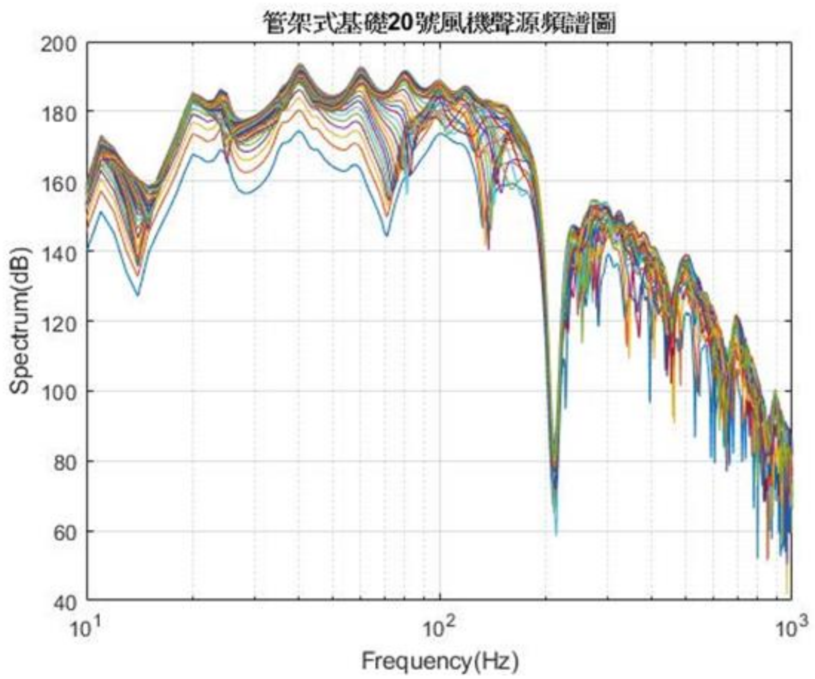


Figure 6.3-8 Spectrum of Noise at the No.20 Turbine (Jacket Type)

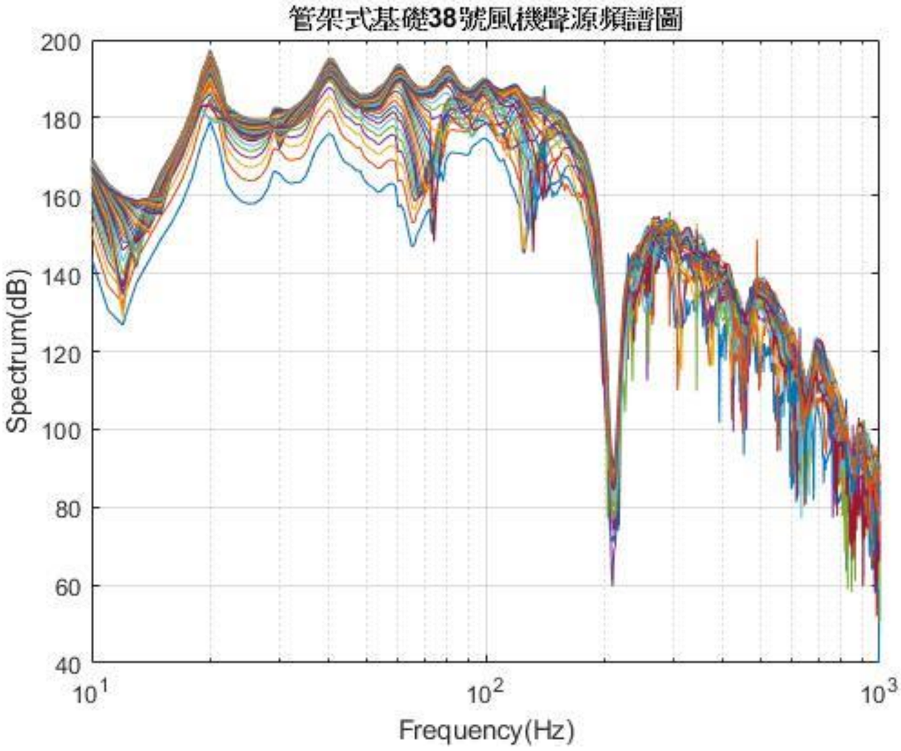


Figure 6.3-9 Spectrum of Noise at the No.38 Turbine (Jacket Type)

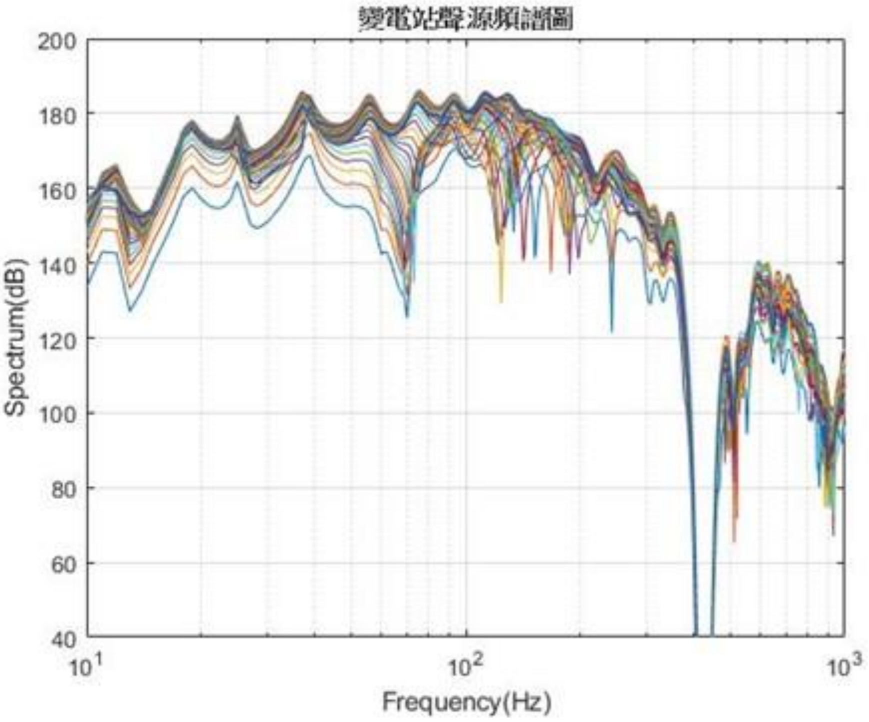
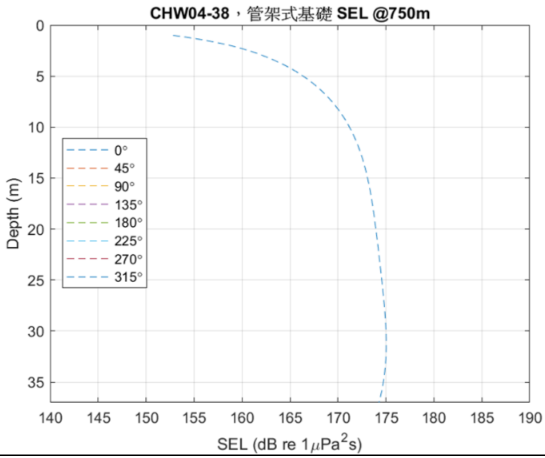
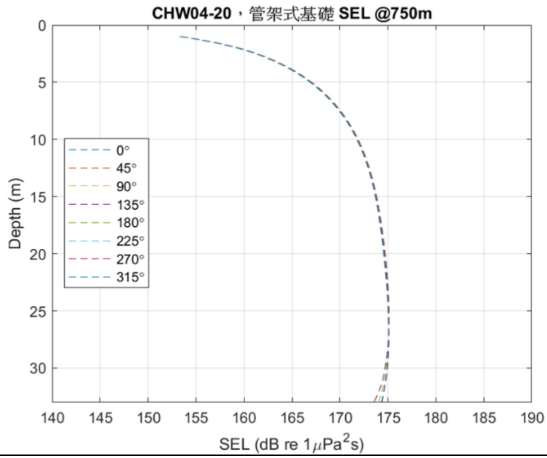


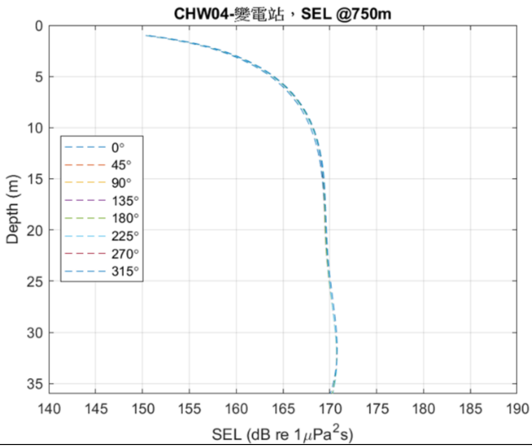
Figure 6.3-10 Spectrum of Noise at the OSS



WTG NO.38 (Jacket foundation)

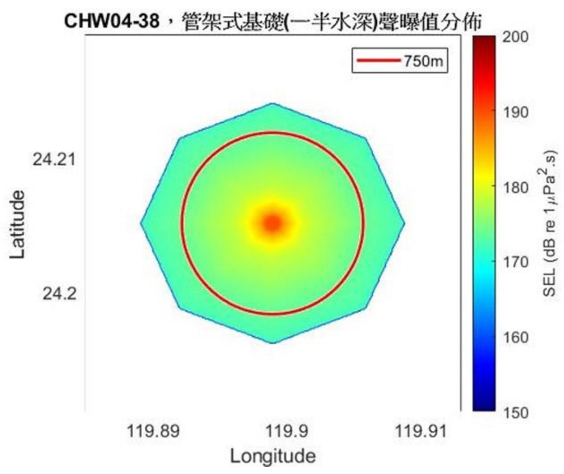
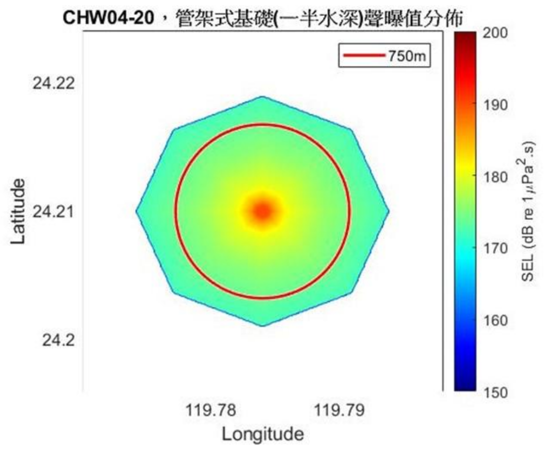


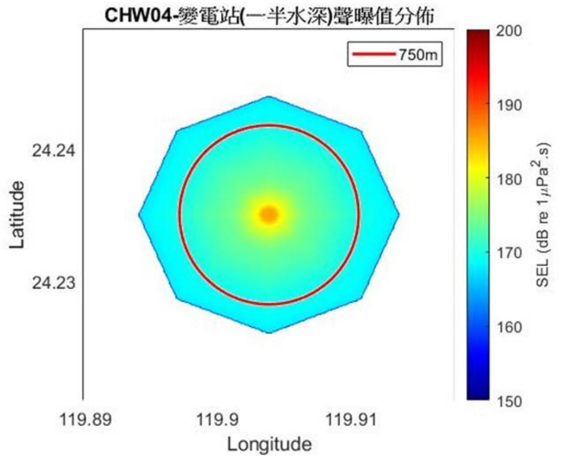
WTG NO. 20 (Jacket foundation)



OSS

Figure 6.3-11 SEL Value 750m from the Pill wall

	
Turbine No.38 Jacket Type Foundation	Turbine No.20 Jacket Type Foundation



OSS

Figure 6.3-12 SEL Distribution at Half Water Depth(18m)

Table 6.3-8 CHW04 – WTG No.38 Jacket Type Foundation SEL@750m (dB re 1μP^2s) in 8 Directions

WTG No.38								
Depth (m)	Bearing Angle							
	0°	45°	90°	135°	180°	225°	270°	315°
1	152.8	152.8	152.8	152.8	152.8	152.8	152.8	152.8
2	158.8	158.8	158.8	158.8	158.8	158.8	158.8	158.8
3	162.2	162.2	162.2	162.2	162.2	162.2	162.2	162.2
4	164.6	164.6	164.6	164.6	164.6	164.6	164.6	164.6
5	166.4	166.4	166.4	166.4	166.4	166.4	166.4	166.4
6	167.8	167.8	167.8	167.8	167.8	167.8	167.8	167.8
7	168.9	168.9	168.9	168.9	168.9	168.9	168.9	168.9
8	169.8	169.8	169.8	169.8	169.8	169.8	169.8	169.8
9	170.6	170.6	170.6	170.6	170.6	170.6	170.6	170.6
10	171.2	171.2	171.2	171.2	171.2	171.2	171.2	171.2
11	171.7	171.7	171.7	171.7	171.7	171.7	171.7	171.7
12	172.2	172.2	172.2	172.2	172.2	172.2	172.2	172.2
13	172.5	172.5	172.5	172.5	172.5	172.5	172.5	172.5
14	172.8	172.8	172.8	172.8	172.8	172.8	172.8	172.8
15	173.1	173.1	173.1	173.1	173.1	173.1	173.1	173.1
16	173.3	173.3	173.3	173.3	173.3	173.3	173.3	173.3
17	173.5	173.5	173.5	173.5	173.5	173.5	173.5	173.5
18	173.7	173.7	173.7	173.7	173.7	173.7	173.7	173.7
19	173.8	173.8	173.8	173.8	173.8	173.8	173.8	173.8
20	174.0	174.0	174.0	174.0	174.0	174.0	174.0	174.0
21	174.1	174.1	174.1	174.1	174.1	174.1	174.1	174.1
22	174.2	174.2	174.2	174.2	174.2	174.2	174.2	174.2
23	174.3	174.3	174.3	174.3	174.3	174.3	174.3	174.3
24	174.5	174.5	174.5	174.5	174.5	174.5	174.5	174.5
25	174.6	174.6	174.6	174.6	174.6	174.6	174.6	174.6
26	174.7	174.7	174.7	174.7	174.7	174.7	174.7	174.7
27	174.8	174.8	174.8	174.8	174.8	174.8	174.8	174.8
28	174.9	174.9	174.9	174.9	174.9	174.9	174.9	174.9
29	175.0	175.0	175.0	175.0	175.0	175.0	175.0	175.0
30	175.0	175.0	175.0	175.0	175.0	175.0	175.0	175.0
31	175.0	175.0	175.0	175.0	175.0	175.0	175.0	175.0
32	175.0	175.0	175.0	175.0	175.0	175.0	175.0	175.0
33	175.0	175.0	175.0	175.0	175.0	175.0	175.0	175.0
34	174.9	174.9	174.9	174.9	174.9	174.9	174.9	174.9
35	174.7	174.7	174.7	174.7	174.7	174.7	174.7	174.7
36	174.5	174.5	174.5	174.5	174.5	174.5	174.5	174.5
37	174.3	174.3	174.3	174.3	174.3	174.3	174.3	174.3

Table 6.3-9 CHW04 – WTG No. 20 Jacket Type Foundation SEL@750m in 8 Directions (dB re 1μPa^2s)

WTG No.20								
Depth (m)	Bearing Angle							
	0°	45°	90°	135°	180°	225°	270°	315°
1	153.4	153.4	153.5	153.5	153.4	153.3	153.3	153.3
2	159.4	159.4	159.5	159.4	159.4	159.3	159.3	159.3
3	162.8	162.8	162.9	162.9	162.8	162.7	162.7	162.7
4	165.2	165.2	165.3	165.3	165.2	165.1	165.1	165.1
5	167.0	167.0	167.1	167.1	167.0	166.9	166.9	166.9
6	168.4	168.4	168.5	168.5	168.4	168.3	168.3	168.3
7	169.5	169.5	169.6	169.6	169.5	169.4	169.5	169.4
8	170.5	170.5	170.5	170.5	170.5	170.4	170.4	170.4
9	171.2	171.2	171.3	171.3	171.2	171.1	171.2	171.1
10	171.9	171.9	171.9	171.9	171.9	171.8	171.8	171.8
11	172.4	172.4	172.4	172.4	172.4	172.3	172.3	172.3
12	172.8	172.8	172.9	172.9	172.8	172.7	172.8	172.7
13	173.2	173.2	173.2	173.3	173.2	173.1	173.1	173.1
14	173.5	173.5	173.6	173.6	173.5	173.4	173.5	173.4
15	173.8	173.8	173.8	173.8	173.8	173.7	173.7	173.7
16	174.0	174.0	174.1	174.1	174.0	173.9	173.9	173.9
17	174.2	174.2	174.3	174.3	174.2	174.1	174.1	174.1
18	174.4	174.4	174.4	174.4	174.4	174.3	174.3	174.3
19	174.5	174.5	174.6	174.6	174.5	174.4	174.5	174.4
20	174.7	174.7	174.7	174.7	174.7	174.6	174.6	174.6
21	174.8	174.8	174.9	174.8	174.8	174.7	174.7	174.7
22	174.9	174.9	175.0	175.0	174.9	174.8	174.8	174.8
23	175.0	175.0	175.0	175.0	175.0	174.9	174.9	174.9
24	175.0	175.0	175.1	175.1	175.0	175.0	175.0	175.0
25	175.1	175.1	175.1	175.1	175.1	175.0	175.1	175.0
26	175.1	175.1	175.1	175.1	175.1	175.1	175.1	175.1
27	175.1	175.1	175.1	175.1	175.1	175.1	175.1	175.1
28	175.0	175.0	175.0	175.0	175.0	175.1	175.1	175.1
29	175.0	175.0	174.9	174.9	175.0	175.0	175.0	175.0
30	174.8	174.8	174.7	174.7	174.8	174.9	175.0	174.9
31	174.6	174.6	174.5	174.5	174.6	174.8	174.8	174.8
32	174.4	174.4	174.1	174.1	174.4	174.6	174.6	174.6
33	174.0	174.0	173.6	173.5	174.0	174.3	174.4	174.3

Table 6.3-10 OSS Jacket Type Foundation SEL@750m in 8 Directions (dB re 1μPa^2s)

OSS								
Depth (m)	Bearing Angle							
	0°	45°	90°	135°	180°	225°	270°	315°
1	150.4	150.6	150.5	150.7	150.7	150.6	150.7	150.7
2	156.3	156.5	156.5	156.6	156.6	156.5	156.7	156.7
3	159.7	159.9	159.9	160.0	160.0	159.9	160.1	160.1
4	162.0	162.2	162.2	162.3	162.3	162.2	162.4	162.4
5	163.7	163.9	163.9	164.0	164.0	163.9	164.0	164.0
6	165.0	165.2	165.2	165.3	165.3	165.2	165.3	165.3
7	166.0	166.2	166.2	166.3	166.3	166.2	166.3	166.3
8	166.8	167.0	167.0	167.0	167.1	167.0	167.1	167.1
9	167.4	167.6	167.6	167.7	167.7	167.6	167.7	167.7
10	167.9	168.1	168.1	168.1	168.2	168.1	168.2	168.2
11	168.3	168.5	168.5	168.5	168.5	168.5	168.6	168.6
12	168.6	168.8	168.8	168.8	168.8	168.8	168.9	168.9
13	168.9	169.0	169.0	169.0	169.0	169.0	169.1	169.1
14	169.1	169.2	169.2	169.2	169.2	169.2	169.3	169.3
15	169.2	169.3	169.3	169.3	169.3	169.3	169.4	169.4
16	169.3	169.4	169.4	169.3	169.4	169.4	169.5	169.5
17	169.4	169.5	169.5	169.4	169.4	169.5	169.5	169.5
18	169.4	169.5	169.5	169.4	169.4	169.5	169.6	169.6
19	169.5	169.6	169.6	169.5	169.5	169.6	169.6	169.6
20	169.5	169.6	169.6	169.5	169.5	169.6	169.6	169.6
21	169.6	169.6	169.6	169.5	169.6	169.6	169.7	169.7
22	169.6	169.7	169.7	169.6	169.6	169.7	169.8	169.8
23	169.7	169.8	169.8	169.7	169.7	169.8	169.8	169.8
24	169.8	169.9	169.9	169.8	169.8	169.9	169.9	169.9
25	169.9	170.0	170.0	169.9	169.9	170.0	170.1	170.1
26	170.1	170.1	170.1	170.1	170.1	170.1	170.2	170.2
27	170.2	170.2	170.2	170.2	170.2	170.2	170.3	170.3
28	170.3	170.3	170.3	170.3	170.3	170.4	170.5	170.5
29	170.5	170.5	170.5	170.5	170.5	170.5	170.6	170.6
30	170.6	170.6	170.6	170.6	170.6	170.6	170.7	170.7
31	170.7	170.7	170.7	170.7	170.7	170.7	170.8	170.8
32	170.7	170.7	170.7	170.7	170.7	170.7	170.8	170.8
33	170.7	170.7	170.7	170.7	170.7	170.7	170.7	170.7
34	170.7	170.7	170.7	170.6	170.6	170.7	170.6	170.6
35	170.5	170.5	170.5	170.5	170.5	170.5	170.4	170.4
36	170.3	170.3	170.3	170.2	170.2	170.3	170.0	170.0

II. Noise Reduction Measures and Effectiveness

Simulation results of piling noise indicate the SEL for jacket type foundation and offshore substation piles at each location will exceed the commitment limitation (Underwater noise cannot exceed 160dB for more than 5% of records. The max underwater noise level cannot exceed SPL_{peak}190 dB re. 1μPa.), therefore, noise reduction measures must be implemented. Currently, the most widely used measure for commercial purposes is the Big Bubble Curtain (BBC). Air pumps installed on the seabed will be used to continuously produce bubbles, and the resonance frequency is based on the size of the bubbles, which also determines the noise reduction frequency. The buoyancy of the water raises the air bubbles to form a curtain that completely surrounds the pile structure; thus, energy attenuation occurs when noise radiation from the piling construction passes through the bubble curtain (as shown in Figure 6.3-13). In reference to relevant cases and literature from wind farms in Europe, noise reduction of DBBC with $0.3m^3$/min·m of air supply is around 8-13dB in water depths around 40m. The effectiveness of the bubble curtain is as shown in Table 6.3-11. The underwater noise simulation results are all above the commitment limitation. Therefore, Double Big Bubble Curtain (DBBC) should be used during the entire process, which should reduce underwater noise to below 160dB SEL. However, during the actual operation, the expected effectiveness of noise reduction cannot be achieved continuously without error as environmental factors including tides, currents, and benthic organisms will come into play. As such, underwater noise monitoring devices should be deployed and used in real-time during the construction process to monitor the underwater noise variation. For this Project, 4 underwater acoustic devices will be deployed to monitor noise levels in real-time at 750m from the center point for turbine foundations. Warning will be implemented, and contingency response measures will be taken when measurements exceed warning levels, such as lowering piling energy (kJ) or lowering piling speed (blow count), and enhancing noise mitigation measures (e.g. increasing air supply for BBC) to control and reduce the underwater noise in real-time. The entire process from noise monitoring contact and coordination implementing response measures□ to reducing underwater noise can be completed in a matter of minutes (as shown in Figure 6.3-14 and Figure 6.3-15). This can ensure the effectiveness of response measures and prevent sudden increases in underwater noise of exceeding the EIA limitation.

Table 6.3-11 Noise Reduction Effectiveness of Bubble Curtains with Various Specifications

No.	Noise Reduction via Bubble Curtain (Model, Air Supply, Water Depth)	Noise Reduction Effectiveness ΔSEL [dB] (min./ average/ max.)	No. of Piles in Measure ments
1	Big bubble curtain (BBC) (> 0.3 m^3/(min·m), water depth < 25 m)	$11 \leq 14 \leq 15$	> 150
2	Double big bubble curtain (DBBC) (> 0.3 m^3/(min·m), water depth < 25 m)	$14 \leq 17 \leq 18$	> 150
3	Big bubble curtain (BBC) (> 0.3 m^3/(min·m), water depth approx. 30 m)	$8 \leq 11 \leq 14$	< 20
4	Big bubble curtain (BBC) (> 0.3 m^3/(min·m), water depth approx. 40 m)	$7 \leq 9 \leq 11$	30
5	Double big bubble curtain (DBBC) (> 0.3 m^3/(min·m), water depth approx. 40 m)	$8 \leq 11 \leq 13$	8

Literature in reference:
Bellmann M. A., Brinkmann J., May A., Wendt T., Gerlach S. & Remmers P. (2020) Underwater noise during the impulse pile-driving procedure: Influencing factors on pile-driving noise and technical possibilities to comply with noise mitigation values.

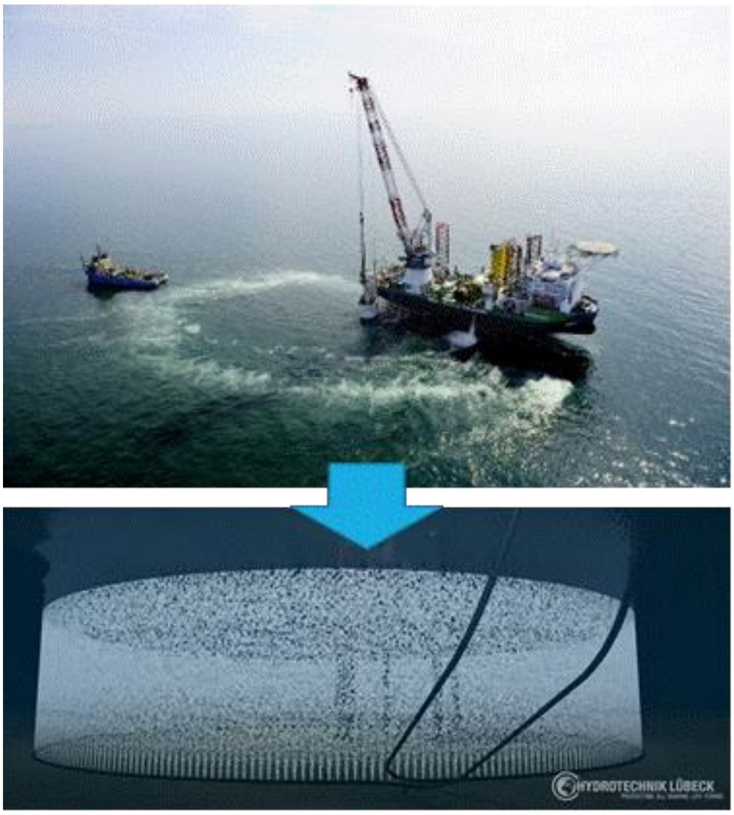


Figure 6.3-13 Underwater Noise Reduction Methods in Operation

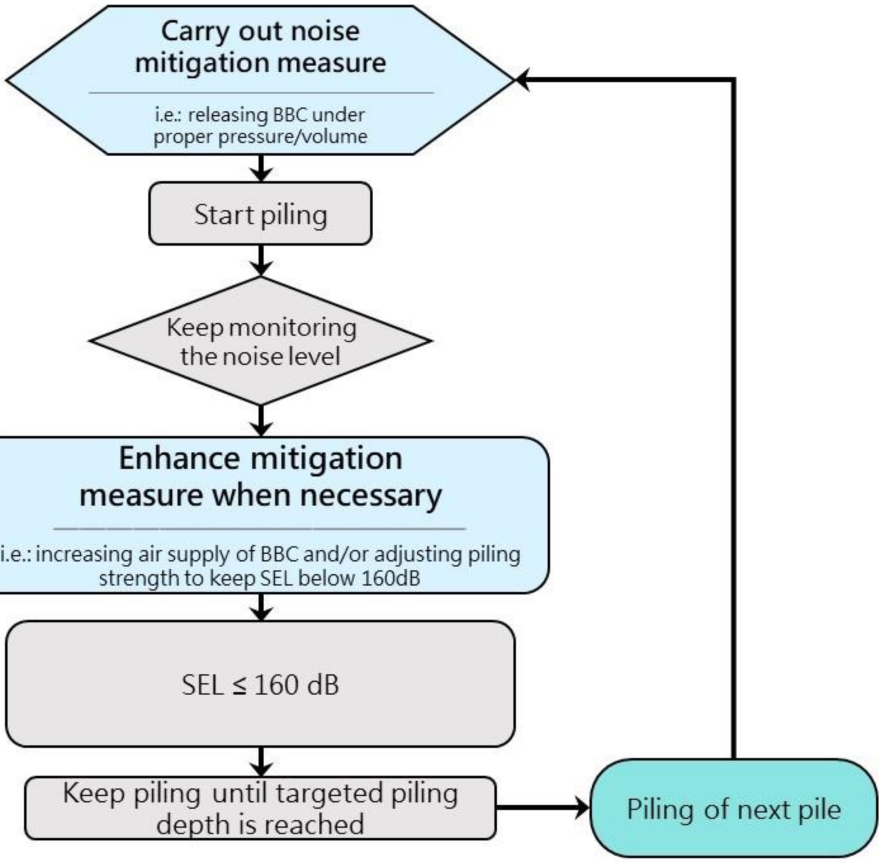


Figure 6.3-14 Process for Underwater Noise Reduction Measures

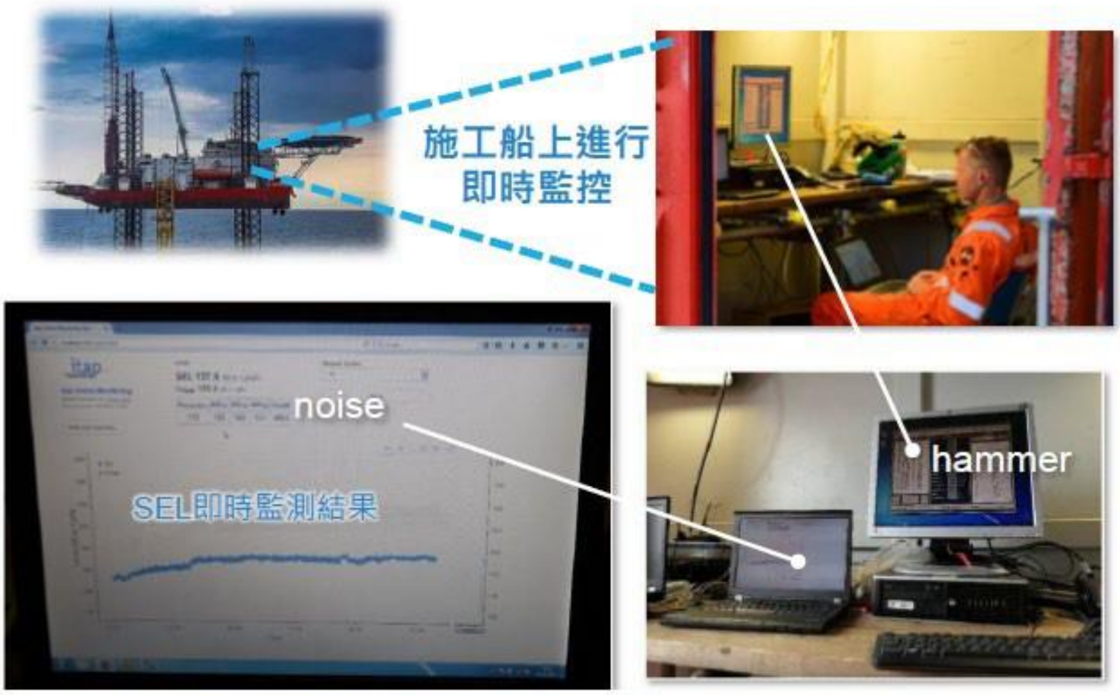


Figure 6.3-15 Real-time Monitoring on the Construction Vessel during Piling

IV. Comprehensive Discussion

i Duration of Noise

The duration of the underwater noise can be discussed from two perspectives:

(a) The overall construction time. However, due to the on-site geology and the limitations to lower underwater piling noise, it is difficult to estimate the time for each foundation pile.

(b) For the echo of underwater piling noise, when the sound pulse is longer than the pause between strikes, the sound pulse will overlap with each other. As per the underwater noise inspection method (NIEA P206.90B) issued by EAL and the original EIS commitment, the SEL can be measured basing on single strike event. Each data will last for 30s, when the time of strikes (N) and equivalent SEL (average level, or L_{eq30s}), the values will be used to calculated SEL for single strike (average pile strikes in 30s) as the reference to see if the value exceed the threshold.

ii Impact assessment on CWD Important Habitat

CWD Important Habitat is used in the simulation of the decline of underwater noise 750m from the piling site. The wind farm is over 45 km from the boundary of CWD Important Habitat. When arriving at the boundary of CWD Important Habitat, the max. SEL of the piling noise from the wind farm all declines to 124.6 dB, and is similar to the background noise of the area.

6.4 Electromagnetic Field

The configuration of the transmission system is revised in this amendment. Therefore, assessment of difference in electromagnetic field is conducted for areas surrounding the onshore substation and the transmission cable route. The following is an explanation for difference in impact after this amendment.

6.4.1 Current Environmental Conditions

Supplemental survey for the electromagnetic field was conducted in September, 2020, and survey locations are as shown in Table 6.4.1-1 and Figure 6.4.1-1. 6 monitoring spots were chosen for the magnetic field simulation along the onshore cable trench between the submarine cable landfall to the planned site of the onshore substation as well as between the planned site for the onshore substation to the ChungKong substation. Simulations and calculations were conducted, and the survey results are as shown in Table 6.4.1-2. The measurement of background values in each monitoring spot for the land cable pipeline is in compliance with reference value (833mG) for electromagnetic field (60Hz) exposure limit. The reference value was announced in “Guidelines to Exposure Limits for Time- Varying Electric Field, Magnetic Field and Electromagnetic Field” by the EPA on November 30th, 2012 (EPA#1010108068).

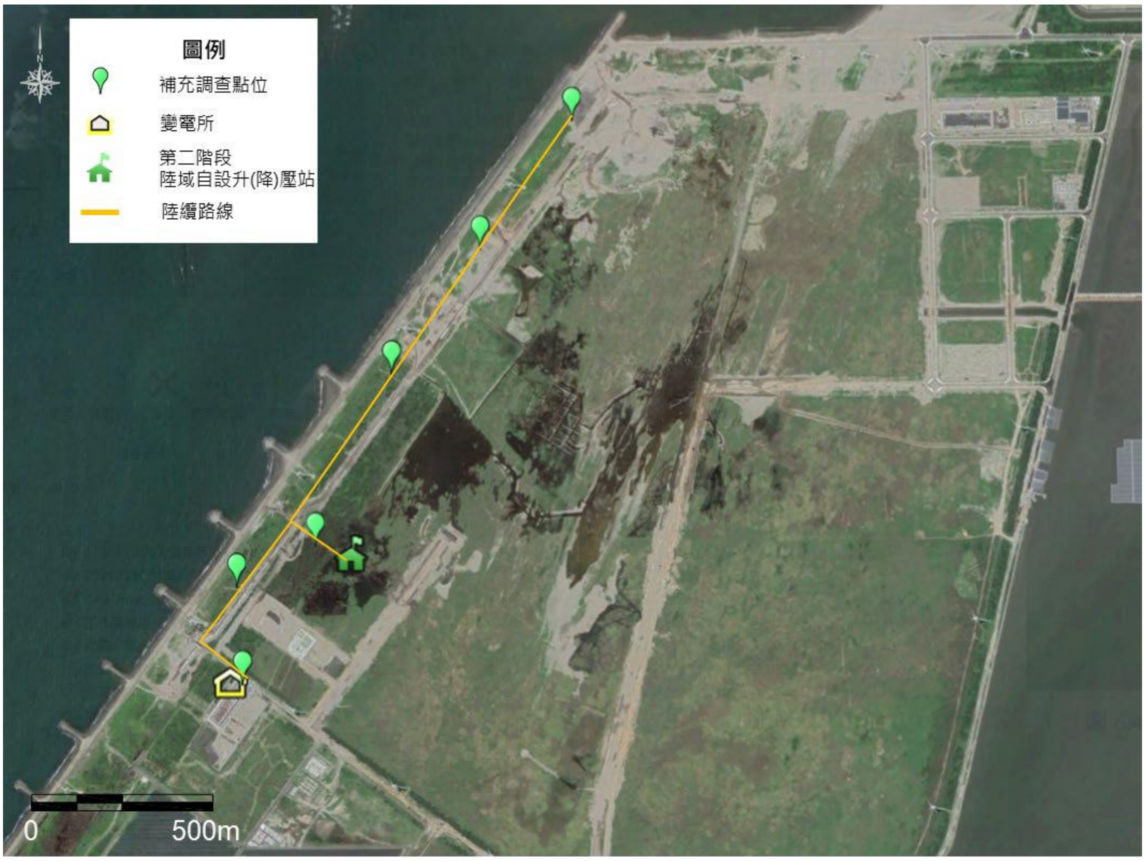


Figure 6.4.1-1 Survey Locations for Electromagnetic Field

Table 6.4.1-1 Sensitive Spots and the Corresponding Serial Number for Supplemental Background Surveys

Sensitive Spot No.	Sensitive Spot
T1	Submarine Cable Landfall
T2	Midway Point 1 Between Landfall and Onshore Substation
T3	Midway Point 2 Between Landfall and Onshore Substation
T4	Entrance to Onshore Substation
T5	Midway Point Between Onshore Substation and TPC ChungKong Substation
T6	Entrance to TPC ChungKong Substation

Table 6.4.1-2 Simulation Results of Supplemental Background Surveys

		Max Value (mG)	Min Value (mG)	Average Value (mG)	EPA Reference Value (mG)
T1	Weekend	16.0	9.57	12.79	833
	Non-Weekend	19.2	10.46	14.83	833
T2	Weekend	17.8	7.65	12.73	833
	Non-Weekend	14.84	5.55	10.2	833
T3	Weekend	15.6	10.57	13.09	833
	Non-Weekend	16.2	8.15	12.18	833
T4	Weekend	33.0	15.2	24.1	833
	Non-Weekend	10.88	4.04	7.46	833
T5	Weekend	31.4	24.4	27.9	833
	Non-Weekend	12.8	9.06	10.93	833
T6	Weekend	14.8	8.15	11.48	833
	Non-Weekend	5.11	3.36	4.24	833

6.4.2 Differential Analysis for the Amendment

The configuration for the transmission system is revised in this amendment. which may impact the areas surrounding the onshore substation and the transmission cable route. Explanations are followed.

I. Assessment Method

Review and calculations of electromagnetic field along sensitive spots of the onshore cable culvert are conducted according to “Guidelines to Exposure Limits for Time-Varying Electric Field, Magnetic Field and Electromagnetic Field”. The max level for electromagnetic field in sensitive spots of the onshore cable culvert once electricity passes through is also estimated.

Based on the electromagnetic theory, it is derived that magnetic field activity generated from electrical frequency is similar to static magnetic fields. Furthermore, calculations and simulations are conducted using Finite Element Software, and are conducted for land cable culvert with 220kV and 345kV cables, 3-dimensional spatial configuration, and different current capacities.

The simulations for land cable culvert with 220kV and 345kV cables and 3-dimensional spatial configuration will be conducted as close to actual situations as possible.

Calculation considerations: During calculations, land cables in all directions are taken into consideration, and calculations are conducted for the 2 types of phase sequence in the cable arrangement. Additionally, only 2 types of current capacities are hypothesized for calculations.

Calculation results: Are compared to EPA standards (recommended levels), 833.3mG.

Simulations and calculations are conducted for the electromagnetic field, and the method of calculation for electrical frequency is derived from relevant theories on electromagnetic fields. It is derived that magnetic field activity generated from electrical frequency is similar to static magnetic fields. Furthermore, Finite Element Software is used to conduct simulations for onshore cable culvert with 220kV and 345kV cables, 3-dimensional spatial configuration.

II. Input Conditions

i Location for Electromagnetic Field Calculations and Review

Simulations are conducted for magnetic fields surrounding the cable route from the landfall to the planned site of the onshore substation and TPC ChungKong substation as well as the onshore substation site itself. Simulation and calculations are conducted for 6 total monitoring spots, and are as shown in Figure 6.4.1-1 and Table 6.4.1-1, the 6 monitoring spots in sequence are T1-T6.

ii Simulation of Transmission Route with 3-Dimensional Configuration

The profile for the onshore cable culvert and phase sequence are as shown in Figure 6.4.2-1. The electromagnetic field source is simulated in a 3-dimensional space, which fully incorporates 220kV and 345kV cables in horizontal and vertical directions.

The correct current value for each circuit is required when conducting simulations for electromagnetic fields. Total capacity for both the second phase of the Northwest wind farm as well as the Northwest wind farm is 920MW. The configuration for cables is as follows:

A total of 3 circuits for 220kV onshore cables will connect the landfall to onshore substation; and another 3 circuits for 345kV onshore cables will connect the onshore substation to the TPC ChungKong substation. Each 220kV cable is assumed to carry 804.79A in current; and each 345kV cable is assumed to carry 513.2A.

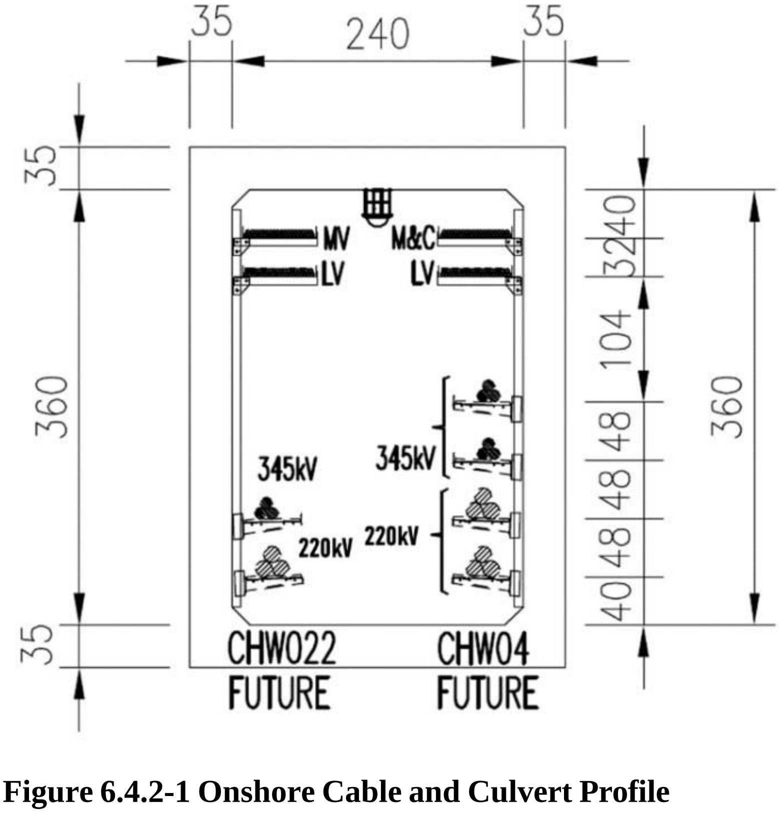


Figure 6.4.2-1 Onshore Cable and Culvert Profile

III. Analysis Results from Simulations

The calculation results indicate the max estimated value of electromagnetic fields in sensitive spots for the cable culvert are far lower than the EPA standards, 833mG, results are as detailed in Table 6.4.2-1.

Table 6.4.2-1 Compiled Chart of Electromagnetic Simulations

Sensitive Spot No.	Sensitive Spot	Calculated Value (mG)	Max Background Value (mG)		Max Background Value Average(mG)	Estimated Value (mG)	EPA Reference Value (mG)
			Non-Weekend	Weekend			
T1	Submarine Cable Landfall	7.84	19.2	16.0	19.2	20.7	833
T2	Midway Point 1 Between Landfall and Onshore Substation	14.52	14.84	17.8	17.8	22.97	833
T3	Midway Point 2 Between Landfall and Onshore Substation	14.91	16.2	15.6	16.2	22.02	833
T4	Entrance to Onshore Substation	0.23	10.88	33.0	33.0	33.0	833
T5	Midway Point Between Onshore Substation and TPC ChungKong Substation	19.17	12.8	31.4	31.4	36.79	833
T6	Entrance to TPC ChungKong Substation	0.17	5.11	14.8	14.8	14.8	833

Note: The calculated value is the electromagnetic value calculated using the provided conditions; the max background value average is the average of max background values from sensitive spots on weekends and non-weekends; and the estimated value is the geometric mean of the average of max background value and the calculated value, and the formula for the estimated values is $\sqrt{(\text{Max Background Value Average})^2 + (\text{Calculated Value})^2}$

6.5 Turbine Foundation Scouring and Coastal Topographic Change

I. Turbine Foundation Scouring

This amendment includes the adjustment on the design of jacket foundation (proposed in the original EIS) and the proposal of SBJ foundation as a new option. This amendment will impact the scouring between turbine foundations, therefore, assessment of differential analysis will use the FLOW-3D model, which was also used in the original EIS. A Comparison Table between the original EIS and this amendment is as shown in Table 6.5-1.

Table 6.5-1 Comparison Table for Foundation Types

Items	Original EIS	This Amendment	
Type of foundation	jacket type	jacket type	SBJ type
Maximum leg number	4	4	4
Maximum pile diameter(m)	4	8	25
Maximum pile spacing (m)	40	55	50

Analysis of scouring between foundations in the original EIS is separated into impact of ocean current and impact of waves. This amendment will assess and analyze the same conditions, and results from analysis are explained as follows:

1. Impact of Ocean Current

Relevant data for sea state from the original EIS is referenced, simulations are conducted using a conservative 1.0m/sec for flow speed. The area for calculations has a water depth of 35m, sediment particle size (0.15mm) is referenced from the median value of drilling surveys conducted in the vicinity. Condition settings in this amendment are the same as the original EIS, however, scouring of foundation 3600sec after flow speed passes through piles (when scour depth approaches stability) is simulated for the jacket foundation (after amendment) and SBJ foundation. Simulation of scouring after amendment is as shown in Figure 6.5-1 and Figure 6.5-2.

Comparisons of the simulation results and the results from the original EIS are shown in Table 6.5-2. Before amendment, pile diameter for jacket type foundation is 3.5m and 4m, and after impact of the ocean current, the max scouring depth is around -1.51m (scouring depth to pile diameter ratio (S/D) is around

0.43 and 0.38); scouring depth is deeper upstream; and the scouring area is around 2.5D. In this amendment, pile diameter for jacket type foundation is 8m, and max scouring depth is around -2.0m. However, impact between piles is not as significant as the spacing between piles is larger (55m), S/D is 0.25 and scouring area is 1.5D. In this amendment, pile diameter for SBJ type foundation is 25m, the SBJ is buried under the seabed, but 6.5m of the structure will protrude from the seabed. Scouring will not occur at the sand texture side of the foundation leg as it is replaced by the SBJ. However, scouring will still occur in front and behind the SBJ close to the seabed (-0.7m to -1.25m), and max scouring depth is around -1.25m. Deposition will occur behind the SBJ in 2 rectangular areas, max deposition is around 0.4m. Impact between piles is not as significant for SBJ foundations, S/D is 0.05 (compared using 25m SBJ) and scouring area is around 2.0D.

In summary, this amendment includes jacket type foundation and SBJ type foundation, and even though larger pile diameters cause deeper scouring, the mutual impact between piles is smaller as the spacing for jacket type foundation is larger. As for SBJ foundation, scouring is also not significant, and therefore, results for the 2 types of foundation indicate the scouring depth to pile diameter ratio is smaller compared to the original EIS. In addition, significant scouring will not occur for any type of foundation during actual operation as scour protection (rocks, rubble, etc.) will be installed to protect foundations no matter which type is used.

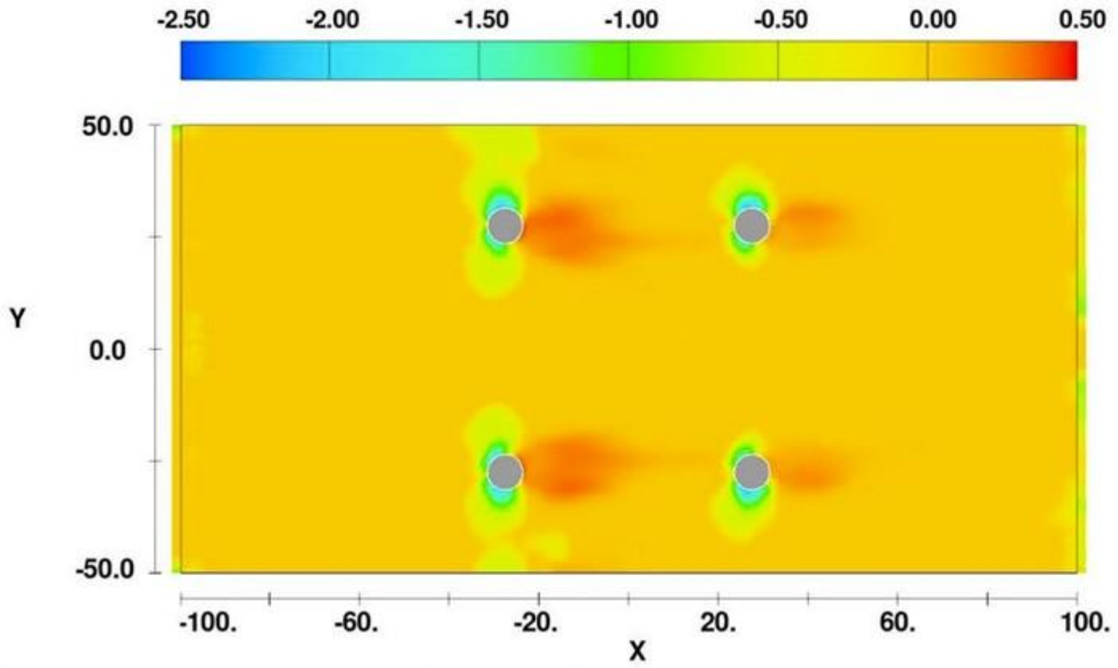


Figure 6.5-1 Distribution of Seabed Scouring for Jacket Type Foundations in this Amendment (due to Ocean Current)

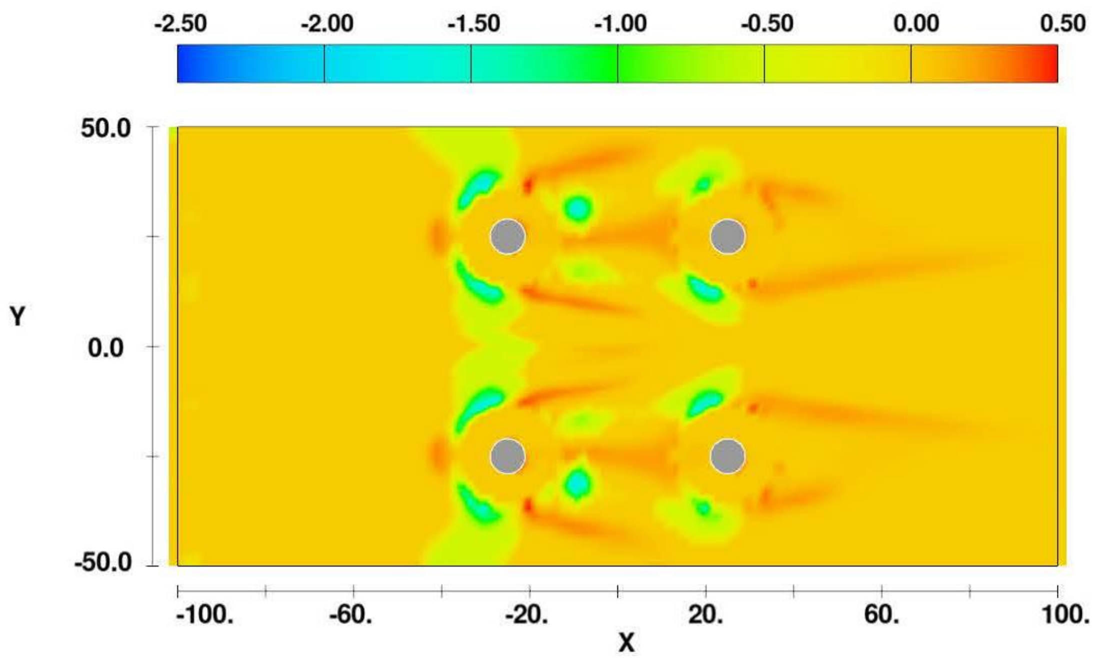


Figure 6.5-2 Distribution of Seabed Scouring of SBJ Type Foundations in this Amendment (due to Ocean Current)

Table 6.5-2 Analysis of Foundation Scouring Before and After this Amendment (due to Ocean Current)

	Pile Diameter, D (m)	Pile Spacing (m)	Scouring Depth		Scouring Area
			S(m)	S/D	
Before Amendment (Jacket Type)	3.5	38	-1.51	0.43	≒2.5D
	4	40	-1.51	0.38	≒2.5D
After Amendment (Jacket Type)	8	55	-2.0	0.25	≒1.5D
After Amendment (SBJ Type)	25	50	-0.70	0.09	≒2.0D

2. Impact of Typhoon Waves

Simulations in the original EIS was conducted using typhoon waves, wave conditions include wave height of 8.1m and cycle of 11.9sec. Additionally, water depth for piles and sediment conditions are the same as in the “Impact of Ocean Current” section. Condition settings in this amendment are the same as the original EIS, however, scouring of foundation after a typhoon wave passes through piles is simulated for the jacket foundation (after amendment) and SBJ foundation. Simulation of scouring after amendment is as shown in Figure 6.5-3 and Figure 6.5-4.

Comparisons of the simulation results and the results from the original EIS are shown in Table 6.5-3. Before amendment, pile diameter for jacket type foundation is 3.5m and 4m, and after impact of waves, the max scouring depth is around -1.15m (scouring depth to pile diameter ratio (S/D) is around 0.33 and 0.29); while scouring depth is deeper upstream. In this amendment, pile diameter for jacket type foundation is 8m, and max scouring depth is around -2.83m. However, impact between piles is not as significant as the spacing between piles is larger (55m), S/D is 0.35 and scouring area is 1.5D. In this amendment, pile diameter for SBJ type foundation is 25m, the SBJ is buried under the seabed, but 6.5m of the structure will protrude from the seabed. Scouring will not occur at the sand texture side of the foundation leg as it is replaced by the SBJ. However, significant scouring will still occur at the SBJ close to the seabed (-1m to -3.5m), and max scouring depth is around -3.5m. Deposition will occur in front and behind the SBJ in circular areas, max deposition is around 0.3m. Impact between piles is not as significant for SBJ foundations, S/D is 0.14 (compared using 25m SBJ) and scouring area is around 2.0D.

In summary, this amendment includes jacket type foundation and SBJ type foundation, and even though larger pile diameters cause deeper scouring, compared to the original EIS, the scouring depth to pile diameter ratio is only slightly bigger and the impact is still slight as the spacing between piles for jacket type foundation is larger. As for SBJ foundation, impact is also slight. Therefore, results for the 2 types of foundation indicate that scouring depth is larger compared to the original EIS only because pile diameter is also larger. In addition, significant scouring will not occur for any type of foundation during actual operation as scour protection (rocks, rubble, etc.) will be installed to protect foundations no matter which type is used.

In summation of scouring between piles after impact of both ocean current and waves, the impact of the amendment is only slight.

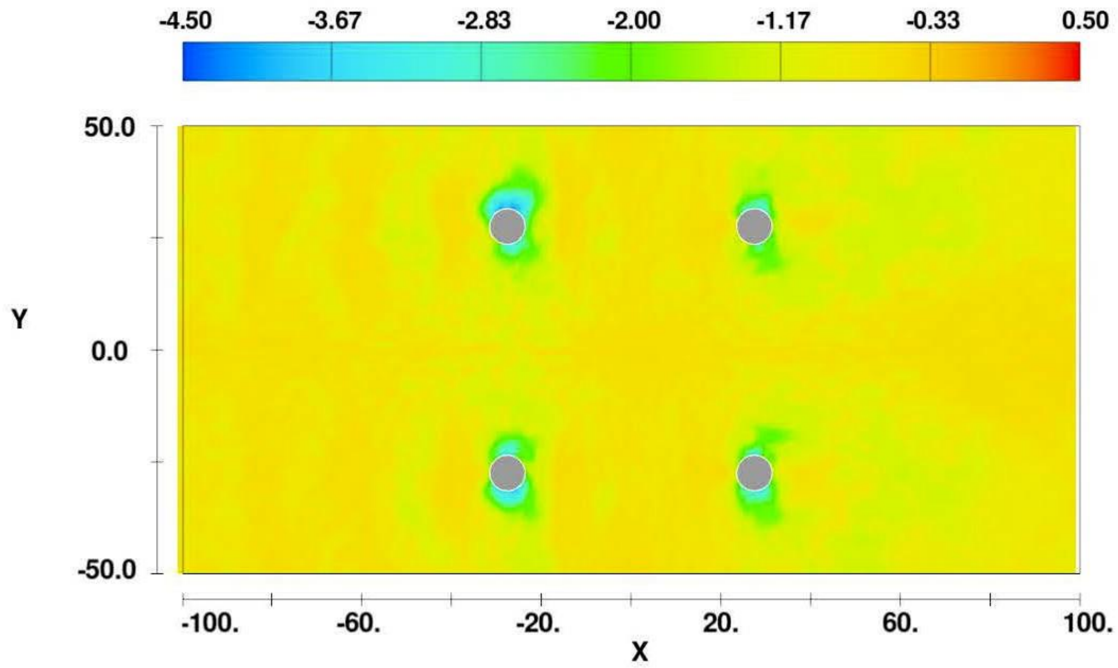


Figure 6.5-3 Distribution of Seabed Scouring for Jacket Type Foundations in this Amendment (due to Typhoon Waves)

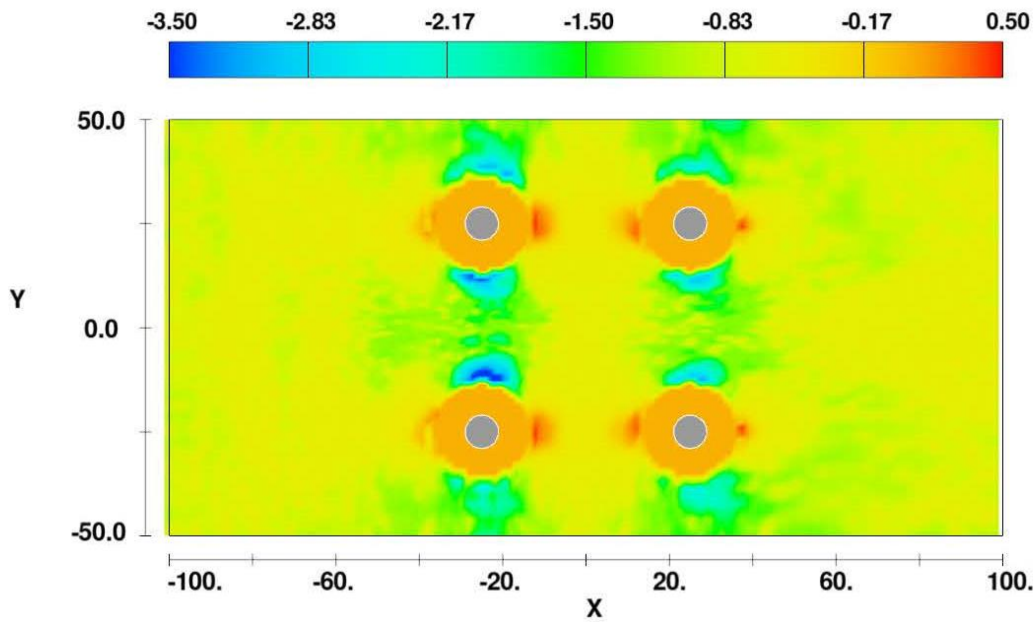


Figure 6.5-4 Distribution of Seabed Scouring of SBJ Type Foundations in this Amendment (due to Typhoon Waves)

Table 6.5-3 Analysis of Foundation Scouring Before and After this Amendment (due to Typhoon Waves)

	Pile Diameter, D (m)	Pile Spacing (m)	Scouring Depth		Scouring Area
			S(m)	S/D	
Before Amendment (Jacket Type)	3.5	38	-1.15	0.33	-
	4	40	-1.15	0.29	-
After Amendment (Jacket Type)	8	55	-2.83	0.35	≒1.5D
After Amendment (SBJ Type)	25	50	-2.2	0.28	≒1.0D

i. Simulation of Coastal Topographic Change

For impact to offshore topographic change in large areas close to the wind farm, the marine hydrology, water quality, and sediment transport model (SED-EOT model, two-dimensional finite element method) developed by EOT is used. The model includes Spectral Wave, Flow Model and Sediment Transport. Simulation and analysis are conducted for wave field, flow field and topographic change before and after the turbines are installed in the wind farm.

The main content in this amendment is in regard to wind farm layout, single turbine capacity, 16MW, is added to the content from the original EIS. As the turbine capacity is larger, the number of turbines should be smaller. Therefore, impact on coastal topographic change should be smaller after the amendment and thus, this amendment should have a slight and positive impact. The explanation for differential analysis is as follows.

II. Assessment of Results from Simulation of Nearshore Current Induced by Wave Field

1. Before Installation of Offshore Wind Farm

Figure 6.5-5 to Figure 6.5-7 separately represent the distribution of coastal nearshore current fields before installation of the wind farm induced by plane waves under the impact of winter wind waves, summer wind waves, and typhoon waves with 50 year return period. Overall results indicate that nearshore current is distributed in water depths between -4m to -30m while under winter and summer wind wave conditions. However, the most significant flow field is still generated from typhoon waves which have higher wave heights, and nearshore current is distributed in water depths between -4m to -50m under these conditions.

2. After Installation of Offshore Wind Farm

Figure 6.5-8 to Figure 6.5-10 separately represent the distribution of coastal nearshore current fields after installation of the wind farm induced by plane waves under the impact of winter wind waves, summer wind waves, and typhoon waves with 50 year return period. Overall results indicate that as the wind farm is located in water depths around -35m, installation of the wind farm will not have a significant impact on nearshore current caused by winter and summer wind waves. For typhoon waves, a slight change may occur due to the impact of refraction and diffraction from typhoon waves within the flow field of the wind farm. However, this will only be a localized impact.

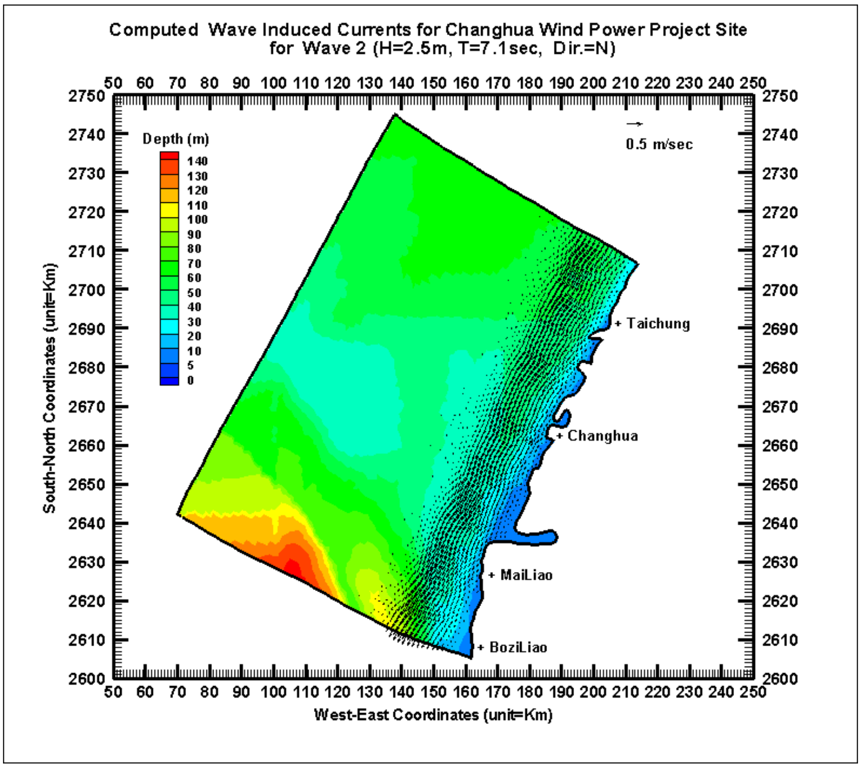


Figure 6.5-5 Distribution of Nearshore Current Induced by Wave Field of Winter Winds Before Installation of Turbines (Offshore Wave Height 2.5m, Cycle 7.1s, Wave Direction N)

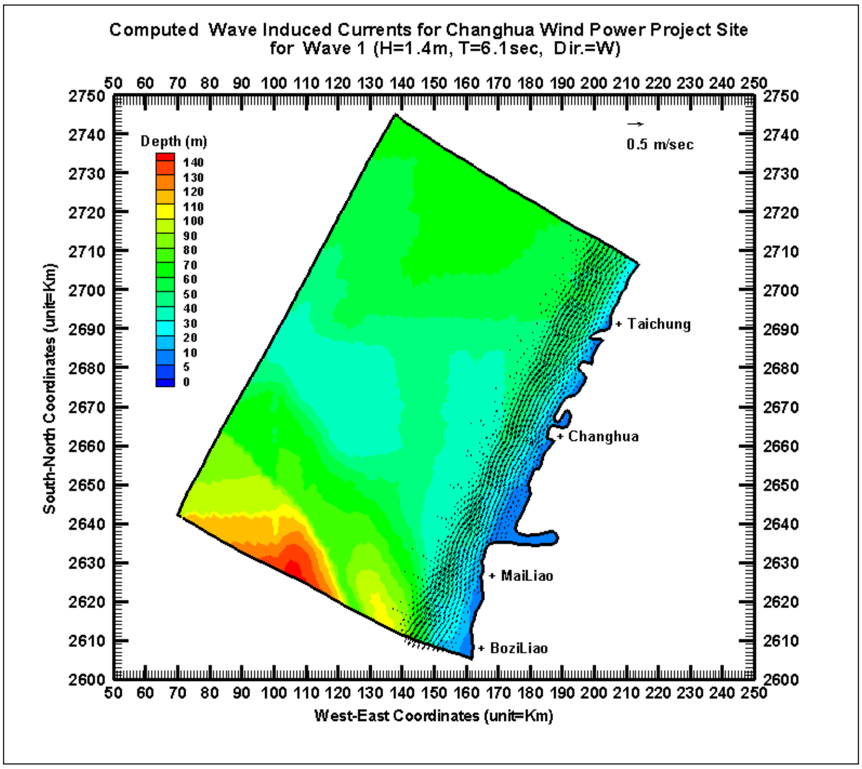


Figure 6.5-6 Distribution of Nearshore Current Induced by Wave Field of Summer Winds Before Installation of Turbines (Offshore Wave Height 1.4m, Cycle 6.1s, Wave Direction W)

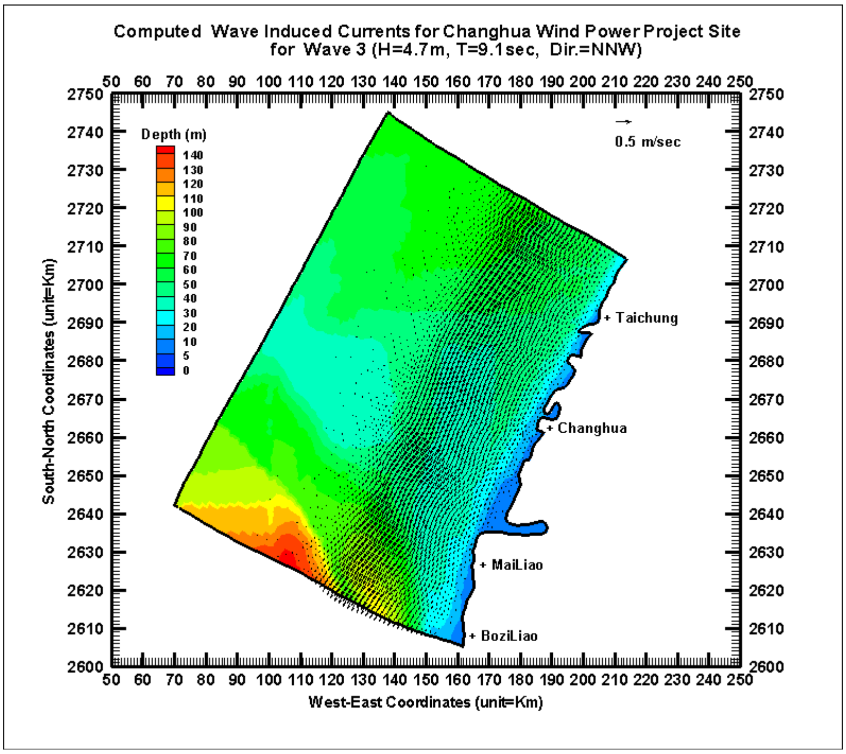


Figure 6.5-7 Distribution of Nearshore Current Induced by Wave Field of Typhoon Winds Before Installation of Turbines (Offshore Wave Height 4.7m, Cycle 9.1s, Wave Direction NNW)

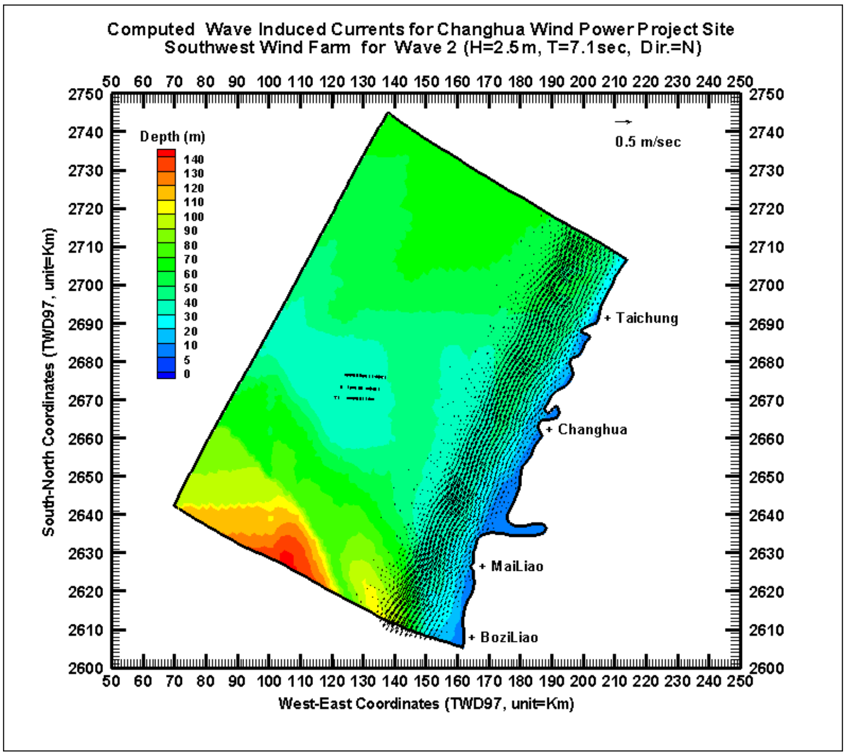


Figure 6.5-8 Distribution of Nearshore Current Induced by Wave Field of Winter Winds After Installation of Turbines (Offshore Wave Height 2.5m, Cycle 7.1s, Wave Direction N)

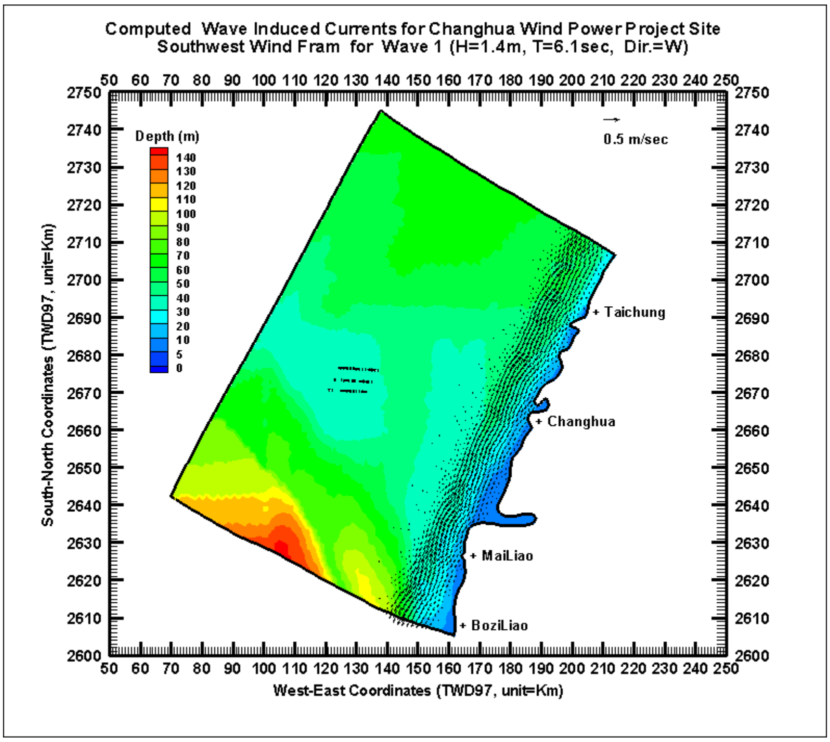


Figure 6.5-9 Distribution of Nearshore Current Induced by Wave Field of Summer Winds After Installation of Turbines (Offshore Wave Height 1.4m, Cycle 6.1s, Wave Direction W)

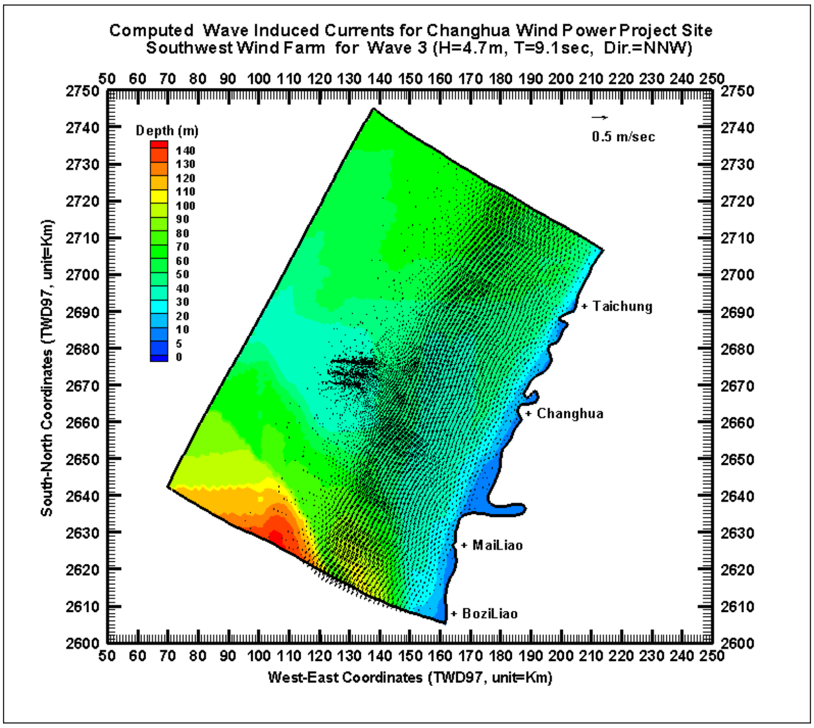


Figure 6.5-10 Distribution of Nearshore Current Induced by Wave Field of Typhoon Winds After Installation of Turbines (Offshore Wave Height 4.7m, Cycle 9.1s, Wave Direction NNW)

III. Simulation and Assessment of Suspended Solid Concentration Under the Impact of Wave Field and Current Field

1. Before Installation of Offshore Wind Farm

   Figure 6.5-11 to Figure 6.5-13 separately represent the distribution of suspended solid concentration before installation of the wind farm caused by effusion under the impact of winter wind waves, summer wind waves, and typhoon waves with 50 year return period. Figure 6.5-14 represents the distribution of suspended solid concentration caused by effusion under the impact of all three types of waves combined. Overall results indicate that suspended solid concentration is higher near the Zhuoshui River estuary and gradually decreases moving north.

2. After Installation of Offshore Wind Farm

   Figure 6.5-15 to Figure 6.5-17 separately represent the distribution of suspended solid concentration after installation of the wind farm caused by effusion under the impact of winter wind waves, summer wind waves, and typhoon waves with 50 year return period. Figure 6.5-18 represents the distribution of suspended solid concentration caused by effusion under the impact of all three types of waves combined. Overall results indicate that suspended solid concentration is higher near the Zhuoshui River estuary and gradually decreases moving north.

IV. Differential Analysis of Topographic Change in the Overall Marine Area near the Wind

Farm

1. Changes to Erosion and Deposition Before and After Wind Turbine Allocation in this Amendment

   For this amendment, erosion and deposition in the marine area resulting from the combination of three types of waves before and after allocation of wind farms is as shown in Figure 6.5-19. For the overall marine area, the simulation results indicate that differences in erosion and deposition depth before and after installation in the offshore and coastal areas are not significant. Erosion and deposition are only different in some localized areas, which means that wind turbine allocation according to the amendment does not have a significant impact on wave height, current conditions or topographic change in the nearby area.

2. Difference Between Erosion and Deposition Before and After Wind Turbine Allocation for the Original EIS and this Amendment

   Figure 6.5-20 shows the impact of erosion and deposition after allocation of offshore wind turbines according to the original EIS; Figure 6.5-21 shows the impact of erosion and deposition after allocation of offshore wind turbines according to this amendment. As both Figure 6.5-20 and Figure 6.5-21 indicate, impact on sediment transport because of nearshore currents induced by waves and marine topographic change are both not significant as the wind farm is quite far offshore. The change in thickness for erosion and deposition after wind turbine allocation is between -0.03 to +0.03m. For the Project wind farm, single turbine capacity was 8- 11MW before the amendment and 16MW wind turbines were added after the amendment. As single turbine capacity is increased, the number of turbine installations are reduced. Under these conditions, diffraction and refraction are not as prevalent when waves pass through the wind farm and the change to nearshore current field is also not significant. In summary, simulation results indicate as single turbine capacity is increased and the number of turbine installations are reduced, impact of the overall wind farm installation on marine topographical change is slight and positive in this amendment.

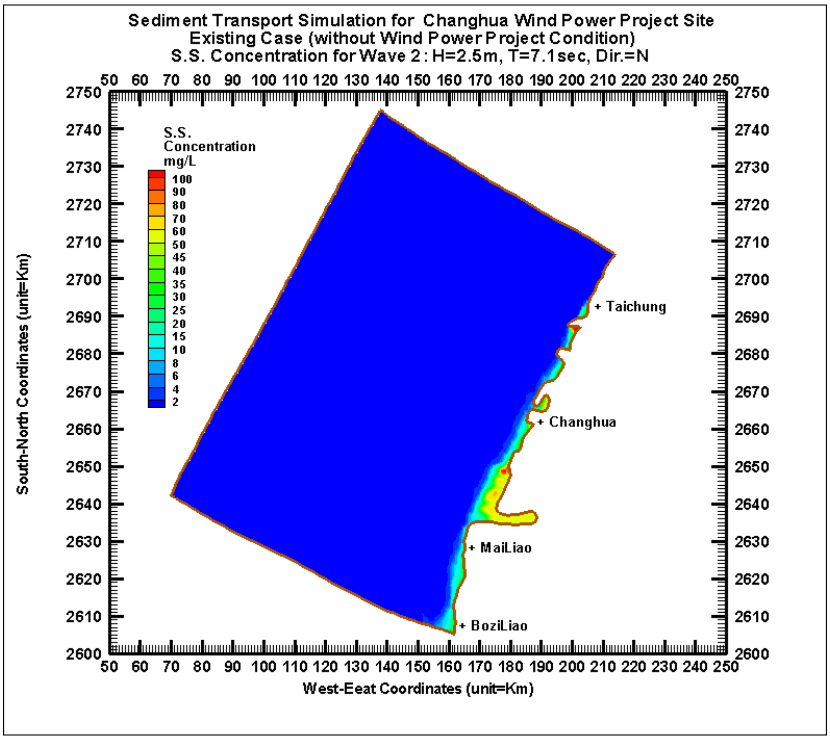


Figure 6.5-11 Distribution of Suspended Solids Caused by Winter Winds Before Installation of Turbines (Offshore Wave Height 2.5m, Cycle 7.1s, Wave Direction N)

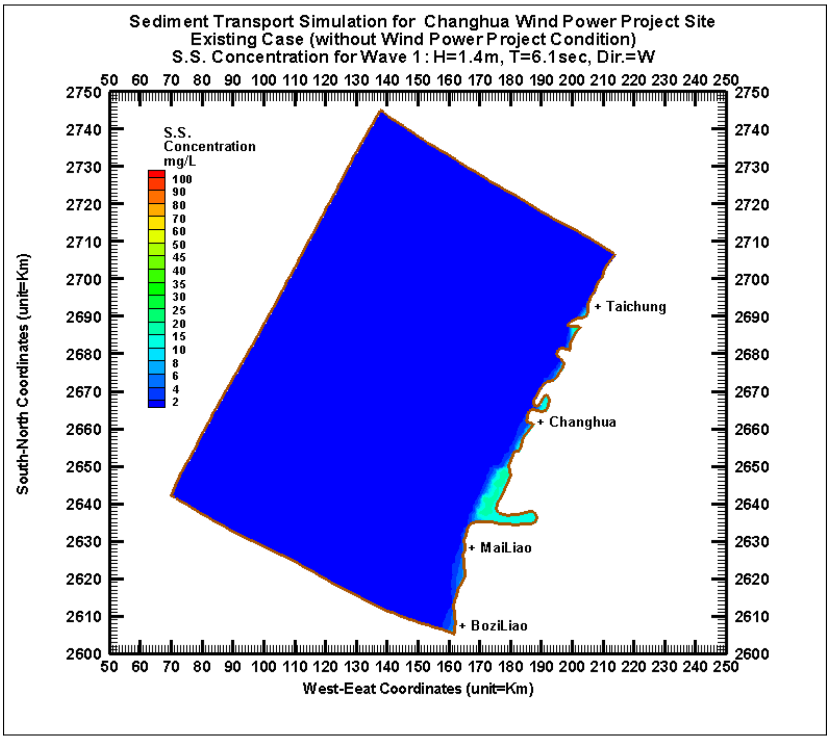


Figure 6.5-12 Distribution of Suspended Solids Caused by Summer Winds Before Installation of Turbines (Offshore Wave Height 1.4m, Cycle 6.1s, Wave Direction W)

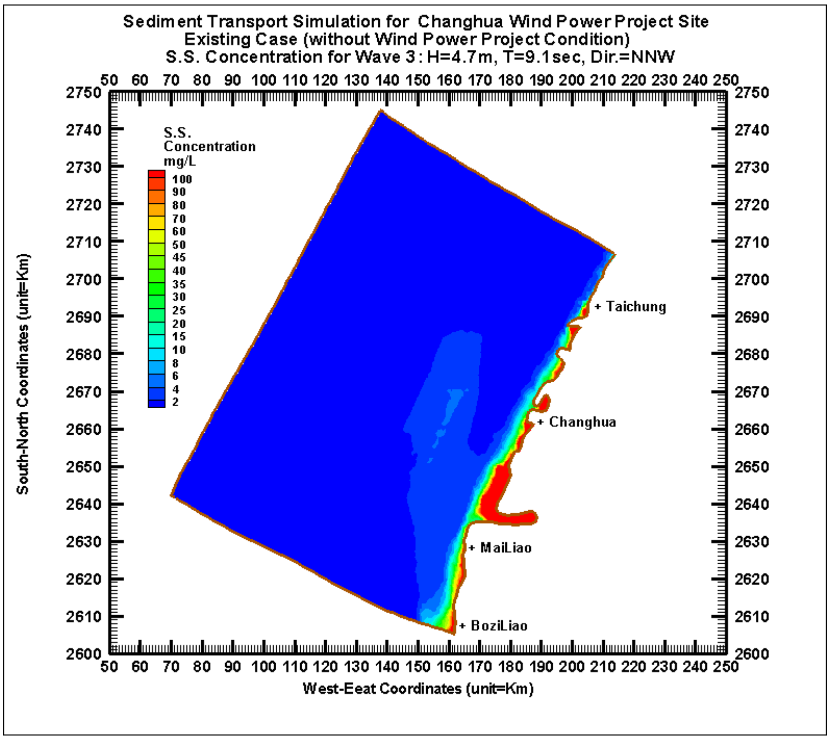


Figure 6.5-13 Distribution of Suspended Solids Caused by Typhoon Winds Before Installation of Turbines (Offshore Wave Height 4.7m, Cycle 9.1s, Wave Direction NNW)

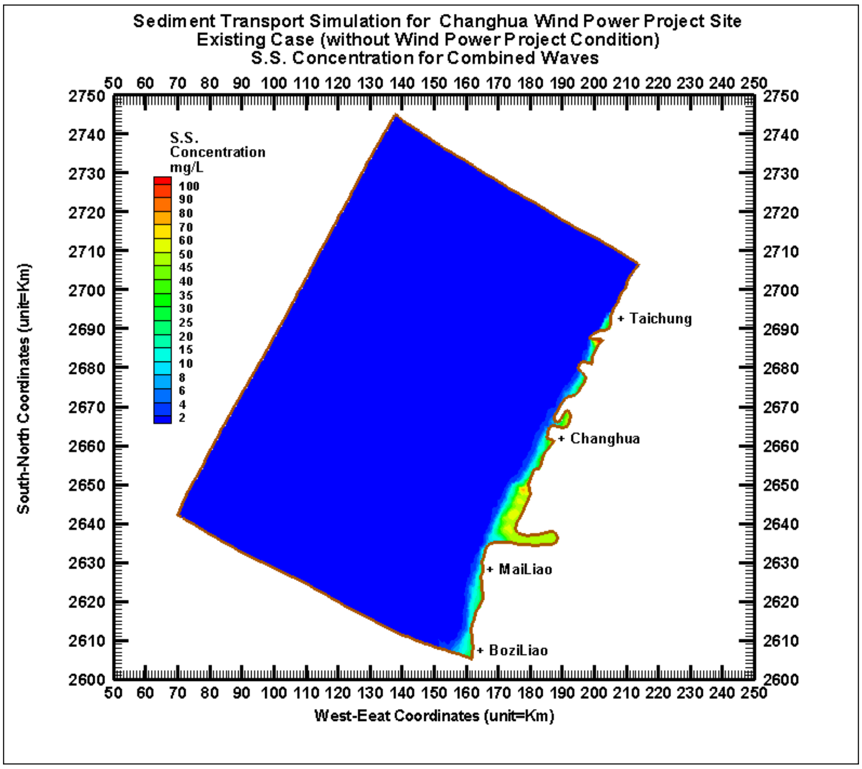


Figure 6.5-14 Distribution of Suspended Solids Caused by the Combination of Three Types of Waves Before Installation of Turbines

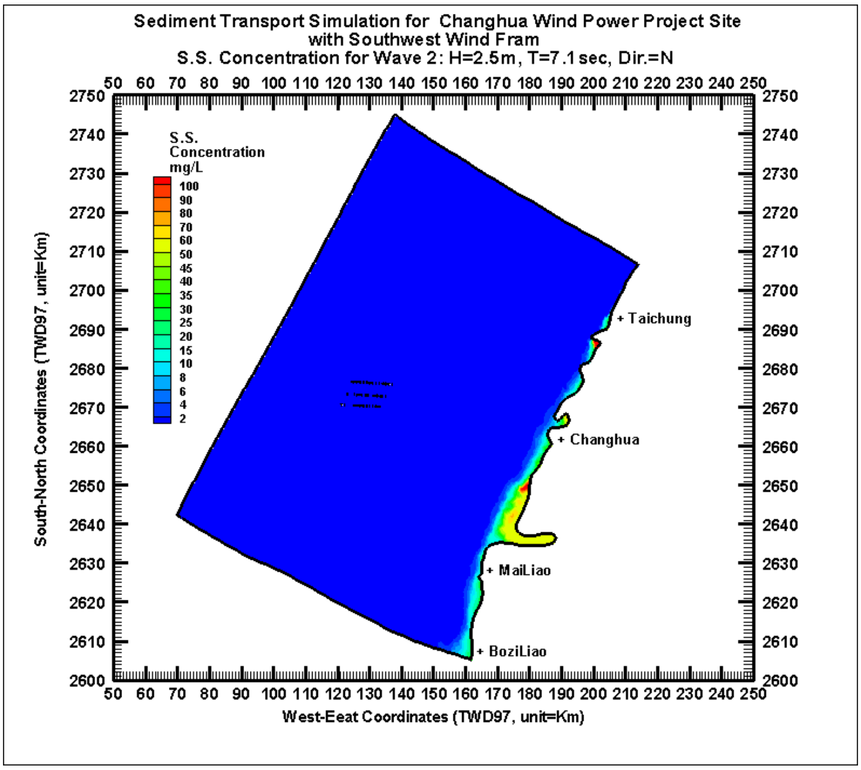


Figure 6.5-15 Distribution of Suspended Solids Caused by Winter Winds After Installation of Turbines (Offshore Wave Height 2.5m, Cycle 7.1s, Wave Direction N)

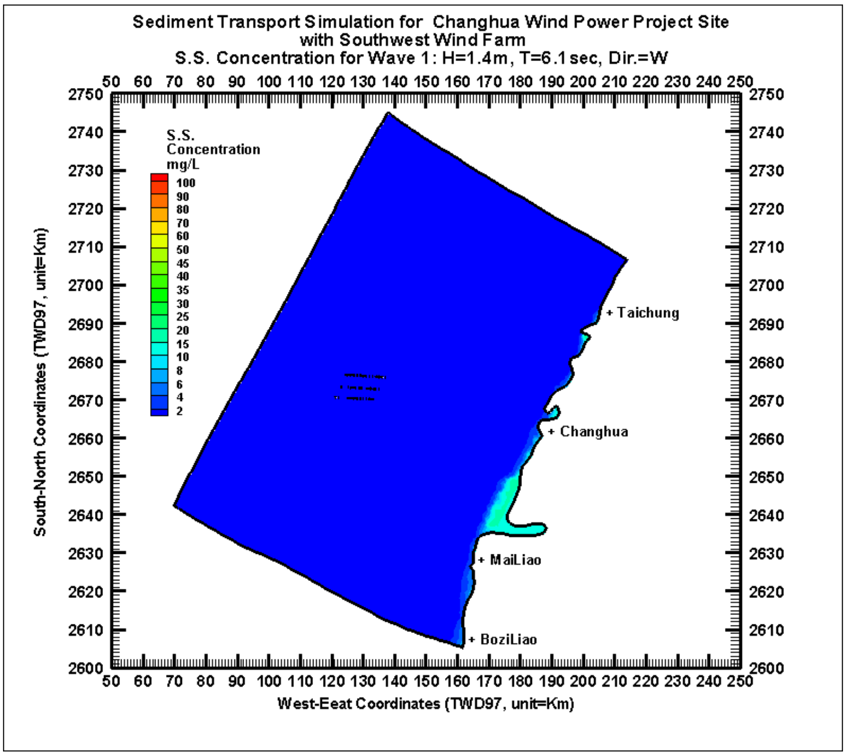


Figure 6.5-16 Distribution of Suspended Solids Caused by Summer Winds After Installation of Turbines (Offshore Wave Height 1.4m, Cycle 6.1s, Wave Direction W)

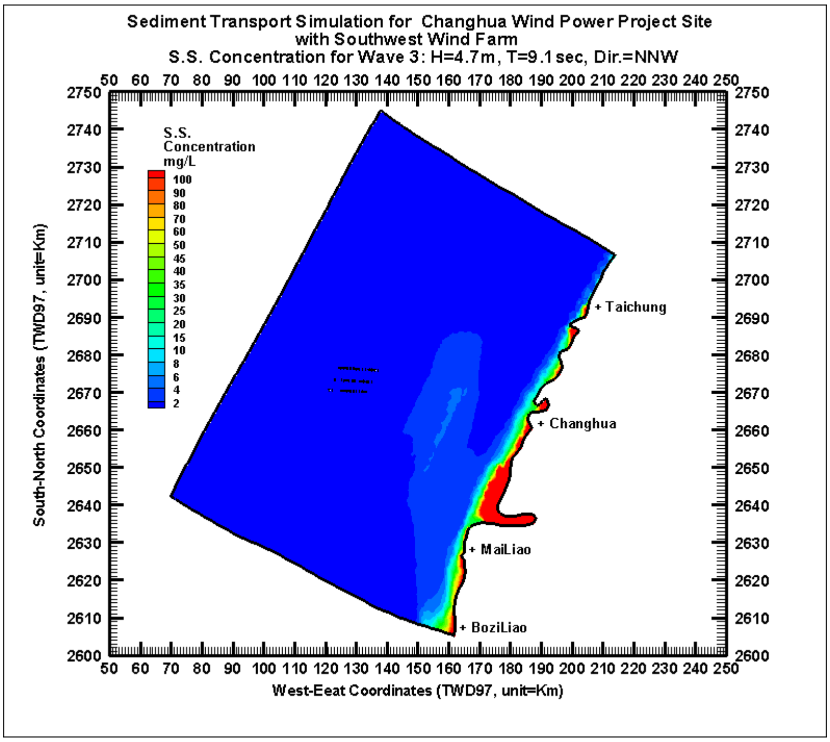


Figure 6.5-17 Distribution of Suspended Solids Caused by Typhoon Winds After Installation of Turbines (Offshore Wave Height 4.7m, Cycle 9.1s, Wave Direction NNW)

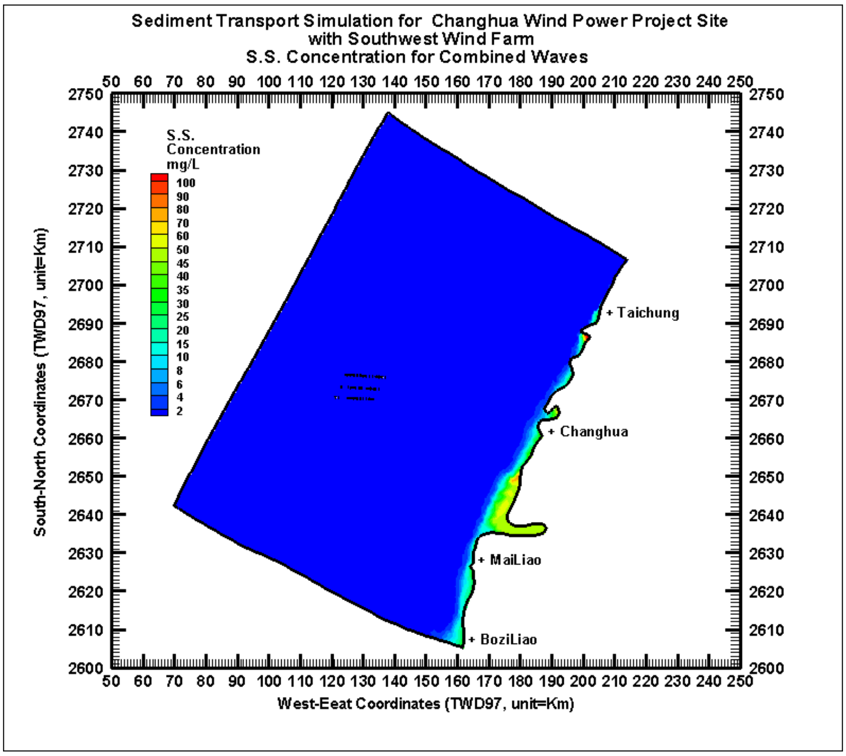
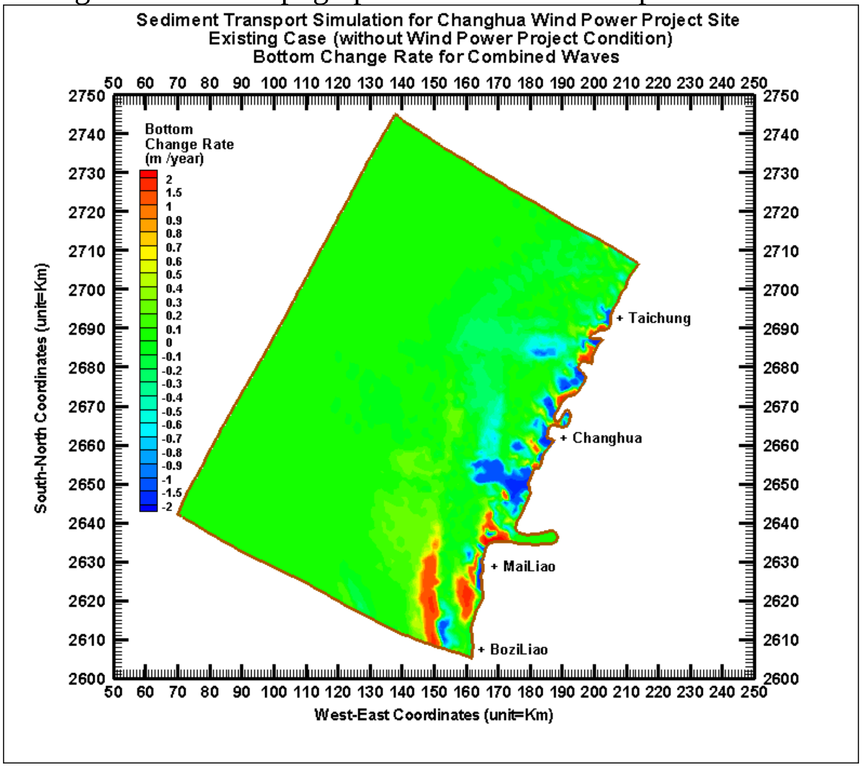


Figure 6.5-18 Distribution of Suspended Solids Caused by the Combination of Three Types of Waves After Installation of Turbines

Potential Change in Marine Topographical Erosion and Deposition Before Installation



Potential Change in Marine Topographical Erosion and Deposition After Installation

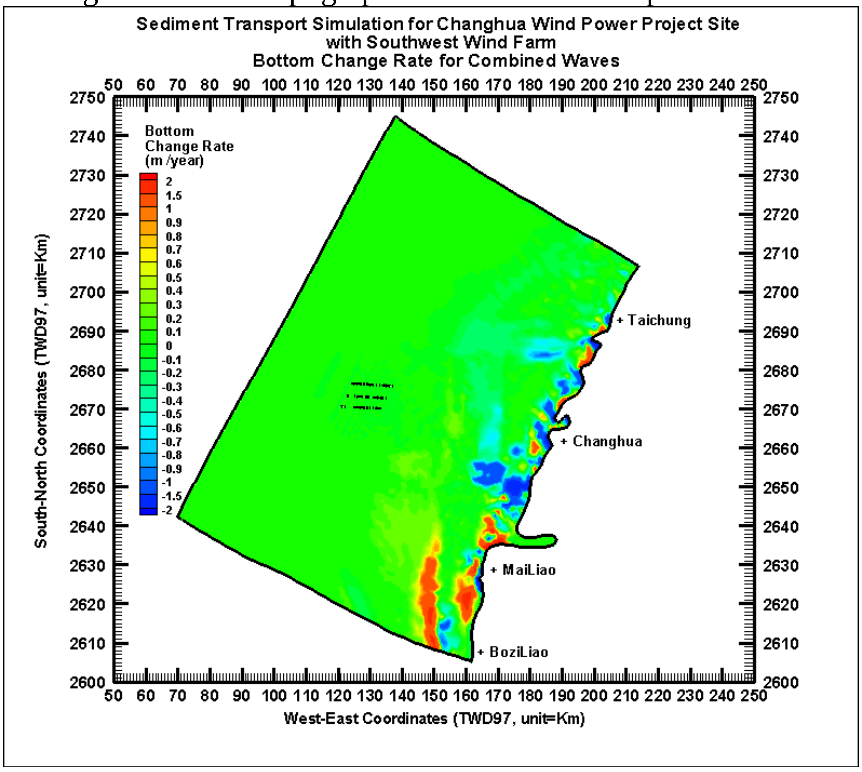


Figure 6.5-19 Change in Topographical Erosion and Deposition Before and After Installation in this Amendment

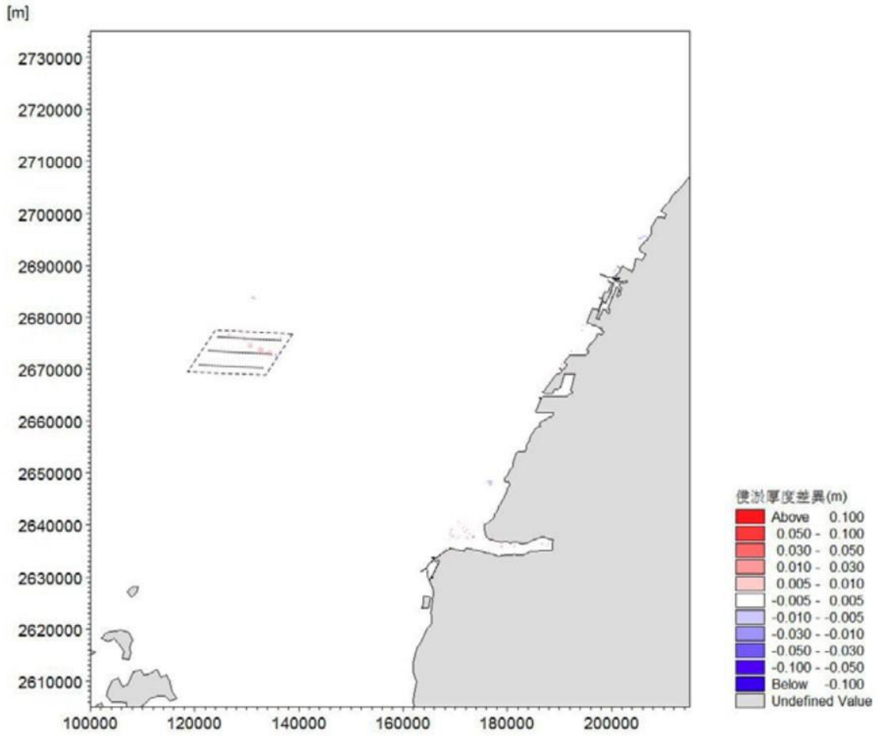


Figure 6.5-20 Difference in Thickness for Topographical Erosion and Deposition Before and After Turbine Installation According to the Original EIS

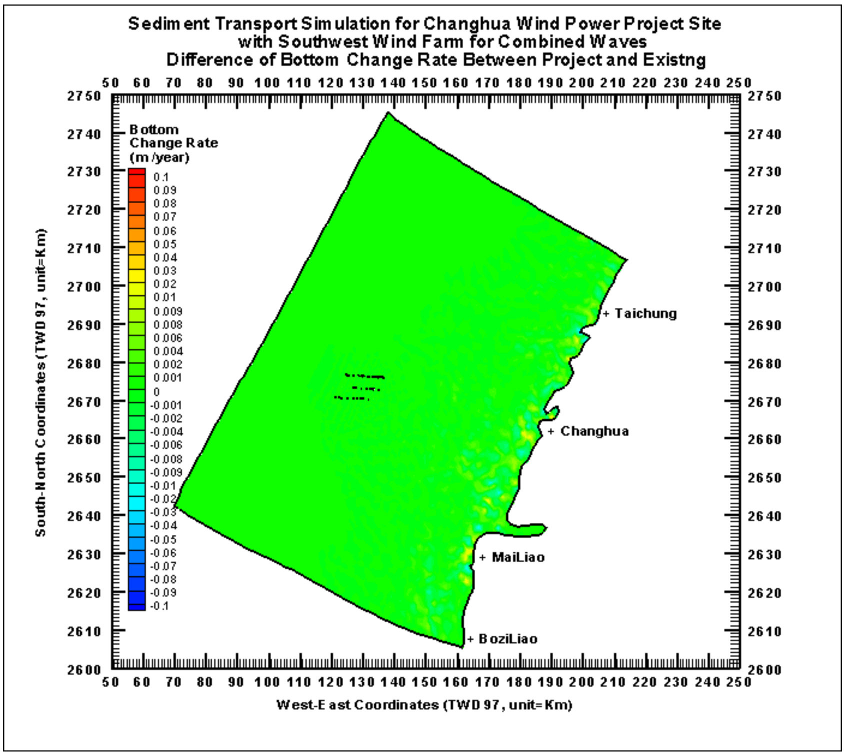


Figure 6.5-21 Difference in Thickness for Topographical Erosion and Deposition Before and After Turbine Installation According to this Amendment

6.6 Hydrology and Water Quality

In this amendment, the pile diameter for jacket pile is changed and suction buckets jacket is added for the foundation options. The change in pile diameter will bring different effect to the seabed, and the level of impact to the seabed and water quality also varies with different foundation types. Therefore, there is a need to reconduct the surveys and simulations regarding the offshore construction's impact to the marine water quality (suspend solid) and sediments. Following are the existing data, results of the supplemental survey, and the simulation of marine water quality and the differential analysis before and after the amendment.

6.6.1 Background Analysis

I. Marine Water Quality

Supplemental surveys are conducted according to "Operation Standard for Environmental Impact Assessment for Development", 12 locations in the Northwest wind farm are selected, and 2 marine water quality surveys are conducted on July 29th, 2020 and November 19th,2020. The survey locations are shown in Figure 6.6.1-1. The surface, middle and bottom layers are analyzed for each station. The relevant survey results are shown in Table 6.6.1-1 to Table 6.6.1-2.

The survey results regarding the marine water quality are as follows: the water temperature is between 25.8-29.3 ℃, pH is between 8.2-8.3, Salinity is between 34.0-34.4psu, BOD is between 0.5~0.8 mg/L, DO is between 6.2-6.4mg/L, Chlorophyll a is between 0.204-0.891μ g/L, Coliform group is <10-95CPU/100mL, suspend solid is between 2.4-14.2 mg/L, Ammonia-N is between N.D.-0.02 mg/L, fat is between 0.5-0.9 mg/L, and transparency 2.9-3.3 m. As for Nutrients, Nitrate is between 0.08-.28mg/L, Nitrite is N.D., Orthophosphate is between 0.022-0.032mg/L, Silicate is between 0.305-0.691 mg/L. As for analysis for heavy metal, Pb is between N.D.-0.0093 mg/L, Zn is between 0.0018-0.0249 mg/L, As is between 0.0010-0.0023 mg/L, and Cd, Cr, Cu, Hg, Ni were all N.D. The result shows that all items near the wind farm area comply with the Marine Environmental Quality Standard for B type Marine Area and are within the natural zone.

Figure 6.6.1-1 Locations for the Supplemental Sampling Stations for Marine Water Quality and Sediments

Table 6.6.1-1 Survey Result of the 1st Marine Water Quality Supplemental Survey

Station		pH	Temperature	Dissolved Oxygen	Salinity	Transparency	Coliform group	Chlorophyll a	BOD	Nitrate	Nitrite	Orthophosphate	Suspended Solid	Ammonia-N	Silicate
		─	℃	mg/L	psu	m	CFU/100mL	μg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
NW-1	sur	8.2	29.1	6.4	34.2	3.2	<10	0.891	0.5	N.D.	N.D.	N.D.	2.8	0.02	0.584
	mid	8.2	28.8	6.3	34.1	-	<10	0.802	0.5	N.D.	N.D.	N.D.	8.2	0.02	0.476
	bot	8.2	28.5	6.2	34.2	-	<10	0.717	0.5	N.D.	N.D.	N.D.	4.6	0.02	0.512
NW-2	sur	8.2	29.0	6.4	34.0	3.0	15	0.661	0.5	N.D.	N.D.	0.023	4.4	0.02	0.548
	mid	8.2	28.8	6.3	34.1	-	<10	0.574	0.5	N.D.	N.D.	N.D.	3.6	0.02	0.691
	bot	8.2	28.4	6.2	34.1	-	30	0.688	0.6	N.D.	N.D.	N.D.	2.5	0.02	0.655
NW-3	sur	8.2	29.3	6.4	34.0	3.2	10	0.374	0.6	N.D.	N.D.	0.028	2.6	0.02	0.440
	mid	8.2	29.0	6.3	34.1	-	<10	0.662	0.6	N.D.	N.D.	0.028	3.6	0.02	0.655
	bot	8.2	28.7	6.2	34.1	-	20	0.544	0.5	N.D.	N.D.	0.023	3.2	0.02	0.584
NW-4	sur	8.2	29.1	6.4	34.1	3.2	<10	0.264	0.5	N.D.	N.D.	0.023	3.7	0.02	0.620
	mid	8.2	28.8	6.2	34.1	-	<10	0.264	0.5	N.D.	N.D.	0.023	2.6	0.02	0.655
	bot	8.2	28.5	6.2	34.2	-	10	0.289	0.6	N.D.	N.D.	0.028	2.4	0.02	0.584
NW-5	sur	8.2	29.0	6.4	34.1	3.1	80	0.348	0.7	N.D.	N.D.	0.023	3.4	0.02	0.512
	mid	8.2	28.8	6.3	34.2	-	45	0.315	0.6	N.D.	N.D.	N.D.	6.4	0.02	0.691
	bot	8.2	28.5	6.2	34.1	-	70	0.349	0.7	N.D.	N.D.	N.D.	6.2	0.02	0.691
NW-6	sur	8.2	29.0	6.4	34.2	2.9	65	0.264	0.7	N.D.	N.D.	N.D.	4.8	0.02	0.655
	mid	8.2	28.7	6.3	34.2	-	25	0.362	0.6	N.D.	N.D.	0.023	3.2	0.02	0.476
	bot	8.2	28.5	6.2	34.3	-	45	0.264	0.6	N.D.	N.D.	0.023	3.0	0.02	0.548
NW-7	sur	8.2	29.0	6.4	34.3	3.2	40	0.345	0.6	N.D.	N.D.	0.023	3.6	0.02	0.655
	mid	8.2	28.8	6.3	34.2	-	15	0.264	0.6	N.D.	N.D.	N.D.	3.2	0.01	0.512
	bot	8.2	28.4	6.2	34.2	-	45	0.260	0.6	N.D.	N.D.	N.D.	3.4	0.02	0.584
NW-8	sur	8.2	29.2	6.4	34.0	3.0	60	0.234	0.7	N.D.	N.D.	0.023	5.0	0.01	0.655
	mid	8.2	28.9	6.3	34.1	-	90	0.234	0.7	N.D.	N.D.	0.023	3.5	0.01	0.655
	bot	8.2	28.6	6.2	34.2	-	75	0.234	0.7	N.D.	N.D.	N.D.	2.5	0.01	0.548
NW-9	sur	8.2	29.1	6.4	34.1	3.0	65	0.293	0.8	N.D.	N.D.	0.032	3.2	0.02	0.584
	mid	8.2	28.8	6.3	34.1	-	75	0.345	0.8	0.10	N.D.	0.032	2.9	0.02	0.691
	bot	8.2	28.6	6.2	34.2	-	65	0.205	0.8	N.D.	N.D.	0.028	3.7	0.01	0.691
NW-10	sur	8.2	29.1	6.4	34.0	3.2	60	0.777	0.6	N.D.	N.D.	N.D.	3.7	0.01	0.548
	mid	8.2	28.8	6.3	34.2	-	20	0.692	0.6	N.D.	N.D.	N.D.	4.7	0.01	0.440
	bot	8.2	28.5	6.2	34.2	-	70	0.747	0.7	N.D.	N.D.	0.023	4.0	N.D.	0.691
NW-11	sur	8.2	29.2	6.3	34.1	3.1	15	0.323	0.6	0.08	N.D.	0.023	2.8	0.01	0.655
	mid	8.2	28.9	6.3	34.2	-	<10	0.345	0.5	N.D.	N.D.	0.023	3.7	0.01	0.655
	bot	8.2	28.7	6.2	34.2	-	<10	0.374	0.5	N.D.	N.D.	0.023	2.9	0.02	0.620
NW-12	sur	8.2	28.9	6.4	34.2	3.0	20	0.404	0.6	N.D.	N.D.	0.028	3.6	0.01	0.584
	mid	8.2	28.6	6.2	34.2	-	15	0.319	0.6	N.D.	N.D.	0.023	4.2	0.01	0.476
	bot	8.2	28.4	6.2	34.3	-	30	0.340	0.6	0.24	N.D.	0.028	4.7	N.D.	0.691

Source: Greater Changhua Southwest Offshore Wind Project- Environmental Monitoring, Q2. Surveys were conducted on April 17, April 20, 2020.

Station		fat	Hg	As	Cr	Cd	Cu	Ni	Pb	Zn
		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
NW-1	sur	N.D.	N.D.	0.0012	N.D.	N.D.	N.D.	N.D.	N.D.	0.0046
	mid	N.D.	N.D.	0.0014	N.D.	N.D.	N.D.	N.D.	N.D.	0.0058
	bot	N.D.	N.D.	0.0013	N.D.	N.D.	N.D.	N.D.	N.D.	0.0070
NW-2	sur	N.D.	N.D.	0.0013	N.D.	N.D.	N.D.	N.D.	N.D.	0.0050
	mid	0.6	N.D.	0.0012	N.D.	N.D.	N.D.	N.D.	N.D.	0.0076
	bot	N.D.	N.D.	0.0012	N.D.	N.D.	N.D.	N.D.	N.D.	0.0052
NW-3	sur	N.D.	N.D.	0.0011	N.D.	N.D.	N.D.	N.D.	N.D.	0.0034
	mid	0.5	N.D.	0.0013	N.D.	N.D.	N.D.	N.D.	N.D.	0.0083
	bot	N.D.	N.D.	0.0012	N.D.	N.D.	N.D.	N.D.	N.D.	0.0146
NW-4	sur	N.D.	N.D.	0.0010	N.D.	N.D.	N.D.	N.D.	N.D.	0.0055
	mid	N.D.	N.D.	0.0011	N.D.	N.D.	N.D.	N.D.	N.D.	0.0160
	bot	N.D.	N.D.	0.0012	N.D.	N.D.	N.D.	N.D.	N.D.	0.0086
NW-5	sur	0.7	N.D.	0.0012	N.D.	N.D.	N.D.	N.D.	N.D.	0.0067
	mid	N.D.	N.D.	0.0013	N.D.	N.D.	N.D.	N.D.	N.D.	0.0090
	bot	N.D.	N.D.	0.0010	N.D.	N.D.	N.D.	N.D.	N.D.	0.0061
NW-6	sur	N.D.	N.D.	0.0011	N.D.	N.D.	N.D.	N.D.	N.D.	0.0124
	mid	N.D.	N.D.	0.0011	N.D.	N.D.	N.D.	N.D.	N.D.	0.0065
	bot	N.D.	N.D.	0.0013	N.D.	N.D.	N.D.	N.D.	N.D.	0.0249
NW-7	sur	0.6	N.D.	0.0011	N.D.	N.D.	N.D.	N.D.	N.D.	0.0108
	mid	N.D.	N.D.	0.0012	N.D.	N.D.	N.D.	N.D.	N.D.	0.0080
	bot	N.D.	N.D.	0.0012	N.D.	N.D.	N.D.	N.D.	N.D.	0.0235
NW-8	sur	N.D.	N.D.	0.0012	N.D.	N.D.	N.D.	N.D.	N.D.	0.0029
	mid	N.D.	N.D.	0.0011	N.D.	N.D.	N.D.	N.D.	N.D.	0.0067
	bot	0.5	N.D.	0.0012	N.D.	N.D.	N.D.	N.D.	N.D.	0.0049
NW-9	sur	N.D.	N.D.	0.0012	N.D.	N.D.	N.D.	N.D.	N.D.	0.0153
	mid	N.D.	N.D.	0.0011	N.D.	N.D.	N.D.	N.D.	N.D.	0.0149
	bot	N.D.	N.D.	0.0013	N.D.	N.D.	N.D.	N.D.	N.D.	0.0079
NW-10	sur	N.D.	N.D.	0.0013	N.D.	N.D.	N.D.	N.D.	N.D.	0.0058
	mid	N.D.	N.D.	0.0013	N.D.	N.D.	N.D.	N.D.	N.D.	0.0048
	bot	0.6	N.D.	0.0013	N.D.	N.D.	N.D.	N.D.	N.D.	0.0227
NW-11	sur	N.D.	N.D.	0.0012	N.D.	N.D.	N.D.	N.D.	N.D.	0.0018
	mid	N.D.	N.D.	0.0012	N.D.	N.D.	N.D.	N.D.	N.D.	0.0209
	bot	N.D.	N.D.	0.0012	N.D.	N.D.	N.D.	N.D.	N.D.	0.0039
NW-12	sur	N.D.	N.D.	0.0013	N.D.	N.D.	N.D.	N.D.	N.D.	0.0044
	mid	N.D.	N.D.	0.0012	N.D.	N.D.	N.D.	N.D.	N.D.	0.0081
	bot	N.D.	N.D.	0.0013	N.D.	N.D.	N.D.	N.D.	N.D.	0.0048

Source: Greater Changhua Southwest Offshore Wind Project- Environmental Monitoring, Q2. Surveys were conducted on April 17, April 20, 2020.

Table 6.6.1-1 Survey Result of the 2nd Marine Water Quality Supplemental Survey (Cont.1)

Station		pH	Temperature	Dissolved Oxygen	Salinity	Transparency	Coliform group	Chlorophyll a	BOD	Nitrate	Nitrite	Orthophosphate te	Suspended Solid	Ammonia-N	Silicate
		–	℃	mg/L	psu	m	CFU/100mL	μg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
NW-1	sur	8.3	26.8	6.4	34.2	3.3	55	0.234	0.5	0.20	N.D.	N.D.	9.2	N.D.	0.448
	mid	8.3	26.6	6.4	34.1	-	25	0.205	0.5	0.21	N.D.	N.D.	8.0	N.D.	0.448
	bot	8.3	26.4	6.2	34.1	-	45	0.285	0.5	0.21	N.D.	N.D.	6.5	0.01	0.341
NW-2	sur	8.3	26.7	6.4	34.0	3.1	75	0.230	0.5	0.22	N.D.	N.D.	8.5	N.D.	0.412
	mid	8.3	26.5	6.3	34.0	-	40	0.230	0.5	0.22	N.D.	N.D.	10.6	0.01	0.412
	bot	8.2	26.2	6.2	34.1	-	85	0.204	0.5	0.22	N.D.	N.D.	11.6	0.02	0.341
NW-3	sur	8.2	26.6	6.3	34.2	3.2	75	0.230	0.6	0.22	N.D.	N.D.	5.3	0.02	0.377
	mid	8.2	26.4	6.3	34.0	-	45	0.260	0.6	0.22	N.D.	N.D.	5.6	0.02	0.341
	bot	8.2	26.1	6.2	34.1	-	40	0.260	0.6	0.22	N.D.	N.D.	7.2	0.02	0.377
NW-4	sur	8.2	26.7	6.4	34.2	3.1	90	0.205	0.6	0.23	N.D.	N.D.	8.9	0.02	0.305
	mid	8.2	26.3	6.3	34.1	-	85	0.260	0.6	0.24	N.D.	N.D.	9.5	0.02	0.341
	bot	8.2	25.9	6.2	34.1	-	90	0.234	0.6	0.22	N.D.	N.D.	11.4	0.02	0.305
NW-5	sur	8.2	26.5	6.4	34.1	3.3	90	0.289	0.6	0.22	N.D.	N.D.	4.6	0.02	0.448
	mid	8.2	26.3	6.3	34.1	-	85	0.289	0.6	0.23	N.D.	N.D.	7.8	0.02	0.448
	bot	8.2	25.9	6.3	34.1	-	70	0.311	0.6	0.24	N.D.	N.D.	3.6	0.02	0.341
NW-6	sur	8.3	26.6	6.4	34.3	3.2	95	0.289	0.6	0.25	N.D.	N.D.	4.0	0.02	0.412
	mid	8.2	26.3	6.4	34.2	-	90	0.315	0.6	0.23	N.D.	0.022	5.6	0.02	0.488
	bot	8.2	25.9	6.3	34.2	-	95	0.260	0.6	0.23	N.D.	N.D.	5.7	0.02	0.412
NW-7	sur	8.2	26.5	6.4	34.2	3.2	10	0.374	0.5	0.27	N.D.	N.D.	5.6	N.D.	0.412
	mid	8.2	26.3	6.3	34.1	-	<10	0.345	0.5	0.24	N.D.	N.D.	6.2	N.D.	0.341
	bot	8.2	26.0	6.3	34.2	-	15	0.400	0.5	0.25	N.D.	N.D.	8.0	N.D.	0.341
NW-8	sur	8.2	26.6	6.3	34.3	3.3	75	0.374	0.5	0.28	N.D.	N.D.	10.2	0.01	0.341
	mid	8.3	26.4	6.3	34.2	-	15	0.289	0.6	0.22	N.D.	0.027	12.3	0.01	0.305
	bot	8.2	26.1	6.3	34.2	-	90	0.259	0.6	0.23	N.D.	0.027	12.4	0.01	0.377
NW-9	sur	8.3	26.6	6.4	34.4	3.1	45	0.264	0.5	0.28	N.D.	0.022	5.6	0.01	0.484
	mid	8.3	26.4	6.3	34.2	-	90	0.260	0.5	0.23	N.D.	N.D.	7.6	0.01	0.484
	bot	8.2	25.8	6.3	34.1	-	85	0.289	0.5	0.21	N.D.	N.D.	8.0	N.D.	0.305
NW-10	sur	8.3	26.6	6.4	34.0	3.3	50	0.319	0.5	0.22	N.D.	N.D.	14.2	0.01	0.341
	mid	8.3	26.2	6.3	34.2	-	80	0.374	0.5	0.22	N.D.	N.D.	11.4	0.01	0.377
	bot	8.3	25.8	6.2	34.1	-	95	0.349	0.5	0.23	N.D.	N.D.	9.0	0.01	0.341
NW-11	sur	8.2	26.6	6.4	34.1	3.3	80	0.319	0.5	0.22	N.D.	N.D.	8.4	N.D.	0.412
	mid	8.2	26.4	6.3	34.0	-	80	0.285	0.5	0.23	N.D.	N.D.	8.0	0.01	0.377
	bot	8.2	25.8	6.2	34.0	-	60	0.289	0.5	0.24	N.D.	N.D.	10.4	0.01	0.341
NW-12	sur	8.2	26.5	6.3	34.3	3.0	50	0.345	0.5	0.22	N.D.	N.D.	8.1	0.01	0.341
	mid	8.3	26.8	6.4	34.2	3.3	55	0.234	0.5	0.20	N.D.	N.D.	9.2	N.D.	0.448
	bot	8.2	26.3	6.3	34.2	-	20	0.348	0.5	0.24	N.D.	N.D.	7.4	0.01	0.448

Source: Greater Changhua Southwest Offshore Wind Project- Environmental Monitoring, Q2. Surveys were conducted on April 17, April 20, 2020.

Station		fat	Hg	As	Cr	Cd	Cu	Ni	Pb	Zn
		mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
NW-1	sur	0.7	N.D.	0.0012	N.D.	N.D.	N.D.	N.D.	N.D.	0.0102
	mid	N.D.	N.D.	0.0012	N.D.	N.D.	N.D.	N.D.	0.0093	0.0093
	bot	0.8	N.D.	0.0013	N.D.	N.D.	N.D.	N.D.	N.D.	0.0100
NW-2	sur	N.D.	N.D.	0.0013	N.D.	N.D.	N.D.	N.D.	N.D.	0.0131
	mid	N.D.	N.D.	0.0013	N.D.	N.D.	N.D.	N.D.	N.D.	0.0156
	bot	0.9	N.D.	0.0016	N.D.	N.D.	N.D.	N.D.	N.D.	0.0139
NW-3	sur	0.9	N.D.	0.0012	N.D.	N.D.	N.D.	N.D.	N.D.	0.0211
	mid	N.D.	N.D.	0.0013	N.D.	N.D.	N.D.	N.D.	N.D.	0.0088
	bot	N.D.	N.D.	0.0014	N.D.	N.D.	N.D.	N.D.	N.D.	0.0234
NW-4	sur	N.D.	N.D.	0.0013	N.D.	N.D.	N.D.	N.D.	N.D.	0.0125
	mid	N.D.	N.D.	0.0013	N.D.	N.D.	N.D.	N.D.	N.D.	0.0090
	bot	0.9	N.D.	0.0013	N.D.	N.D.	N.D.	N.D.	N.D.	0.0071
NW-5	sur	N.D.	N.D.	0.0014	N.D.	N.D.	N.D.	N.D.	N.D.	0.0035
	mid	N.D.	N.D.	0.0015	N.D.	N.D.	N.D.	N.D.	N.D.	0.0051
	bot	0.6	N.D.	0.0013	N.D.	N.D.	N.D.	N.D.	N.D.	0.0029
NW-6	sur	N.D.	N.D.	0.0014	N.D.	N.D.	N.D.	N.D.	N.D.	0.0114
	mid	0.9	N.D.	0.0013	N.D.	N.D.	N.D.	N.D.	N.D.	0.0031
	bot	0.8	N.D.	0.0012	N.D.	N.D.	N.D.	N.D.	N.D.	0.0121
NW-7	sur	N.D.	N.D.	0.0012	N.D.	N.D.	N.D.	N.D.	N.D.	0.0036
	mid	0.7	N.D.	0.0015	N.D.	N.D.	N.D.	N.D.	N.D.	0.0082
	bot	N.D.	N.D.	0.0013	N.D.	N.D.	N.D.	N.D.	N.D.	0.0045
NW-8	sur	N.D.	N.D.	0.0016	N.D.	N.D.	N.D.	N.D.	N.D.	0.0195
	mid	0.6	N.D.	0.0012	N.D.	N.D.	N.D.	N.D.	N.D.	0.0058
	bot	N.D.	N.D.	0.0014	N.D.	N.D.	N.D.	N.D.	N.D.	0.0118
NW-9	sur	0.5	N.D.	0.0014	N.D.	N.D.	N.D.	N.D.	N.D.	0.0045
	mid	N.D.	N.D.	0.0016	N.D.	N.D.	N.D.	N.D.	N.D.	0.0029
	bot	N.D.	N.D.	0.0015	N.D.	N.D.	N.D.	N.D.	N.D.	0.0018
NW-10	sur	N.D.	N.D.	0.0013	N.D.	N.D.	N.D.	N.D.	N.D.	0.0028
	mid	0.5	N.D.	0.0013	N.D.	N.D.	N.D.	N.D.	N.D.	0.0029
	bot	0.8	N.D.	0.0023	N.D.	N.D.	N.D.	N.D.	N.D.	0.0099
NW-11	sur	N.D.	N.D.	0.0014	N.D.	N.D.	N.D.	N.D.	N.D.	0.0033
	mid	N.D.	N.D.	0.0014	N.D.	N.D.	N.D.	N.D.	N.D.	0.0065
	bot	0.7	N.D.	0.0014	N.D.	N.D.	N.D.	N.D.	N.D.	0.0042
NW-12	sur	0.9	N.D.	0.0016	N.D.	N.D.	N.D.	N.D.	N.D.	0.0066
	mid	0.7	N.D.	0.0012	N.D.	N.D.	N.D.	N.D.	N.D.	0.0102
	bot	N.D.	N.D.	0.0013	N.D.	N.D.	N.D.	N.D.	N.D.	0.0042

Source: Greater Changhua Southwest Offshore Wind Project- Environmental Monitoring, Q2. Surveys were conducted on April 17, April 20, 2020.

II. Marine Sediments

Supplemental surveys are conducted according to “Operation Standard for Environmental Impact Assessment for Development”, 12 locations in the Northwest wind farm are selected, and 2 marine water quality surveys are conducted on July 29th, 2020 and November 19th,2020. The survey locations are shown in Figure 6.6.1-1. Relevant environmental standard is not yet established in Taiwan. Therefore, standard for marine sediment issued by National Ocean and Atmosphere Administration (NOAA) is referred for the assessment standards in the Project. The details are listed in Table 6.6.1-2.

The result of the survey carried out on July 29th, 2020 is shown as Table 6.6.1-3. Concentration of As is 10.8~11.2 mg/kg, Hg is 0.026-0.032 mg/kg, Cd is 1.16-1.21 mg/kg, Cr is 109-140 mg/kg, Cu is N.D., Ni is 17.7-19.2 mg/kg, Pb is 10.0-10.1 mg/kg, Zn is 38.7-41.1 mg/kg. The concentration of all heavy metals do not exceed the PEL regulated in NOAA’s standard for marine sediment.

The result of the survey carried out on November 19th, 2020 is shown as Table 6.6.1-3. Concentration of As is3.54~3.56 mg/kg, Hg is 0.027-0.030 mg/kg, Cd is 4.51-4.67, Cr is 116-118 mg/kg, Cu is N.D., Ni is 25.2 mg/kg, Pb is 24.1-25.0 mg/kg, Zn is 89.9-91.9 mg/kg. The concentration of all heavy metals do not exceed the PEL regulated in NOAA’s standard for marine sediment.

Table 6.6.1-2 Marine Sediment Standard of National Ocean and Atmosphere Administration

Item	Threshold effect level (TEL)	Effects range low (ERL)	Predicted effects level(PEL)	Effects range median (ERM)
As	7.24	8.2	41.6	70
Cd	0.7	1.2	4.2	9.6
Cr	52.3	81	160	370
Cu	18.7	34	108	270
Pb	30.2	46.7	112	218
Hg	0.13	0.15	0.7	0.71
Ni	15.9	20.9	42.8	51.6
Zn	124	150	271	410

Table 6.6.1-3 Survey Result of Marine Sediment Conducted in this Amendment

Date	Sample Station	Heavy Metal Concentration (mg/kg)							
		As	Hg	Cd	Cr	Cu	Ni	Pb	Zn
		mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg
2020.7.29	NW-7	10.8	0.032	1.21	109	N.D.	17.7	10.1	38.7
	NW-11	11.2	0.026	1.16	140	N.D.	19.2	10.0	41.1
2020.11.19	NW-7	3.54	0.027	4.51	116	N.D.	25.2	25.0	89.9
	NW-11	3.56	0.030	4.67	118	N.D.	25.2	24.1	91.9

Source: Greater Changhua Northwest Offshore Project- Differential Analysis Report
Note 1: Value that exceed PEL is indicated with grey background.
Note 2: N.D indicates that the item is not detected.

6.6.2 Differential Analysis for the Amendment

To have a conservative estimation on the impact of the marine water quality (suspend solid), the assessment applies 810m^3/hr for the rock-dumping speed (the simulation of this amendment applies the WQM 2-dimentional hydraulic/water quality module).

According to the assessment result for WTG foundations, under rock-dumping speed 810m^3/hr, the increment of SS concentration 200m from the construction area of turbine scour protection is approx. 0.48mg/L. The distribution of SS increment is shown as Figure 6.6.2-1 and Figure 6.6.2-2.

According to the assessment result for OSS foundations, under rock-dumping speed 810m^3/hr, the increment of SS concentration 200m from the construction area of turbine scour protection is approx. 0.95mg/L. The distribution of SS increment is shown as Figure 6.6.2-3.

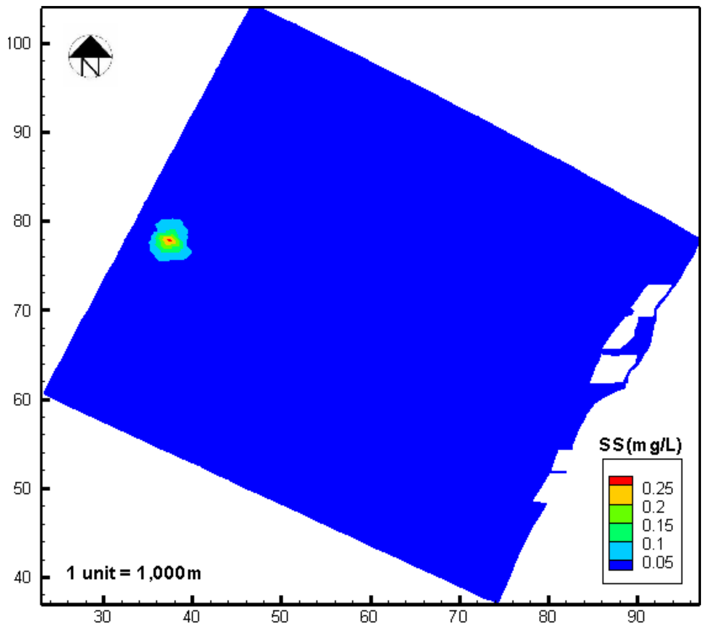
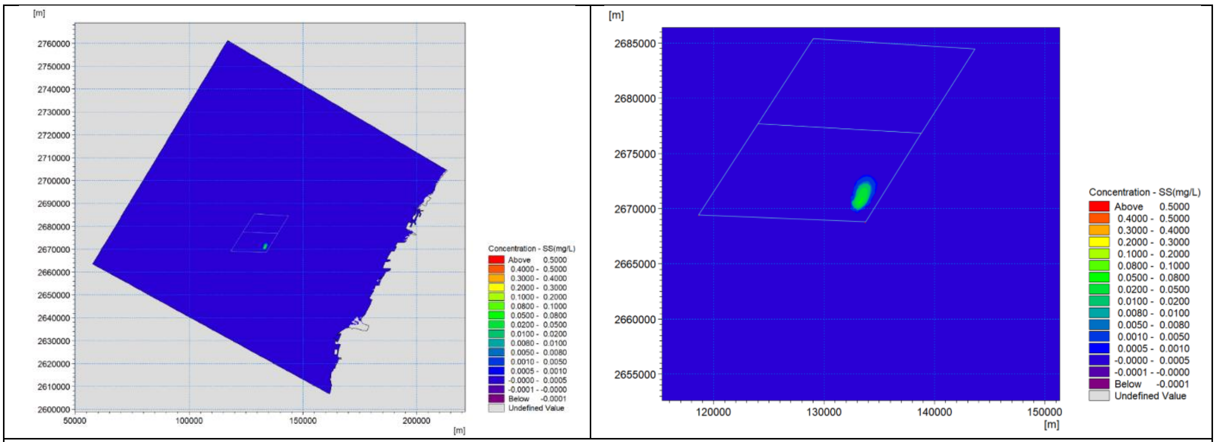


Figure 6.6.2-1 Simulation Results of Increment in Suspended Solid Concentration during Foundation Installation before this Amendment



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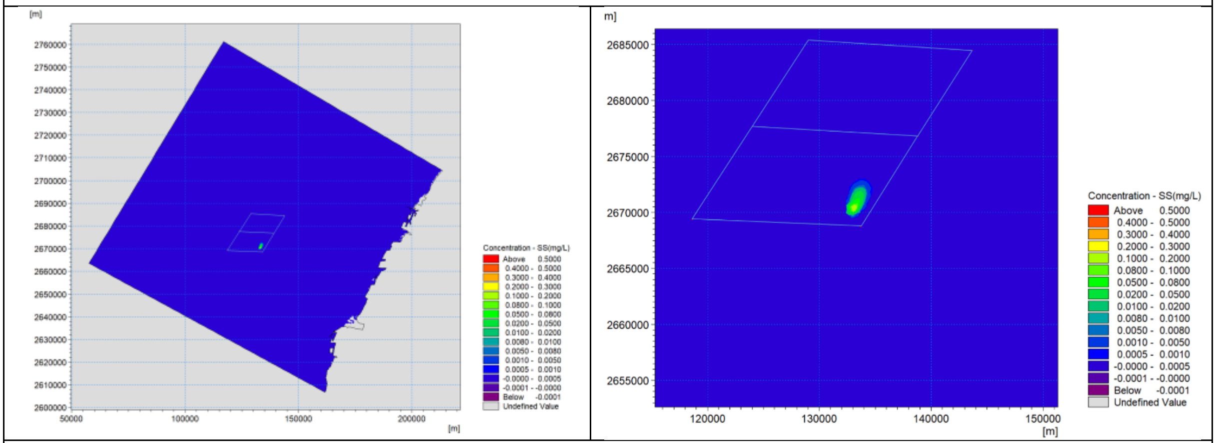

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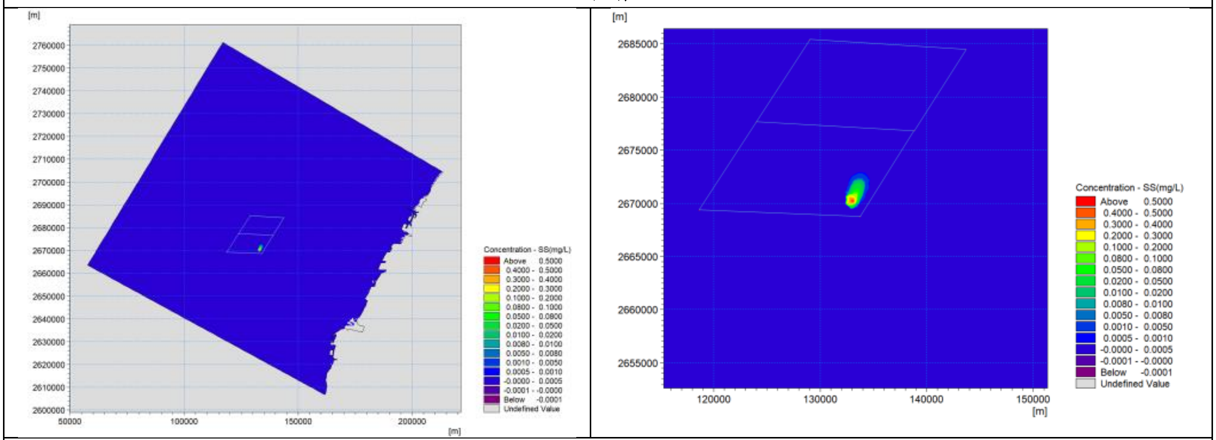

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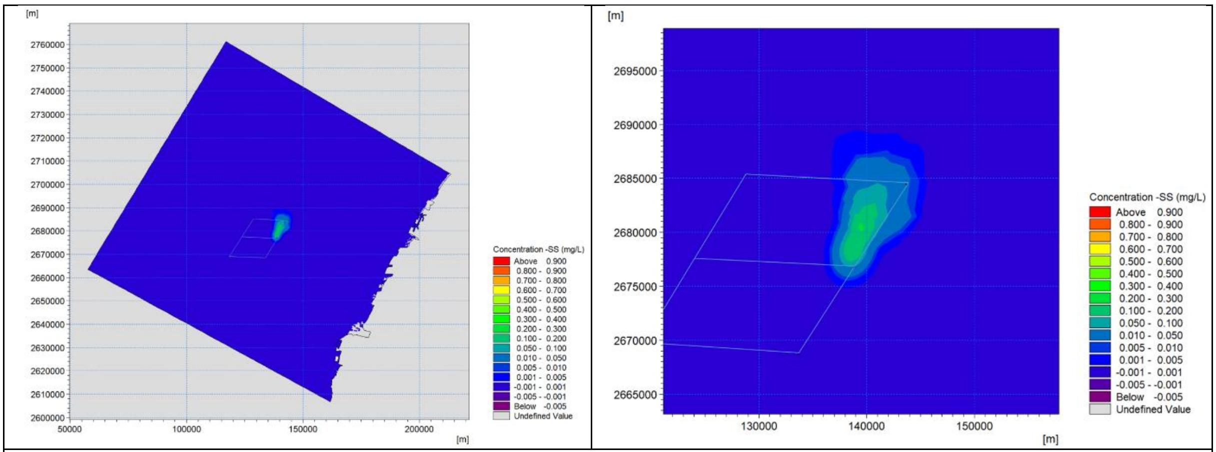
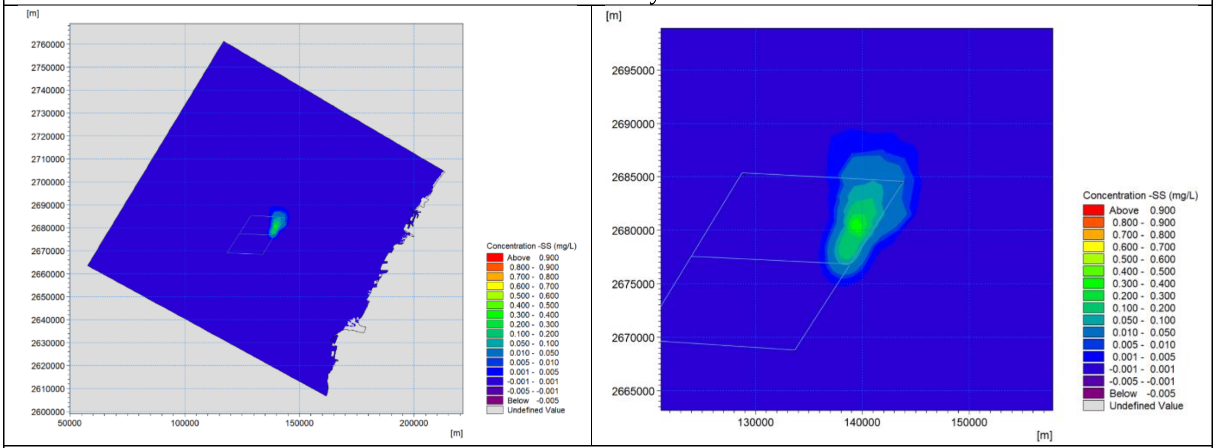
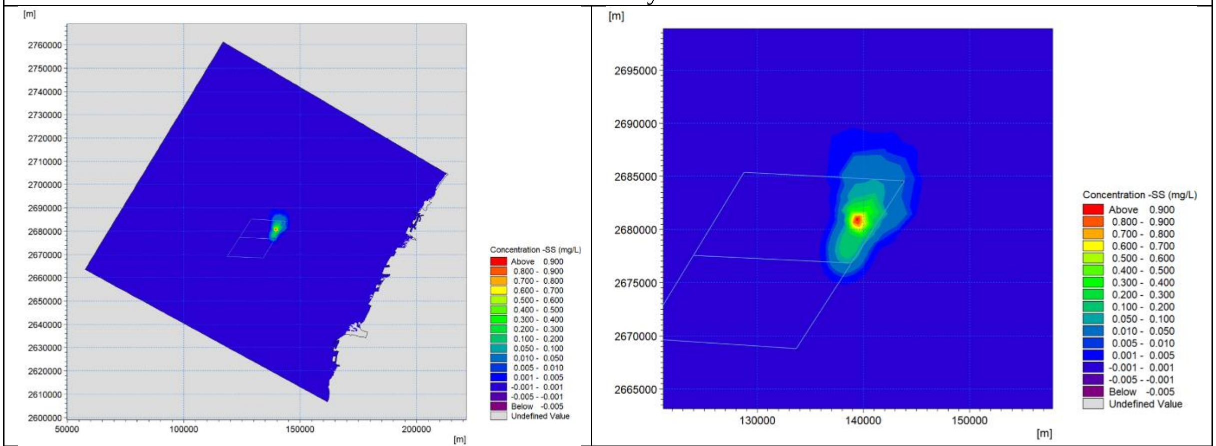
Figure 6.6.2-2 Simulation Results of Increment in Suspended Solid Concentration during Foundation Installation after this Amendment



Surface Layer



Middle Layer



Bottom Layer

Figure 6.6.2-3 Simulation Results of Increment in Suspended Solid Concentration during Foundation Installation after this Amendment

The SS increment during offshore construction before and after the amendment is compared in Table 6.6.2-1 and Table 6.6.2-2. After this amendment, under rock dumping rate 810m^3/hr, the SS increment 200m from the construction location of WTG and OSS at surface, middle and bottom layer is approx. 0.05~0.48mg/L and 0.32~0.95mg/L. The difference in SS increment comparing with EIA stage is 0.21mg/L (bottom).

In general, the background SS concentration is approx. 2.4-14.2 mg/L. Even though the SS concentration will increase in the construction area of OSS and WTG, the increment are still within the natural range of the marine. Furthermore, under the diffusion effect of currents and flows, the SS concentration for WTG may return from 0.48 mg/L to 0.047 mg/L, 12 hours after the construction of scour protection is completed, and return to 0.028 mg/L after 24 hours; the SS concentration for OSS may return from 0.95 mg/L to 0.12 mg/L, 12 hours after the construction of scour protection is completed, and return to 0.09 mg/L after 24 hours. Therefore, the increment in SS concentration for both WTG and OSS can return to background levels after 24 hours and impact from construction will no longer be present.

Additionally, in order to reduce impact on marine water quality induced by scour protection operations, the Project will use fall-pipe vessels to conduct the operations. The rock dumping will be conducted by straight or diagonal pipes close to the seabed (2-3m from the seabed, depending to tidal conditions and characteristics of the location), after the vessel has accurately located the construction position. A schematic is shown in Figure 6.6.2-4.

Table 6.6.2-1 Comparison of SS Increment during the Offshore Construction Phase before and After the Amendment (WTG)

Distance from the construction area (m)	Simulation Result of the SS Increment during Low Tide (mg/L)		
	Before the Amendment (Original EIS)	After the Amendment (this DA)	Difference in Increment
	Turbine	Turbine	
200	0.27	Surface: 0.12	0.23 (3D sediment)
		Middle: 0.20	
		Bottom: 0.50	

Note: Rock dumping rate in this DA is 810m^3/hr.

Table 6.6.2-2 Comparison of SS Increment during the Offshore Construction Phase before and After the Amendment (OSS)

Distance from the construction area (m)	Simulation Result of the SS Increment during Low Tide (mg/L)		
	Before the Amendment (Original EIS): WQM	After the Amendment (this DA): Mike3	Difference in Increment
	Turbine	Turbine	
200	–	Surface: 0.32	OSS was not conducted in the original EIS, therefore, comparison is not conducted
		Middle: 0.56	
		Bottom: 0.95	

Note: Rock dumping rate in this DA is 810m^3/hr.

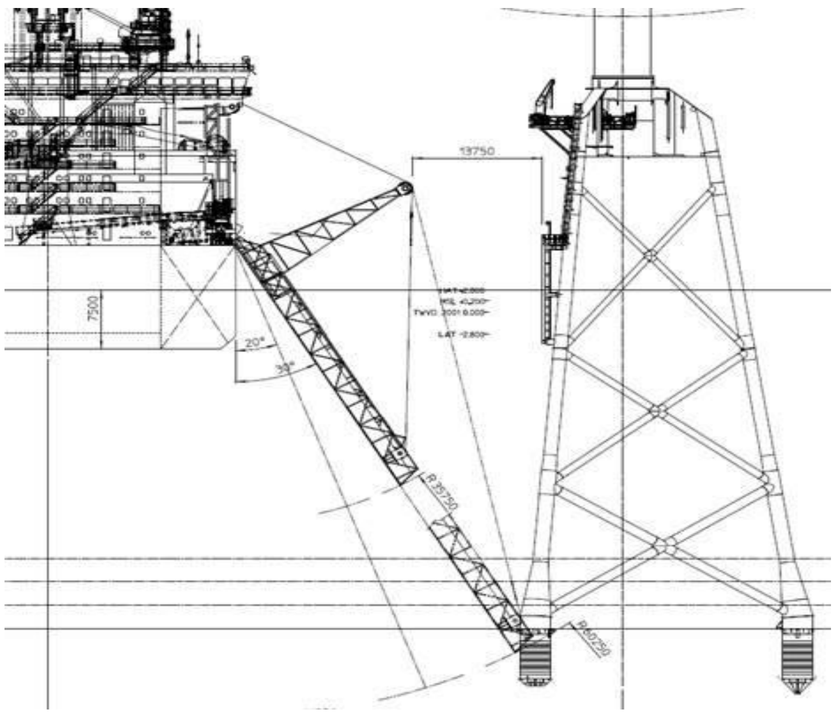


Figure 6.6.2-4 Installation of DP2 Fall-pipe Jacket

6.7 Marine Ecology

6.7.1 Background Analysis

2 marine ecology surveys were conducted on August 14^{th} and November 18^{th} of 2020; 2 fish surveys were conducted on August 22^{nd} and November 18^{th} of 2020, the survey areas are shown as Table 6.7.1-1, Table 6.7.1.2 and Figure 6.7.1-1. The survey locations, water depth and water layers for the marine ecology surveys during the EIA stage and supplemental surveys are shown in Table 6.7.1-3 and Figure 6.7.1-2.

Table 6.7.1-1 Coordinates for the Survey Stations for the Supplemental Surveys of Marine/Intertidal Ecology in this Amendment

No. of Sampling Station	Water Depth (m)	No. of sampling layers for phytoplankton	Coordinates	
			X	Y
DE12-1	35.5	4	133329	2684902
DE12-2	32.3	4	127064	2681483
DE12-3	36.0	4	131691	2681659
DE12-4	33.4	4	125398	2678085
DE12-5	40.4	4	140284	2680664
DE12-6	38.0	4	135321	2680496
DE12-7	37.0	5	138333	2683852
DE12-8	33.9	4	129756	2677488
DE12-9	37.5	4	138144	2677469
DE12-10	33.0	4	129607	2683842
DE12-11	33.2	4	129441	2680026
DE12-1	35.5	4	133329	2684902

Source: Differential Analysis of Greater Changhua Offshore Wind Project
Note: The coordinate system is TWD97 (two degree zone).

Table 6.7.1-2 Coordinates for the Survey Stations for the Supplemental Surveys of Fish in this Amendment

測線	採樣深度	GPS 座標(下)	GPS 座標(上)	採樣距離	採樣日期	採樣日期
底拖測線T1	30~33m	24° 11.671'北 119° 53.915'東	24° 14.030'北 119° 55.116'東	4K	2020.08.22	2020.11.18
底拖測線T1	28~30m	24° 14.168'北 119° 50.620'東	24° 11.760'北 119° 49.742'東	4K	2020.08.22	2020.11.18
底拖測線T1	33~35m	24° 14.353'北 119° 47.833'東	24° 12.283'北 119° 46.445'東	4K	2020.08.22	2020.11.18

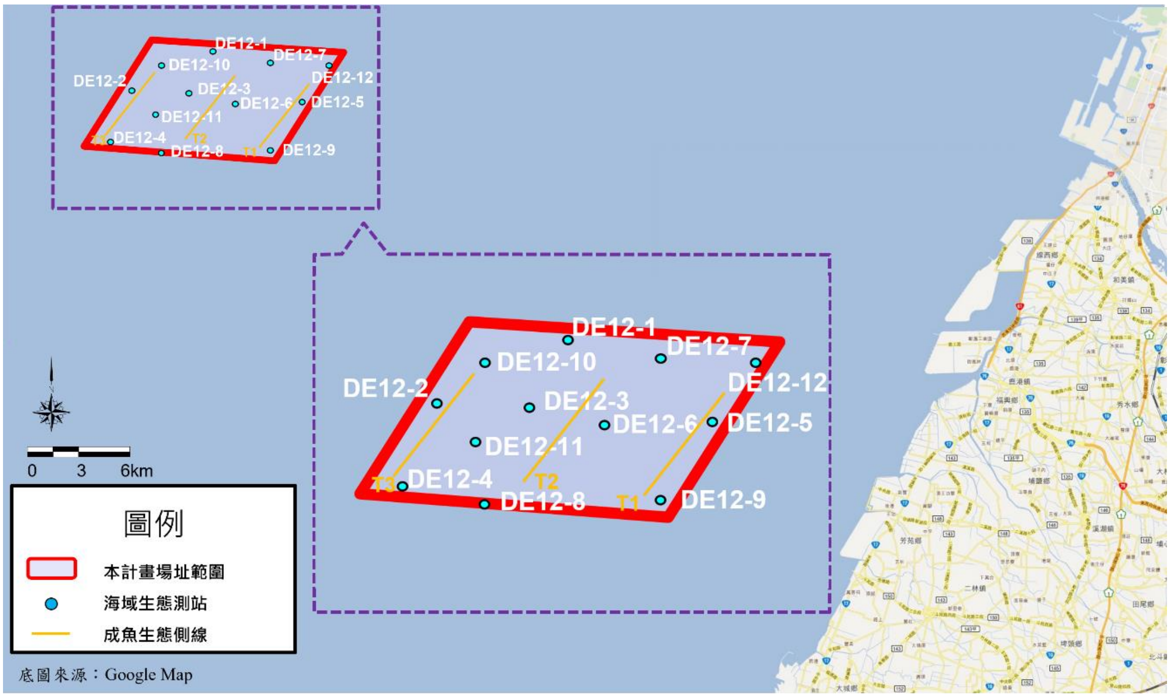


Figure 6.7.1-1 Locations for the Marine Ecology Supplemental Survey in this Project

Table 6.7.1-2 Survey Locations for the Marine Ecology in the EIS Stage

EIS Stage Sampling Point No.	Water Depth (m)	No. of water layers for Plankton Sampling	Coordinates (TWD_97)	
			X	Y
12-1	35.1	5	133420	2685300
12-2	31.1	4	126175	2681775
N12-3	31.3	5	131691	2681659
12-3	32.6	5	130198	2683593
12-4	33.2	4	125398	2678085
N12-5	36.9	5	177661	2671037
12-5	48.3	5	140914	2680794
12-6	34.6	5	135321	2680496
12-7	38.3	5	138333	2683852
12-8	32.0	4	129665	2676791
12-9	35.6	5	138144	2677469
12-10	39.9	5	145823	2682246
N12-11	30.8	4	186060	2671861
12-11	20.3	4	129716	2679765
12-12	40.6	5	143773	2683595

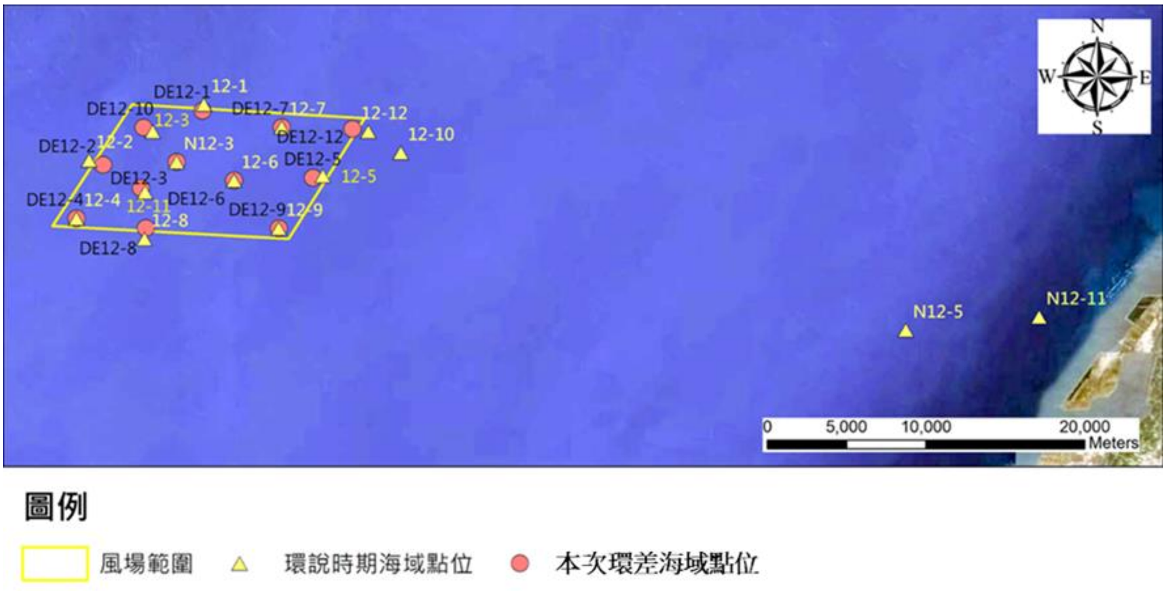


Figure 6.7.1-2 Survey Coordinates for Marine Ecology in the 1st Da and the EIS Stage

I. Basis of Surveys

Survey area, methodology, and reports were conducted according to “Technical Regulations for Marine Ecology” (EPA#0960058664A).

II. Survey Result

1. Phytoplankton

(1) Species Composition

In total, 5 phyla, 75 genre and 179 species were recorded; 5 phyla, 57 genre and 124 species were recorded in the first survey; and 4 phyla, 54 genre and 115 species were recorded in the second survey.

21-55 species were recorded in each layer/station in the first survey. Surface layer of station DE12-12 records the most species. Abundance in each layer/station is between 1,780-13,660cells/L. Surface layer of station DE12-1 records the highest abundance. (Figure 6.7.1-3)

14~45 species were recorded in each layer/station in the second survey. Surface layer of station DE12-10 records the most species. Abundance in each layer/station is between 454~5,050cells/L. Surface layer of station DE12-2 records the highest abundance. (Figure 6.7.1-3)

(2) Dominant Species

In the first survey, Pseudo-nitzschia seriata has the highest relevative abundance (24.25%), followed by Pseudo-nitzschia pungens (18.19%). Pseudo-nitzschia seriata, Pseudo-nitzschia pungens, Chaetoceros decipiens and Eucampia cornuta have the highest observation frequency (100.00%).

They are recorded in all stations and are species that are frequently spotted in the marine area.

In the second survey, Trichodesmium erythraeum has the highest relevative abundance (21.89%), followed by Leptolyngbya boryana (7.24%). Thalassiosira eccentrica had the highest observation frequency (100.00%) followed by Pleurosigma angulatum (98.00%) and Pleurosigma (94.00%). They are species that are frequently spotted in the marine area.

(3) Diversity Index

In the first survey, *H'* in each station/layer is between 2.07-3.31; *J'* is between 0.62-0.83. *H'* and *J'* in 10m layer of DE12-9 are the lowest, indicating that species composition is less abundant than other stations, and the index is lower as affected by the dominant species Pseudo-nitzschia seriata. The species do not distribute evenly, leading to a lower index. (Figure 6.7.1-4)

In the second survey, *H'* in each station/layer is between 0.53-3.37; *J'* is between 0.17-0.94. *H'* and *J'* in surface layer of DE12-2 are the lowest, indicating that species composition is less abundant than other stations, and the index is lower as affected by the dominant species Leptolyngbya boryana. The species do not distribute evenly, leading to a lower index. (Figure 6.7.1-4)

(4) Chlorophyll a

In the first survey, in each sampling station and sea level, concentration of Chlorophyll a was between 0.08-0.84μg/L. Results indicate that bottom layer of DE12-9 had the lowest concentration of Chlorophyll a, and surface layer of DE12-1 had the highest level of concentration. (Figure 6.7.1-5)

In the second survey, in each sampling station and sea level, concentration of Chlorophyll a was between 0.02-1.22μg/L. Results indicate that the 10m layer of DE12-3, 10m layer of DE12-4, 10m and bottom layer DE12-6, 3m layer of DE12-8, and 3m, bottom and surface layer of DE12-11 had the lowest concentration of Chlorophyll a, and 3m layer of DE12-1 had the highest level of concentration. (Figure 6.7.1-5)

(5) Primary Productivity

In the first survey, in each sampling station and sea level, primary productivity was between 2.65-51.40 μgC/L/d. Results indicate bottom layer of DE12-9 had the lowest primary productivity, and surface layer of DE12-1 had the highest primary productivity.

In the second survey, in each sampling station and sea level, primary productivity was between 0.49-80.96 μgC/L/d. Results indicate the 10m layer of DE12-6 and 3m layer of DE12-8 had the lowest primary productivity, and the 3m layer of DE12-1 had the highest primary productivity.

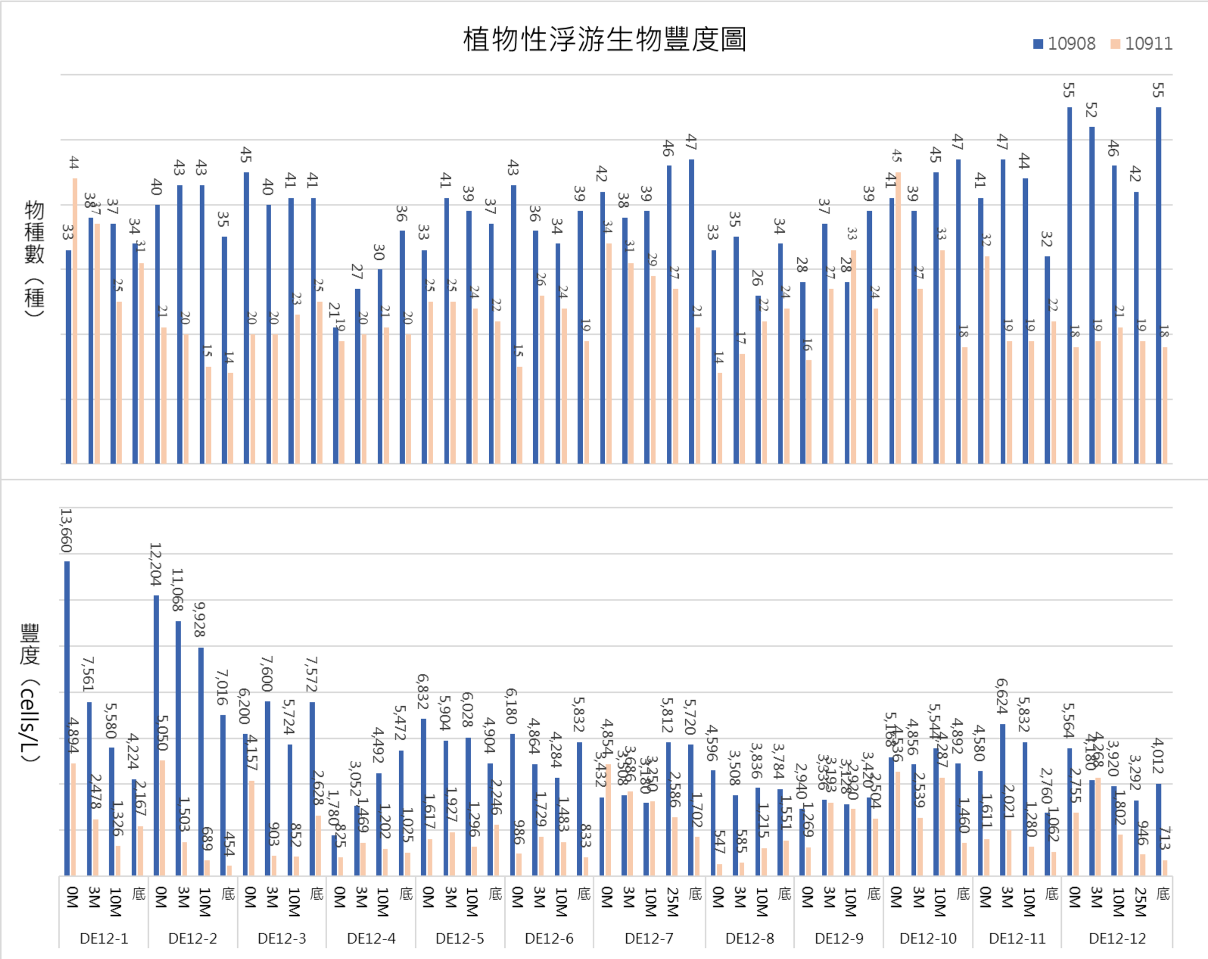


Figure 6.7.1-3 Northwest Wind Farm Phytoplankton Abundance

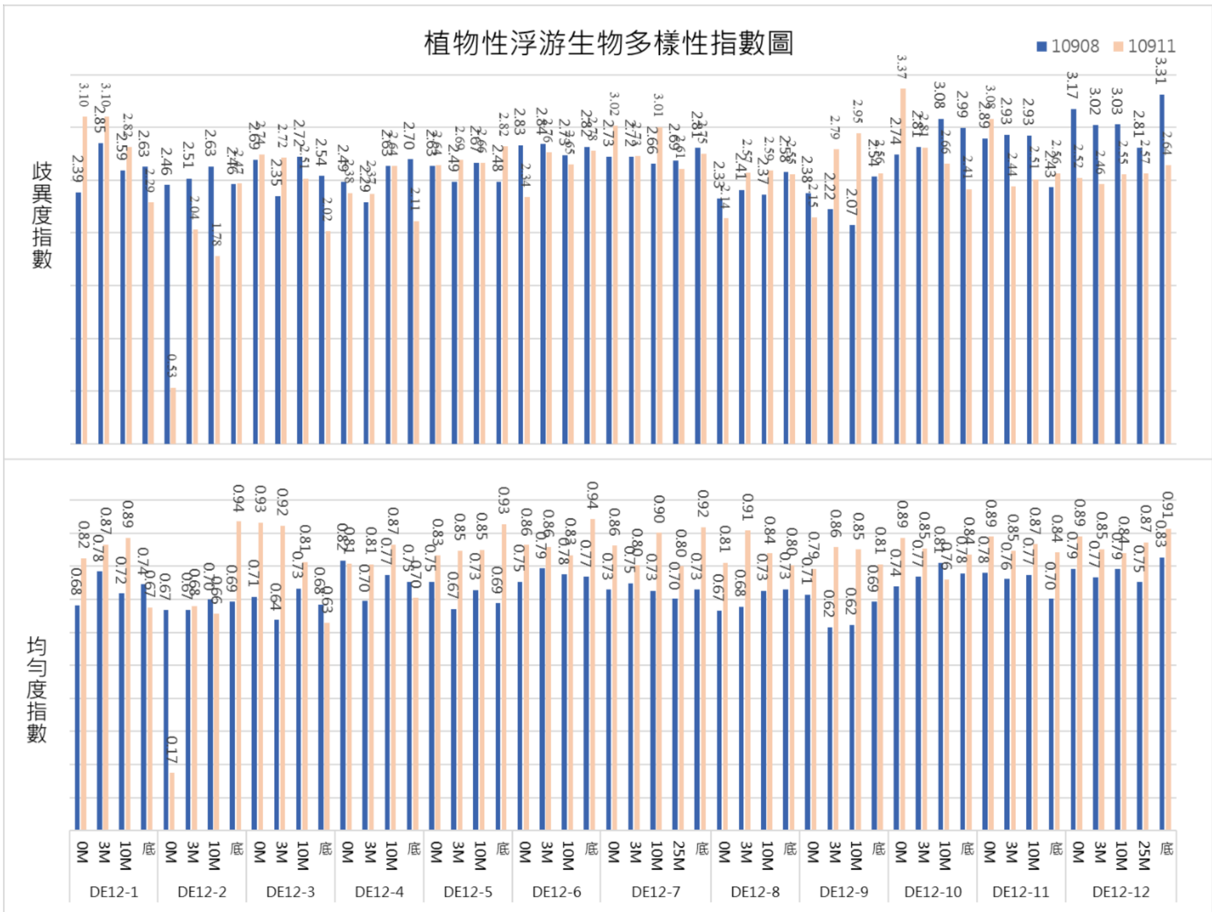


Figure 6.7.1-4 Northwest Wind Farm Phytoplankton Diversity

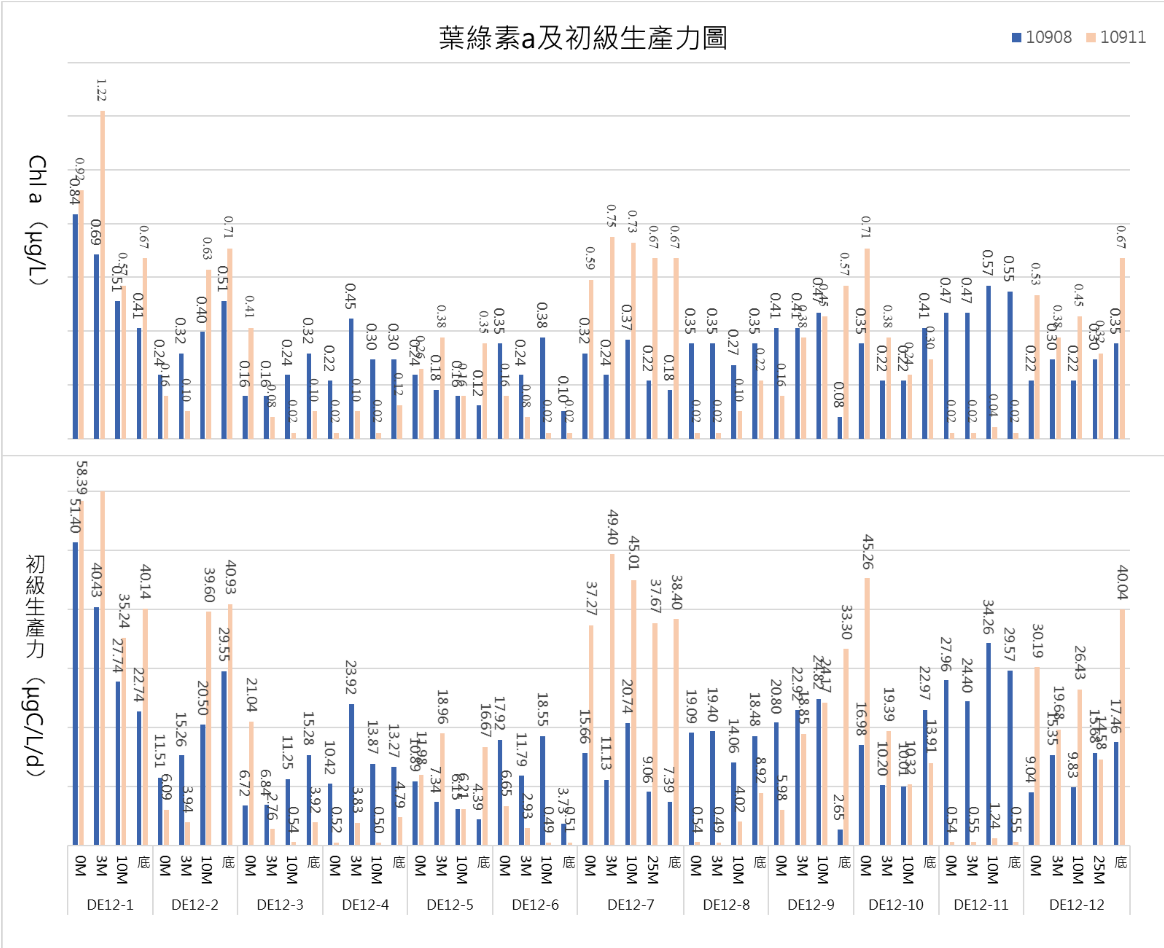


Figure 6.7.1-5 Northwest Wind Farm Chlorophyll-a and Primary Productivity

2. Zooplankton

(1) Species Composition

In total, 16 phyla and 41 groups were recorded; 11 phyla and 34 groups were recorded in the first survey; and 16 phyla and 38 groups were recorded in the second survey.

19-26 groups were recorded in each layer/station in the first survey. DE12-2 and DE12-10 recorded the most species. Abundance in each layer/station is between 165,868-1,005,156 inds./1,000 m^3. DE12-5 recorded the highest abundance. (Figure 6.7.1-6)

21-26 groups were recorded in each layer/station in the second survey. DE12-4 and DE12-12 recorded the most species. Abundance in each layer/station is between 106,759-706,618 inds./1,000 m^3. DE12-7 recorded the highest abundance. (Figure 6.7.1-6)

(2) Dominant Species

In the first survey, Calanoida has the highest relative abundance (1,765,211 inds./1,000 m^3, 27.58%), followed by Cyclopoida (1,672,752 inds./1,000 m^3, 26.13%) and Urodela (1,533,758 inds./1,000 m^3, 23.96%), indicating that the 3 species are the dominant species in the area. 17 species, including Foraminifera, Radiolaria, Siphonophorae, Cladocera, juvenile Decapod, juvenile Copepods, Cyclopoida, Calanoida, Harpacticoida, Polychaete, Pteropoda, other Gastropoda, Chaetognatha, juvenile Echinodermata, Urodela, Doliolum and fish eggs have the highest observation frequency（100.00%）. They are species that are frequently spotted in the marine area.

In the second survey, Calanoida has the highest relative abundance (1,445,980 inds./1,000 m^3, 47.47%), followed by Noctiluca scintillans (622,200 inds./1,000 m^3, 23.11%) and Cyclopoida (385,358 inds./1,000 m^3, 12.65%), indicating that the 3 species are the dominant species in the area. Calanoida and Cyclopoida are commonly considered dominant species, however, this survey is the first survey that recorded Noctiluca scintillans as a dominant species. The species was not recorded in 2016 and only a small quantity were recorded in May 2020 at DE12-2.

12 species, including Foraminifera, Siphonophorae, Calycopsis borchgrevinki, juvenile Decapod, Cyclopoida, Calanoida, Harpacticoida, Ostracoda, Polychaete, Pteropoda, Chaetognatha and juvenile Echinodermata have the highest observation frequency (100.00%). They are species that are frequently spotted in the marine area.

(3) Diversity Index

In the first survey, *H'* in each station/layer is between 1.72-2.08; *J'* is between 0.55-0.66. *H'* indicates that number of the species distributedevenly, and *J'* indicates that due to Calanoida, quantity of each species is not distributed evenly. (Figure 6.7.1-7)

In the second survey, H' in each station/layer is between 0.90-1.77; J' is between 0.30-.56. H' indicates that number of the species distributedevenly, and J' indicates that due to Calanoida and Cyclopoida quantity of each species is not distributed evenly. (Figure 6.7.1-7)

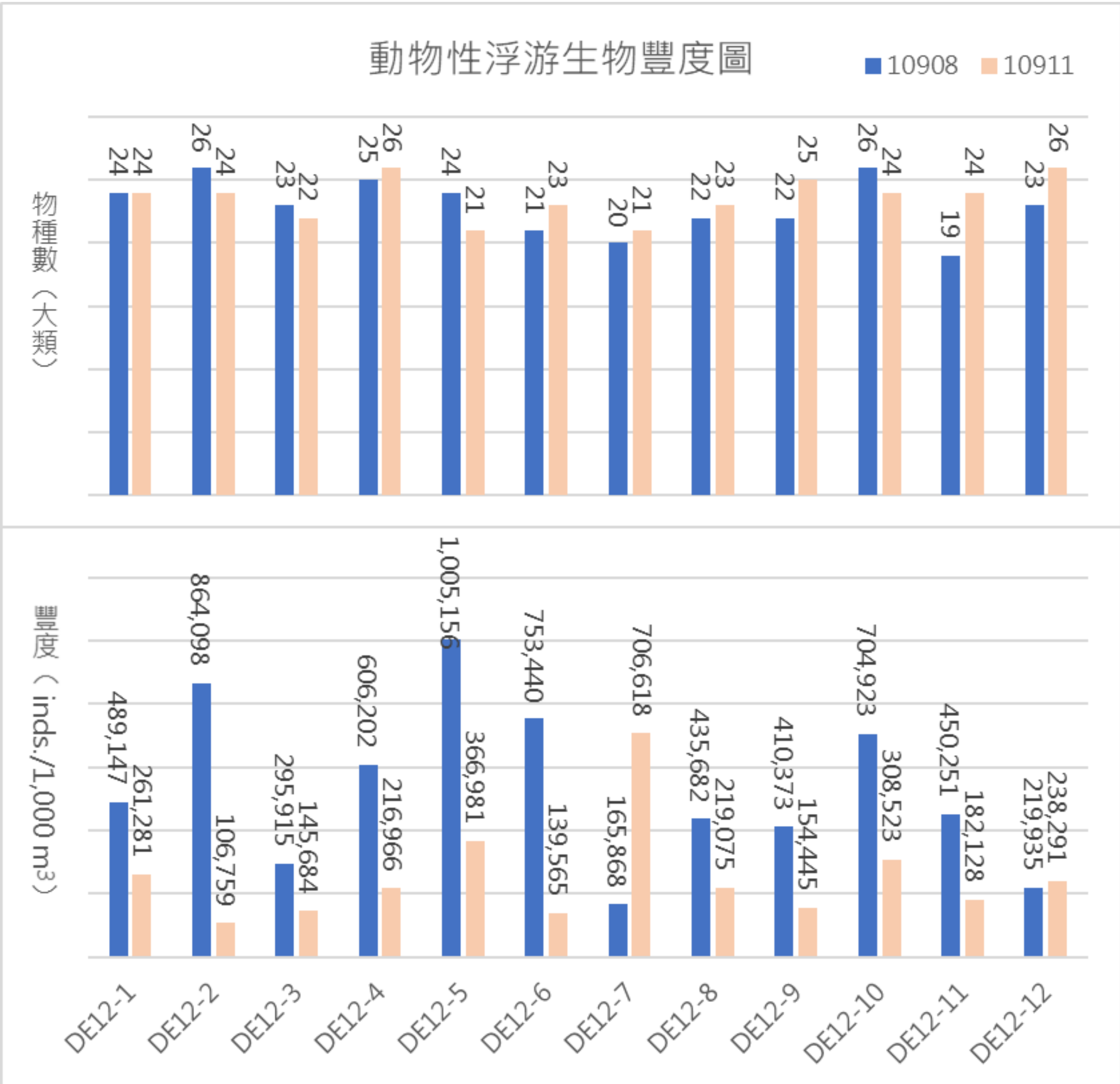


Figure 6.7.1-6 Northwest Wind Farm Zooplankton Abundance

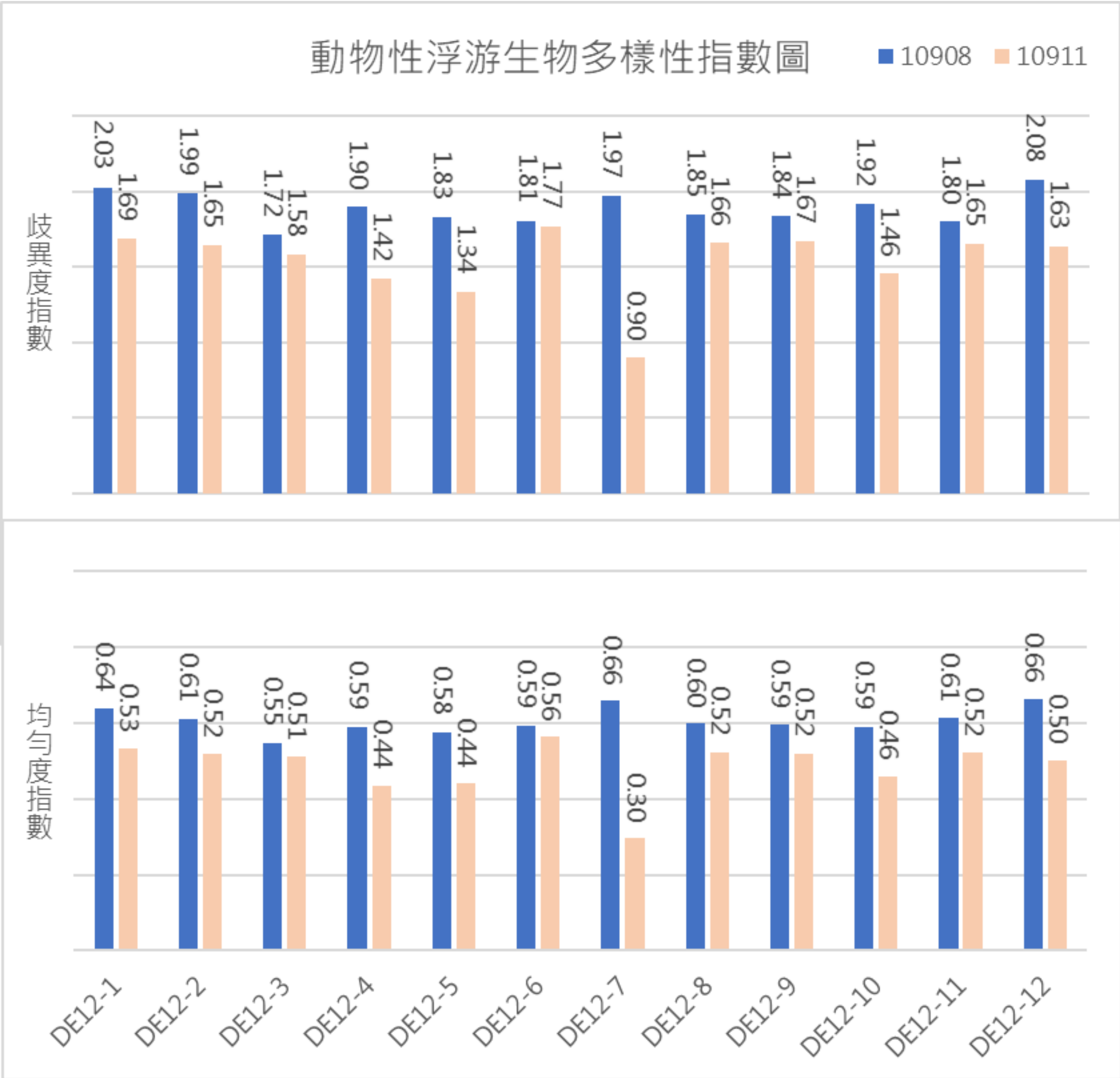


Figure 6.7.1-7 Northwest Wind Farm Phytoplankton Diversity

3. Benthic Organisms

(1) Species Composition

In total, 5 phyla, 10 genre and 15 species were recorded.

5 orders, 9 families, and 11 species were recorded during the first survey. Between 1-4 species were recorded in each sampling station, DE12-1 and DE12-10 recorded the most species; and abundance ranged between 3-14 inds./net, DE12-10 had the highest abundance. (Figure 6.7.1-8)

5 orders, 8 families, and 11 species were recorded during the second survey. Between 1-3 species were recorded in each sampling station, DE12-6 recorded the most species, while no species were recorded in DE12-5, DE12-8 and DE12-9; and abundance ranged between 1-5 inds./net for the remaining stations, DE12-2 and DE12-10 had the highest abundance.

(Figure 6.7.1-8)

(2) Dominant Species

For the first survey, Nereis had the highest relative abundance (38 inds./net, 36.54 %), followed by Nassarius conoidalis (11 inds./net, 10.58%) and Nassarius nodifer (8 inds./net, 7.69 %). This indicates these 3 benthic organisms have relatively higher abundance. In addition, Nereis (58.33%) appeared with the highest frequency, followed by Olivella spretoides (25.00 %), indicating they are common species.

For the second survey, juvenile Stomatopoda and Metapenaeopsis barbata had the highest relative abundance (5 inds./net, 17.86 %), followed by Spear shrimp (4 inds./net, 14.29%). This indicates these 3 benthic organisms have relatively higher abundance. In addition, Metapenaeopsis barbata (25.00%) appeared with the highest frequency, followed by Spear shrimp, juvenile Stomatopoda, Nereis and Lophiotoma leucotropis (16.67 % each), indicating they are common species.

(3) Diversity Index

Only 1 species was recorded in DE12-5, DE12-7 and DE12-8, as such, the diversity index and uniformity index for these stations are 0.00 and incalculable, respectively. For the remaining stations, the diversity index for benthic organisms was between 0.64 -1.37, and uniformity index was between 0.91-0.99. Species composition and abundance are distributed evenly, and a significantly dominant species was not recorded (Figure 6.7.1-9).

Only 1 species was recorded in DE12-4 and DE12-12, as such, the diversity index and uniformity index for these stations are 0.00 and incalculable, respectively. 0 species was recorded in DE12-5, DE12-8 and DE12-9, as such, the diversity index and uniformity index for these stations are incalculable. For the remaining stations, the diversity index for benthic organisms was between 0.56-1.04, and uniformity index was between 0.81-1.00. Species composition and abundance are distributed evenly, and a significantly dominant species was not recorded (Figure 6.7.1-9).

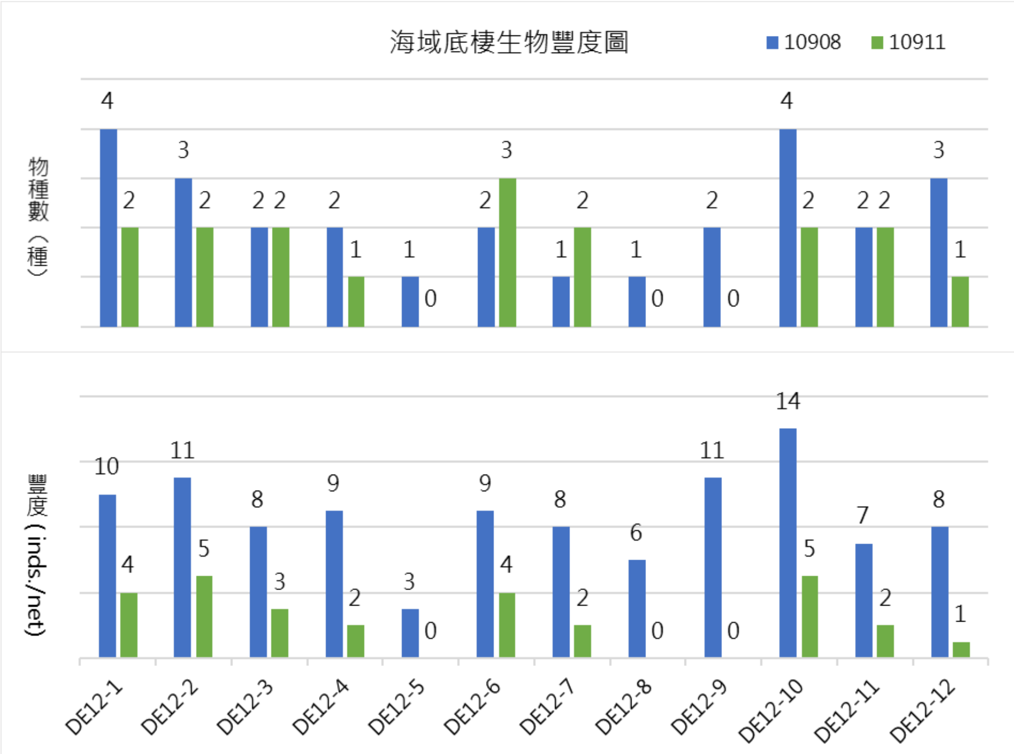


Figure 6.7.1-8 Northwest Wind Farm Benthic Organisms Abundance

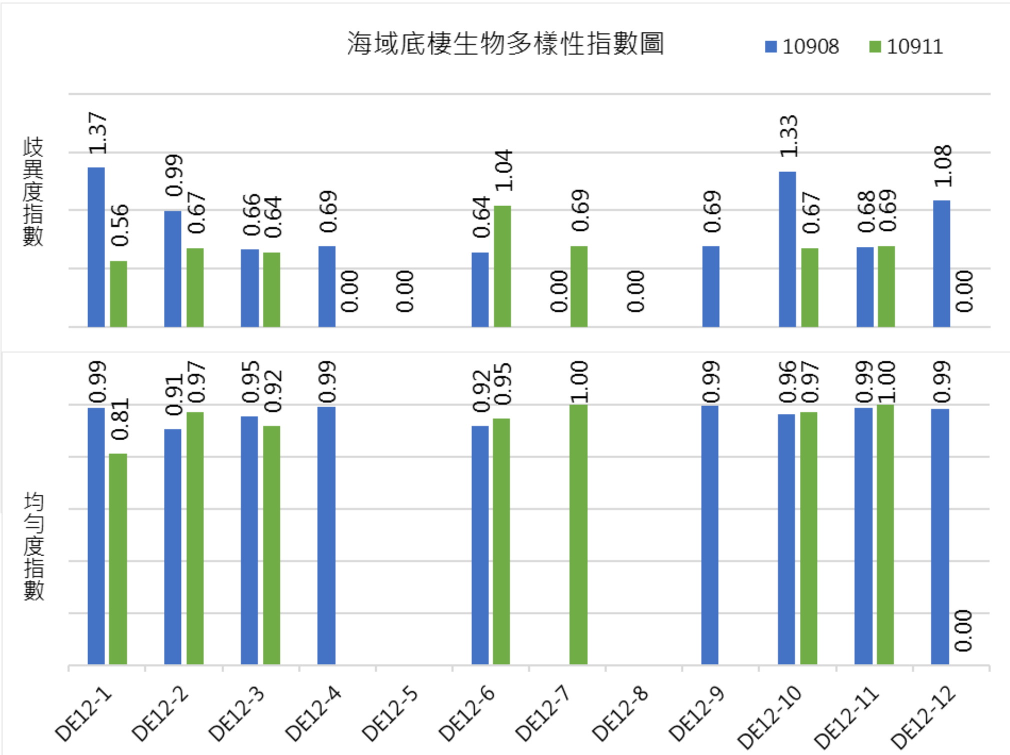


Figure 6.7.1-9 Northwest Wind Farm Benthic Organisms Diversity

4. Fish Survey

(1) Fish Egg and Fish Larva

Sampling and analysis for this Project has been completed. Sampling was conducted on August 14th and November 18th of 2020. The samples were selected manually in a lab. To follow-up, they were put under the microscope, to identify form, quantity, conduct photography, and categorize to the lowest classification possible.

a. Survey Results

A total of 1,844 eggs and 79 juvenile fish were collected in the first survey. For species composition, 11 families, 13 genre and 1 unidentified species was recorded. The dominant species is Mene maculata from Menidae, followed by Euthynnus affinis from Scombridae and Trichiurus sp. from Trichiuridae. Abundance of the remaining species are less than 100 eggs/100 m^3. A dominant species can be identified clearly. For fish larva, 13 families, 17 genre were identified. The dominant species is Scomberoides tol from Carangidae and Thunnus albacares from Scombridae, followed by Gempylus serpens from Gempylidae. Abundance of the remaining species are less than 10 individuals/100 m^3. (Table 6.7.1-5)

A total of 267 eggs and 3 juvenile fish were collected in the first survey. For species composition, 7 families, 9 genre was recorded. The dominant species is Evynnis cardinalis from Sparidae, followed by Trichiurus sp. from Trichiuridae and Uranoscopus oligolepis from Uranoscopidae (Table 6.7.1-4). Abundance of the remaining species are less than 10eggs/100 m^3. A dominant species can be identified clearly. For fish larva, 3 families, 3 genre and 3 individuals were identified. The species include Blenniidae, Ptereleotris evides from Ptereleotridae and Acanthopagrus latus from Sparidae. (Table 6.7.1-5)

Table 6.7.1-4 Species Composition and Abundance of Fish Eggs for Northwest Wind Farm in August and November 2020 (eggs/100m³)

Taxa\Station	Chinese Name	20200813	20201118	Total
Carangidae				
Scomberoides tol	托爾逆鈎鰺	48		48
Coryphaenidae				
Coryphaena hippurus	鬼頭刀	7		7
Engraulidae				
Encrasicholina punctifer	銀灰半稜鯷		5	5
Engraulis japonicus	日本鯷	11		11
Fistulariidae				
Fistularia commersonii	康氏馬鞭魚	30		30
Menidae				
Mene maculata	眼眶魚	1018		1018
Mugilidae				
Mugil cephalus	鯔		4	4
Muraenidae				
Gymnothorax sp.	裸胸鯙屬sp.	3		3
Priacanthidae				
Priacanthus macracanthus	大棘大眼鯛	2		2
Sciaenidae				
Chrysochir aureus	黃金鰭(魚或)		2	2
Pennahia macrocephalus	大頭白姑魚		9	9
Scombridae				
Auxis rochei rochei	圓花鰹	1		1
Euthynnus affinis	巴鰹	385		385
Sarda orientalis	東方齒鰆	8		8
Soleidae				
Liachirus melanospilos	黑斑圓鱗鰨	1		1
Sparidae				
Acanthopagrus latus	黃鰭棘鯛		4	4
Evynnis cardinalis	紅鋤齒鯛		45	45
Synodontidae				
Synodontidae sp.	合齒魚科	44		44
Trachinocephalus myops	準大頭狗母魚		2	2
Trichiuridae				
Trichiurus sp.	帶魚屬sp.	292	39	331
Uranoscopidae				
Uranoscopus oligolepis	寡鱗騰	5		5
unknown				
unknown	unknown		11	11
Total		**1855**	**121**	**1976**
Family		11	7	15
Species		13	9	21
No. of Fish Eggs		1844	267	2111

Table 6.7.1-5 Species Composition and Abundance of Larvae for Northwest Wind Farm in August and November 2020 (individuals/100m^3)

Taxa\Station	Chinese Name	20200813	20201118	Total
Blenniidae				
Blenniidae sp.	鳚科sp.		1	1
Carangidae				
Scomberoides tol	托爾逆鈎鰺	20		20
Coryphaenidae				
Coryphaena hippurus	鬼頭刀	3		3
Emmelichthyidae				
Erythrocles sp.	紅諧魚屬sp.	3		3
Exocoetidae				
Parexocoetus brachypterus	短鰭擬飛魚	1		1
Gempylidae				
Gempylus serpens	帶鰆	12		12
Gobiidae				
Gobiidae sp.	鰕虎科sp.	3		3
Gonostomatidae				
Cyclothone sp.	鑽光魚屬sp.	2		2
Holocentridae				
Myripristis sp.	鋸鱗魚屬sp.	1		1
Mullidae				
Upeneus japonicus	日本緋鯉	9		9
Muraenidae				
Gymnothorax sp.	裸胸鯙屬sp.	1		1
Myctophidae				
Bolinichthys sp.	虹燈魚屬sp.	1		1
Ceratoscopelus warmingii	瓦明氏角燈魚	4		4
Myctophidae sp.	燈籠魚科sp.	2		2
Pomacentridae				
Abudefduf bengalensis	孟加拉豆娘魚	7		7
Abudefduf vaigiensis	條紋豆娘魚	1		1
Pomacentrus coelestis	霓虹雀鯛	1		1
Ptereleotridae				
Ptereleotris evides	黑尾凹尾塘鱧		1	1
Scombridae				
Thunnus albacares	黃鰭鮪	20		20
Sparidae				
Acanthopagrus latus	黃鰭棘鯛		1	1
unknown				
unknown	unknown	2		2
Total		**93**	**3**	**96**
Family		13	3	16
Species		16	3	20
No. of Larvae		79	3	82

b. Analysis Results

The Shannon-Wiener diversity index, (H') and Pielou's evenness (J') of fish egg and fish larva are analyzed.

In the first survey, regarding fish egg, *H'* is between 1.12-1.98, *J'* is between 0.81-0.97. st.2 has the highest *H'* index (*H'*=1.98), st.11 has the lowest *H'* index (*H'*=1.12). Regarding fish larva, in s6, only 1 fish larva was captured, *H'* is 0 and *J'* is incalculable. For the rest of the stations, *H'* is between 0.59-2.15, *J'* is between 0.85-1.00. st.5 has the highest *H'* index *(H'*=2.15), st.12 has the lowest *H'* index (*H'*=0.59). (Figure 6.7.1-11)

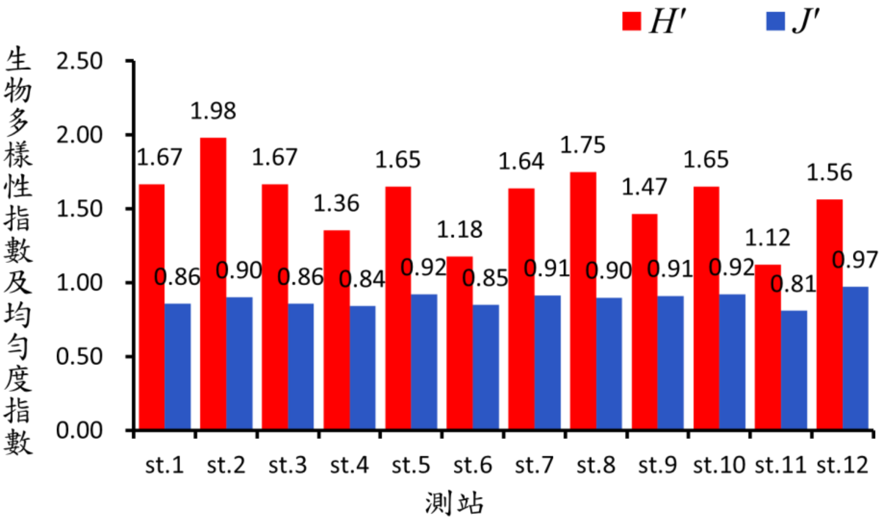


Figure 6.7.1-10 Shannon-Wiener diversity index, (H') and Pielou's evenness (J') of Fish Egg for Northwest Wind Farm in August 2020

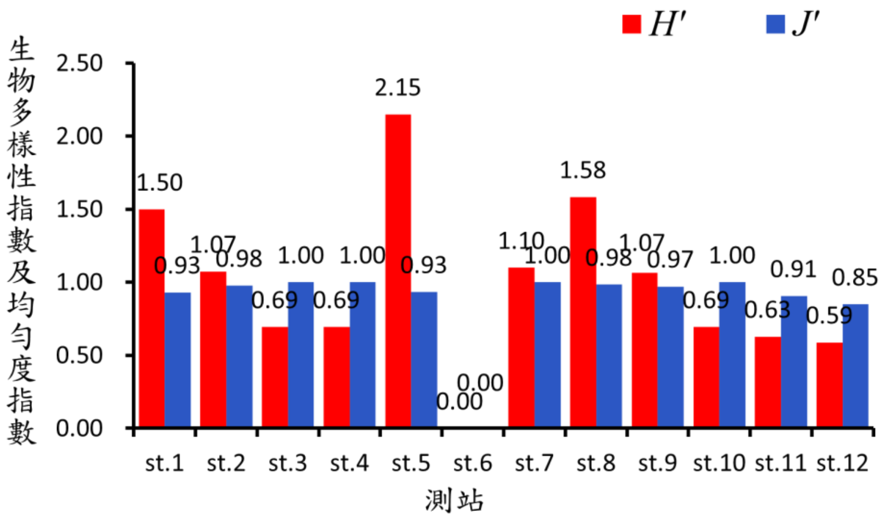


Figure 6.7.1-11 Shannon-Wiener diversity index, (H') and Pielou's evenness (J') of Larvae for Northwest Wind Farm in August 2020

In the second survey, regarding fish egg, *H'* is between 0.64-1.71, *J'* is between 0.81-0.96. st.10 has the highest *H'* index (*H'*=1.71), st.7 has the lowest *H'* index (*H'*=0.64) (Figure 6.7.1-12). Regarding fish larva, 1 individual was caught in st.3, st.6 and st.10, as such, *H'*=0 and *J'* was incalculable (Figure 6.7.1-13).

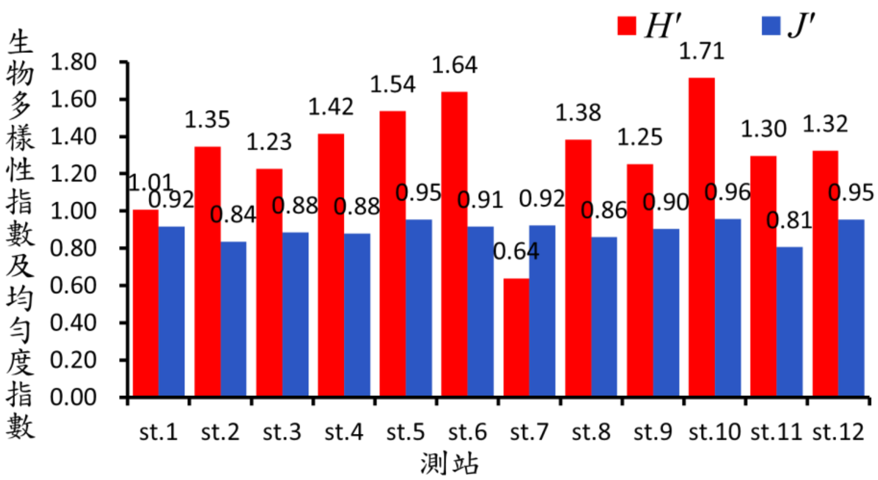
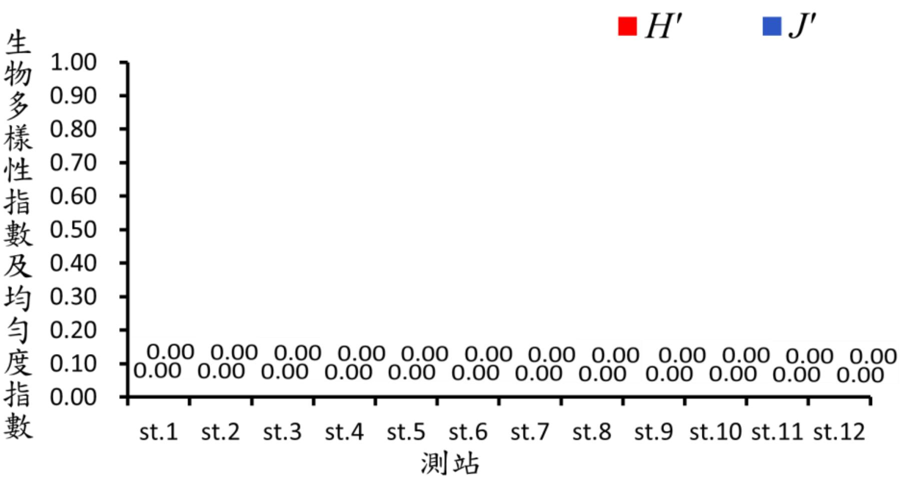


Figure 6.7.1-12 Shannon-Wiener diversity index, (H') and Pielou's evenness (J') of Fish Egg for Northwest Wind Farm in November 2020



Note： 1 individual was caught in st.3, st.6 and st.10, as such, H'=0 and J' was incalculable. No species were recorded in the other stations.

Figure 6.7.1-13 Shannon-Wiener diversity index, (H') and Pielou's evenness (J') of Larvae for Northwest Wind Farm in November 2020

(2) Adult Fish

The first survey was conducted on August 22nd, 2020. In the first survey, 8 families, 10 species and 33 individuals were captured, weighing for 5.6kg. For T1, a total of 3 families, 4 species, 5 individuals and around 0.34 kg of fish were caught (Table6.7.1-6). Triacanthus biaculeatus with no commercial value was the most abundant with 2 individuals, they are usually thrown back into the ocean, the remaining species each had 1 individual, including Trichiurus lepturus. For T2, a total of 2 families, 2 species, 3 individuals and around 0.4 kg of fish were caught (Table 6.7.1-6). Decapterus macrosoma was the most abundant with 2 individuals, the body length was between 23-24cm, between sub-adult to adult, the average size seen at markets. For T3, a total of 4 families, 6 species, 25 individuals and around 4.9 kg of fish were caught (Table 6.7.1-6). Decapterus macrosoma with average commercial value was the most abundant with 17 individuals, the body length was between 22-27cm, followed by Seriolina nigrofasciata with 2 individuals. In regard to species and individuals, T3>T1>T2; while for fishery yield comparisons indicate T3>T2>T1. The diversity index (H') was 0.64-1.55 and uniformity index (J') was 0.62-0.96. Sorensen coefficient between 2 survey lines was 0-0.25, fish caught in each survey line was not similar.

The second survey was conducted on November 18th, 2020. In the second survey, 25 families, 40 species and 6729 individuals were captured, weighing for 88kg. For T1, a total of 21 families, 31 species, 2074 individuals and around 53.67 kg of fish were caught (Table 6.7.1-7). Benthosema pterotum with no commercial value was the most abundant, with a body length between 3-5cm, they are usually thrown back into the ocean, followed by juvenile Sillago asiatica, with a body length between 4.5-9cm, even though they have high commercial value, smaller individuals are usually thrown back into the ocean, the remaining includes 13 commercially valuable fish. For T2, a total of 15 families, 21 species, 2720 individuals and around 23.7 kg of fish were caught (Table 6.7.1-7). Benthosema pterotum was the most abundant with 2270 individuals, the body length was similar to T1, followed by Pennahia macrocophalus with average commercial value with 83 individuals, with a body length between 4-19cm, however, the majority were juvenile fish between 4-6cm (2 individuals were between 15-19cm), smaller individuals are usually thrown back into the ocean, the remaining includes 8 commercially valuable fish. For T3, a total of 17 families, 26 species, 1935 individuals and around 10.37 kg of fish were caught (Table 6.7.1-7). Benthosema pterotum was the most abundant with 1310 individuals, the body length was similar to T1 and T2, followed by Pennahia macrocophalus with 170 individuals, however, the majority were juvenile fish between 4.5-8cm, smaller individuals are usually thrown back into the ocean, the remaining includes 9 commercially valuable fish. In regard to species, T1>T3>T2, and in regard to individuals, T2>T1>T3; while for fishery yield comparisons indicate T1>T2>T3. The diversity index (H') was 0.85-1.79 and uniformity index (J') was 0.28-0.52. Sorensen coefficient between 2 survey lines was 0.63-0.68, fish caught in each survey line was highly similar.

43 species were caught in the two 2020 surveys, 7 species were caught in both quarters, and Sorensen coefficient is only 0.28. Fishery yield is subpar in August and relatively better in November. The 2 surveys included 8 surface layer migratory fish species, 34 mud-silt type species, and 1 reef type species. Indicating this marine area mainly consists of typical mud-silt type species in western Taiwan and migratory fish species. In the 2 surveys, no Taiwanese fishing vessels were spotted in the wind farm area.

Table 6.7.1-6 Results for Northwest Wind Farm in August 2020

		Time		2020.08.22			2020.08.22			2020.08.22			2020.08	
		漁法/風場		底拖T1			底拖T2			底拖T3			Total	
Family	Fish	中文名	棲性	TL	BW	No.	TL	BW	No.	TL	BW	No.	BW	No.
Ariidae	*Arius maculatus*	斑海鯰	沙							30	520	1	520	1
Carangidae	*Decapterus macrosoma*	長身圓鰺	表				23~24	260	2	22~27	1900	17	2160	19
	Seriolina nigrofasciata	小甘鰺	表							22~28	1200	3	1200	3
Carcharhinidae	*Carcharhinus sorrah*	沙拉真鯊	表							56	990	1	990	1
Scombridae	*Scomber japonicus*	白腹鯖	表				25	140	1				140	1
Synodontidae	*Saurida filamentosa*	長條蛇鯔	沙	25	60	1							60	1
	Trachinocephalus myops	大頭花桿狗母	沙	18	50	1				19~25	190	2	240	3
Tetraodontidae	*Lagocephalus wheeleri (=spadiceus)*	懷氏兔頭魨	沙							20	100	1	100	1
Triacanthidae	*Triacanthus biaculeatus*	雙棘三棘魨	沙	20~21	120	2							120	2
Trichiuridae	*Trichiurus lepturus*	白帶魚	中層	60	110	1							110	1
	尾數					5			3			25		33
	種數					4			2			6		10
	重量				340			400			4900		5640	
	歧異度指數(H')					1.6			0.64			1.11		
	均勻度指數(J')					1			0.92			0.62		

Table 6.7.1-7 Results for Northwest Wind Farm in November 2020

		時間		2020.11.18			2020.11.18			2020.11.18			2020.11	
				底拖T1			底拖T2			底拖T3			Total	
魚科名	魚名	中文名	棲性	TL	BW	No.	TL	BW	No.	TL	BW	No.	BW	No.
Apogonidae	*Apogon ellioti(=Jaydia truncata)*	截尾銀口天竺鯛	沙	3.5~8	226	130	3.8~6	119	70	4~6.5	294	130	639	330
	Ostorhinchus kiensis	中線鸚天竺鯛	沙				4.1~4.5	22	20	5.3~5.5	37	20	59	40
Ariidae	*Arius maculatus*	斑海鯰	沙	18~28	13050	129	18~24	7740	82	18~25	1600	3	22390	214
Bregmacerotidae	*Bregmaceros japonicus*	日本海鰗鰍	沙	4~8	48	30	7.5	27	10	8.5	28	10	103	50
Carangidae	*Caranx sexfasciatus*	六帶鰺	表	26	220	1							220	1
	Decapterus macrosoma	長身圓鰺	表	25	65	1							65	1
	Decapterus russelli	羅氏圓鰺	表	21~25	2350	15	20~26	4150	32	21~26	1000	7	7500	54
	Seriola dumerili	杜氏鰤	表	36	540	1	32~36	1200	2	32	490	1	2230	4
Centrolophidae	*Psenopsis anomala*	刺鯧	沙	21	60	1							60	1
Dasyatidae	*Dasyatis zugei*	尖嘴土魟	沙		160	1							160	1
Haemulidae	*Pomadasys argenteus*	銀雞魚	沙				28~33	2720	6				2720	6
	Pomadasys kaakan	星雞魚	沙	28~30	1600	2				25~30	2100	5	3700	7
Kyphosidae	*Microcanthus strigatus*	柴魚	礁							10	30	1	30	1
Leiognathidae	*Leiognathus berbis*	細紋鰏	沙	4.1~5.5	52	60	3.5~4	14	20	3.5~5.5	110	90	176	170
	Photopectoralis bindus	黃斑光胸鰏	沙							8.5	85	10	85	10
	Secutor ruconius	仰口鰏	沙	3~6	131	50	3.5~4.5	22	20	3.2~6.5	162	79	315	149
Myctophidae	*Benthosema pterotum*	七星底燈魚	中層	3~5	499	1130	3~4.5	937	2270	2~4.5	540	1310	1976	4710
Nomeidae	*Cubiceps whiteleggii*	懷氏方頭鯧	中層							12	30	1	30	1
Platyrhinidae	*Platyrhina tangi*	湯氏黃點鯆	沙		2400	4		1450	2		1250	20	5100	26
Polynemidae	*Polydactylus sextarius*	六指多指馬鮁	沙							8~9.2	89	20	89	20
Pristigasteridae	*Ilisha melastoma*	黑口鰳	沙							10	102	10	102	10
Rachycentridae	*Rachycentron canadum*	海鱺	表	48	900	1							900	1
Sciaenidae	*Johnius belangerii*	皮氏叫姑魚	沙	5~7	163	70							163	70
	Pennahia anea	截尾白姑魚	沙							13	30	1	30	1
	Pennahia argentata	白姑魚	沙	20	95	1				15	35	1	130	2
	Pennahia macrocophalus	大頭白姑魚	沙	5~11	427	141	4~19	453	83	4.5~8	455	170	1335	394
Siganidae	*Siganus fuscescens*	褐籃子魚	礁	21~22	265	2	20	110	1				375	3
Sillaginidae	*Sillago asiatica(sihama)*	(多鱗)亞洲沙鮻	沙	4.5~9	270	190	4.2~5	24	40	6.8	14	10	308	240
Sparidae	*Evynnis cardinalis*	紅鋤齒鯛	沙	12~15	490	9	10~18	280	4	10~12	150	4	920	17
	Rhabdosargus sarba	平鯛	沙				20	160	1				160	1
Synodontidae	*Saurida filamentosa*	長條蛇鯔	沙	20~25	330	6				23	60	1	390	7
	Trachinocephalus myops	大頭花桿狗母	沙	11~26	95	2	9~22	179	11				274	13
Terapontidae	*Terapon jarbua*	花身鯻	沙	21	140	1							140	1
Tetraodontidae	*Lagocephalus gloveri*	克氏兔頭魨	沙	20~30	300	2							300	2
	Lagocephalus lunaris	月尾兔頭魨	沙	20~37	20200	50	24~26	1950	5	20~36	1300	3	23450	58
	Lagocephalus wheeleri	懷氏兔頭魨	沙	20~34	3560	20	20~22	590	4	20	110	1	4260	25
	Takifugu oblongus	橫紋多紀魨	沙	21~35	4250	14	20~28	890	4	21	160	1	5300	19
Triacanthidae	*Triacanthus biaculeatus*	雙棘三棘魨	沙	18~20	220	2							220	2
Trichiuridae	*Trichiurus lepturus*	白帶魚	中層	45~72	360	7	22~90	669	33	18~35	110	26	1139	66
Triglidae	*Chelidonichthys kumu*	黑角魚	沙	26	200	1							200	1
	尾數					2074			2720			1935		6729
	種數					31			21			26		40
	重量				53666			23706			10371		87743	
	歧異度指數(H')					1.79			0.85			1.34		
	均勻度指數(J')					0.52			0.28			0.41		

III. Differential Analysis between the EIS stage and Baseline Data

1. Phytoplankton

For the same quarters during EIA (August and November 2016), 6 phyla, 58 genre and 84 species were recorded, the abundance of phytoplankton in each layer is between 5,790-78,933 cells/L. The dominant species was Chaetoceros curvisetus. More species were recorded in the current surveys compared to the EIS stage, as many species were categorized as spp. during the EIS, while they are categorized to specific species in the current surveys. For example, Ceratium spp. now includes 5 separate species; and Nitzschia spp. now includes 7 separate species.

2. Zooplankton

For the same quarters during EIA (August and November 2016), 8 phyla and 28 groups were recorded. 15 species were newly recorded in the current surveys, including Noctiluca scintillans, Ctenophora, Scyphozoa, other juvenile Cnidaria, Platyzoa, juvenile Stomatopoda, Isopoda, juvenile Nemertina, juvenile Sipuncula, juvenile Bivalvia, juvenile Phoronida, juvenile Brachiopoda, juvenile Bryozoa, juvenile Hemichordata and juvenile Ascidiacea; while 2 unrecorded species include Jellyfish and other Mollusks. Dominant species was Calanoida and Cyclopoida in both stages. Zooplankton is highly influenced by short term food and temperature changes resulting in high variations in populations. Species composition and abundance are lower this quarter.

Noctiluca scintillans population has increased around the globe, possibly due to global warming and coastal eutrophication. This has caused an increase in nutrients in coastal areas, which has resulted in the sudden increase of zooplankton and Noctiluca scintillans population. The species was not recorded in 2016 and only a small quantity were recorded in May 2020 at DE12-2. However, it is a dominant species in November 2020.

3. Benthic Organism

For the same quarters during EIA (August and November 2016), 7 phyla, 16 genre and 22 species were recorded. 7 species were newly recorded in the current surveys, including Anchisquilla fasciata, juvenile Stomatopoda, Turricula nelliae spurius, Terebridae, Olivella spretoides, Nassarius conoidalis and Mactra veneriformis; while 14 unrecorded species include Portunus tridentatus, Parapenaeopsis cornuta, Hyastenus diacanthus, Diogenes, Clibanarius virescens, Parthenope, Calappa lophos, Stomatopoda, Cavernularia obesa, Pteroeides sparmanni, Tonna olearium, Pharaonella perna, Venus foveolata and Dosinia japonica. Benthic organisms inhabit and move around the bottom layer of the marine area, as offshore construction has not begun. The difference between the 2 stages is due to the limited sampling area for bottom trawling.

4. Fish Egg and Fish Larva

A total of 2,111 eggs and 82 juvenile fish were collected in the 2 current surveys. For species composition of fish eggs, 15 families, and 21 genre were recorded. The dominant species is Mene maculata from Menidae, followed by Euthynnus affinis from Scombridae and Trichiurus sp. from Trichiuridae. Abundance of the remaining species are less than 100 eggs/100 m^3. A dominant species can be identified clearly. For fish larva, 16 families, 20 genre were identified. The records mainly consisted of coastal fish and mud-sand type fish species, including Sparidae, Trichiuridae, and Uranoscopidae.

The Shannon-Wiener diversity index, (*H’)* and Pielou’s evenness *(J’)* of fish egg and fish larva are analyzed. Regarding fish egg, *H’* is 2.33, *J’* is 0.91 for the first quarter; and *H’* is 2.04, *J’* is 0.93 for the second quarter. Regarding larvae, *H’* is 2.66, *J’* is 0.94 for the first quarter; and *H’* is 1.09, *J’* is 0.99 for the second quarter.

5. Fish

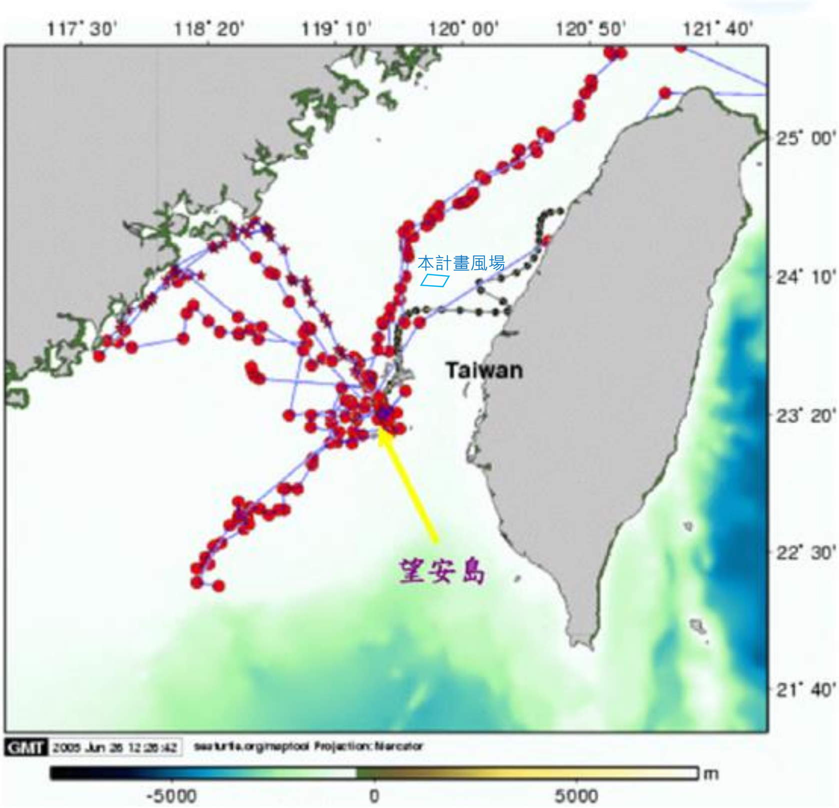
   6 total surveys were conducted between 2016-2020, the results for species composition and no. of individuals were similar for each survey line. Fish yield is subpar for April-July (Spring, Summer), and is relatively better between October- January (Fall, Winter). This may be due to seasonal differences. In terms of species, more migratory species are recorded in fall and winter, possible reasons for this outcome might be because the wind farm is within a migratory route resulting in more records in fall and winter compared to spring and summer. Survey periods for 2 surveys each in 2016 and 2020 overlap, in total 36 families, 59 species and 7167 individuals were captured, weighing 154 kg. Arius maculatus is the only species that was recorded in each survey, with low commercial value, and small body length (mostly <30cm), most are thrown back into the ocean. The most species are from the Carangidae family (5 species), followed by Leiognathidae, Sciaenidae, and Tetraodontidae families 4 species each), the remaining families including Apogonidae, Paralichthyidae, and Dasyatidae had less than 3 species. The results indicate the amount of fish from each family is limited, and species vary inconsistently. Comparisons of current surveys and EIS surveys indicate fishery resources are limited in the wind farm area, and fishery activity rarely occur in the area.

6. Migratory routes of sea turtles

   According to the "Report on the Results of the Annual Survey of Sea Turtle Populations around Taiwan in 2019" commissioned by the OCA, OAC, the main travel paths of sea turtles in Taiwan include the Western Pacific Ocean and the South China Sea. According to the data of the sea turtle satellite tracked by Taiwan, most of them are scattered throughout the western Pacific Ocean. The prevailing hypothesis is that sea turtles follow ocean currents to their feeding grounds to save effort. The report also collected the migratory paths of 12 postnatal green turtles in the Taiwan Strait from 1994-2004 on Wangan Island, Penghu (Figure 6.7.1-14), and found that some females would go to the Okinawa Islands in Japan, the Cauldron Islands, or south to Hainan Island in the South China Sea. The paths do not overlap with the wind farm area.

   The “Report on the Results of the Post-Recovery Reach of Sick and Injured Sea Turtles in Taiwan Waters” issued by Marine National Park Headquarters (2018 December) is also referred to. In the report, a total of 9 sea turtles were traced on their post-recovery travel paths. The results showed that all sea turtles ended up near their rescue sites, which is consistent with previous studies (Laber and Waller, 1994); Balazs, 1994) that sea turtles have fidelity to both marine foraging and terrestrial breeding habitats. According to the literature, sea turtles are mostly active in shallow water because of the availability of algae and the proximity to the land-based spawning environment. The sea turtle spawning beaches in Taiwan are mainly located on five outlying islands, namely Wangan Island in Penghu County, Lanyu in Taitung County, Xiao

Liuqiu in Pingtung County, Dongsha Islands, and Taiping Island in Nansha Islands. The nearest distance from the wind farm to the shore is about 50 km, and the landing site of the submarine cable is located in the Changbin Industrial Area of Changhua County, which is far away from the sea turtle's feeding and spawning environment.



Source: "Report on the Results of the Annual Survey of Sea Turtle Populations around Taiwan in 2019" commissioned by the OCA, OAC

Figure 6.7.1-14 Travel Path of 12 Green sea turtles in Wanan Island of Penghu from 1994-2004

6.7.2 Differential Analysis before and after the Amendment

This amendment includes applying bigger turbines, adding new turbine foundation option, OSS foundation option, and layout of offshore transmission system. The main impact to the marine ecology after the amendment include Disturbance in water quality in the construction phase and the increment of seabed area impacted due to the increased area of protection.

I. Increment of the Scour Protection

In this amendment, the scour protection of the jacket foundation increase from 800 m^2 to 6,600 m^2 (max), and the scour protection of the SBJ is 8,000 m^2. The scour protection of the OSS is also 8,000 m^2. Therefore, not only the construction area on the seabed will increase during the construction phase, but the seabed habitat may also be partly changed during the operation phase due to the protection.

As OWF development does not fully cover the area, the construction area is smaller comparing to other marine constructions. Before the amendment, the scour protection area for each turbine foundation is 800 m^2. Max. turbine number is 74. The maximum area of scour protection increases to approx. 59,200 m^2, accounting for 0.04% of the overall wind farm area. After the amendment, when 16 MW turbine is applied, max. turbine number is 37, The max area of scour protection increases to approx. 6,600 m^2, and the total affected area is 244,200 m^2, accounting for 0.21% of the overall wind farm area (as shown in Table 6.7.2-1). In addition, regarding the SBJ foundation added in this amendment, the area of scouring foundation is 8,000 m^2. If this foundation is selected, the total impacted seabed area will be approx. 296,000 m^2, accounting for 0.25% (as shown in Table 6.7.2-2). The scour protection for OSS is 8000 m^2, accounting for 0.007% (as shown in Table 6.7.2-3. For benthic organism, the organisms on the soft seabed will leave the impacted area or the place where the sediment is changed to 5-10m from the foundation. Therefore, regarding the amendment, slight impact is derived from the change of seabed habitat on the benthic organism.

Table 6.7.2-1 Estimation of the Impacted Area of the Seabed before and after the Amendment

Project	Impacted area for single turbine (m^2)	Impacted area for all turbines (m^2)	Wind farm area (km^2)	Percentage taking up the wind farm area (%)
Before amendment	800	59,200	117.4	0.04
After amendment	6,600	244,200	117.4	0.21

Table 6.7.2-2 Estimation of the Impacted Area of the Seabed before and after the Amendment regarding SBJ

Project	Impacted area for single turbine (m^2)	Impacted area for all turbines (m^2)	Wind farm area (km^2)	Percentage taking up the wind farm area (%)
CHW04	8,000	296,000	117.4	0.25

Table 6.7.2-3 Estimation of the Impacted Area of the Seabed before and after the Amendment (OSS)

Project	Impacted area for single turbine (m^2)	Wind farm area (km^2)	Percentage taking up the wind farm area (%)
CHW04 OSS scour protection	8,000	117.4	0.07

The impact on the marine ecology is mainly on benthic organisms and fish species, which are described as follows.

I. Impacts to Benthic Organism

Since the waters in this project area are mainly sediment habitats and the benthic environment is similar, the average value of the supplemental survey results from the first environmental impact analysis report was used to calculate the loss of benthic organisms caused by the anti-scrubbing protection work, and the biological loss was calculated for the impact area by referring to the "Marine Assessment Ecological Technical Specification (Environmental Protection Administration, Executive Yuan, 2007)". The average biomass of each station was 10.91 g, and the sampling area was 277.8 m^2. In this amendment, the maximum area of the scour protection work for a single wind turbine is 8,000 m^2, and the loss of benthic organisms caused by the scour protection work for each wind turbine is about 0.31 kg. It is estimated that with 37 wind turbines in the second stage, the total loss of organisms is about 11.6 kg. The maximum area of the second stage of the scour protection work for a OSS is 8,000 m^2, and the loss of benthic organisms caused by the scour protection work is about 0.31 kg. The impact of the scour protection work on benthic organisms was not significant.

Table 6.7.2-4 Benthic Organism in the Supplemental Surveys in this Amendment

Stn. / Season	Mass of Benthic Organism (g)													
	DE 12-1	DE 12-2	DE 12-3	DE 12-4	DE 12-5	DE 12-6	DE 12-7	DE 12-8	DE 12-9	DE 12-10	DE 12-11	DE 12-12	total	average
10908	11.41	6.95	27.46	19.09	11.27	47.88	1.24	0.94	20.13	27.75	7.50	24.56	206.18	17.18
10911	2.14	5.22	6.74	4.28	0.00	6.82	5.18	0.00	0.00	17.37	3.81	3.75	55.31	4.61
Average in each station														10.90

Note 1: Sampling area = trawl width (45 cm) × trawl speed (2 knots) × operating time (10 min) = 0.45mx(2×1852m/60 min) × 20 min =555.6 m^2

Note 2: Average biomass density = average biomass per station/sampling area = 11.33 g/555.6 m^2 = 0.0204 g/m^2

Note 3: Biological loss = average biomass density × area of sea development

The amount of biological loss of the single-seat fan against brush protection = 0.0204 g/m2×8,000 m^2=163.20 g ≒0.16 kg

In addition, during the construction of the scour protection, sand, mud or suspend solids within a certain area may raise, which results in the increment of turbidity in a certain area. However, with the dispersion of the currents, the value will return to normal within a short period. The concentration of these suspended substances will not be too high or persistent. Therefore, the impact on phytoplankton and mid-surface nekton will be less.

On the other hand, fouling organism, from Algae, Bryozoan, sponge, Cnidariaro Ascidiacea, bivalve and Barnacle, will start to grow on the hard substrate and the surface of the foundation structure provided by the installation of turbines. These organisms will help enhancing fish-gathering effect and increasing biodiversity. In other words, part of the ecosystem or habitat that was originally sand or mud will become reef habitat, which will increase the diversity of habitat.

Overall, after the amendment, the impact of the change in seabed and marine water turbidity on the marine ecology is not significant. Yet, the area will benefit from the fish-gathering effect and resource cultivation due to the scour protection. This should be a positive impact on the marine biodiversity.

II. Impacts on Fish

Generally speaking, if the marine environment is of the rocky reef type habitat, there will be more sedentary fish. However, since this wind farm is a sediment type habitat, and judging from the field survey, there is no obvious fish settlement, most of the fish species surveyed should be traveling through this area.

The protection can serve as artificial reefs and provide fish gathering effects. According to the results of the survey conducted by the Ministry of Science and Technology in 2017-2018 on the effects of fishing reefs in Taiwan, the fish catch in the marine habitat increased from 1.5 g/m^2 in the sandy mud to 77.3-206 g/m^2 in the vicinity of the wind tower and fishing reef, which has a significant fish aggregation effect. In addition, according to the report of the Marine Ecological Research and Analysis - Demonstration Wind Farm Operation Period, the PCA analysis of fish aggregation data in the wind farm area for three years showed no significant aggregation between years, seasons and stations, indicating that the impact of the wind farm is not obvious.

III. Impacts on Sea turtles

Referring to the "Report on the Results of the Annual Survey of Sea Turtle Populations around Taiwan in 2019" commissioned by the OCA, OAC and the "Report on the Results of the Post-Recovery Reach of Injured and Sick Sea Turtles in Taiwan Waters" (December 2018), the sea turtles are mainly observed on five outlying islands in Taiwan, namely, Wangan Island in Penghu County, Lanyu in Taitung County, Xiao Liuqiu in Pingtung County, Dongsha Islands, and Taiping Island in Nansha Islands. Little Liuqiu in Pingtung County, Dongsha Islands, and Taiping Island in Nansha Islands. The nearest distance between the feeding and spawning environment of the sea turtles and the wind farm of this project is about 50 km, which is far away from each other.

6.8 Bird Ecology

During the EIA phase, marine bird radar observation and bird visual survey were conducted from 2016-2018. This project is near to CHW02, and the background of the two projects are similar. Also, the bird collision simulation results using the bird survey data from the EIA stage are similar. CHW02 has carried out pre-construction bird monitoring from 2019 to 2020, which is a long-term, continuous monitoring. Therefore, in this amendment, supplemental survey is added in this DA, and the monitoring results of offshore bird radar and bird visual surveys are included. Followings are the results of each survey.

6.8.1 Bird Ecology

I. Baseline Survey Data

1. Radar survey

i Survey Result in EIS stage

8 radar surveys were carried out in August (Summer), October (Fall) in 2017 and January (Winter) and April-May (Spring) in 2018.

ii Survey Results in 2017

A total of 69 bird flights were recorded in the two surveys conducted in 2017, and 16 flying altitude was recorded. The results showed that the flight direction of night birds in this survey was mainly in the south direction. Vertical records were only collected in October. The lowest height in 16 records was near the horizon, and the highest height was 953 meters. The average height was 10-70 meters. In terms of time analysis, nocturnal bird activity showed with the highest number (14 records) in the 04-06 period, followed by 9 and 8records in the 21-22 and 02-03 period, and the lowest number in the 18-21 period.

iii Survey Results in 2018

A total of 14 bird flight activities and 147 flying altitude records were recorded during the winter survey. The results showed that the flight direction of birds at night in this survey was mainly in the north direction, followed by the west direction, but the overall proportion was not high, indicating that the flight direction was more complicated this season. There were 8 records of heights lower than 20 meters, the lowest being 13 meters, and there were no records of flights higher than 200 meters, with the highest being 180 meters. The flight records of birds below 200 m in height were further divided into 38 records less than 50 m, 66 records between 51 and 100 m as the largest, 38 records between 101 and 150 m, and 5 record between 151 and 200 m (Figure 6.8.1-1). In terms of time analysis, nocturnal bird activity was the highest between 23-00 a.m. (4 records), followed by

22-2 p.m., with 3 records, but the overall number was not large (Figure 6.8.1-2).

A total of five surveys were conducted in spring 2018. Analysis of the results of the five spring vertical radar surveys showed that the main flight direction in spring was toward the north-northeast, accounting for 23.6% of all recorded tracks, followed by 20.8% toward the north and 13.3% toward the north-northwest (Figure 6.8.1-3). With regard to the flying altitude data, the most common flying altitude used by birds during the spring transit was the airspace between 150 and 200 meters, accounting for 24.1% of the total number of records. The data recorded at altitudes above 200 m accounted for 36.8% (Figure 6.8.1-4). In terms of time analysis, it can be found that nighttime is the obvious peak of flight activity for spring birds, and the number of flight birds recorded between 19:00 and 07:00 at night accounted for 85.2% of all vertical radar records (Figure 6.8.1-5).

iv Supplemental Survey in this DA

One radar survey was carried out in winter on December 14, 2021. Analysis of the results of the vertical radar surveys showed that the main flight in winter was toward the south-southeast direction, accounting for 30.8%, followed by the south direction, accounting for 26.9% (Figure 6.8.1-6). With regard to the flying altitude data, the most common flying altitude used by birds during the winter was above 500m, accounting for 28.8%(Figure 6.8.1-7). In terms of time analysis, it can be found that nighttime is the obvious peak of flight activity for winter birds, and the number of flight birds recorded between 18:00 to 06:00, accounted for 71.7% of all vertical radar records (Figure 6.8.1-8).

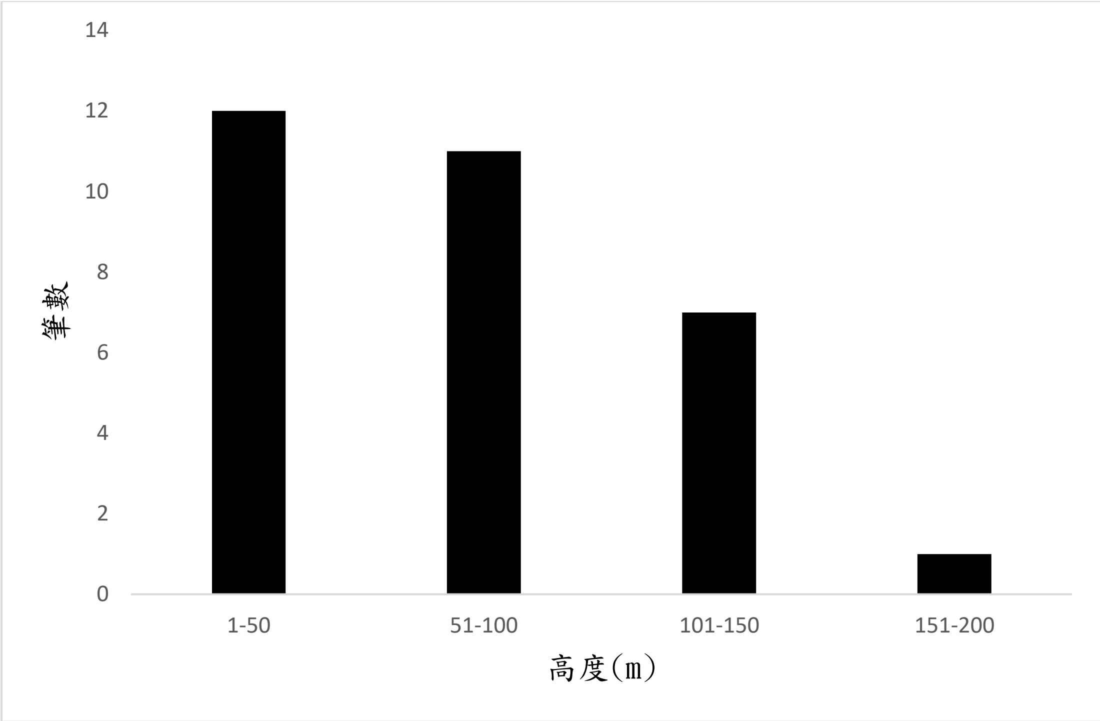


Figure 6.8.1-1 Nocturnal Bird Flying Altitude in 2018 Winter

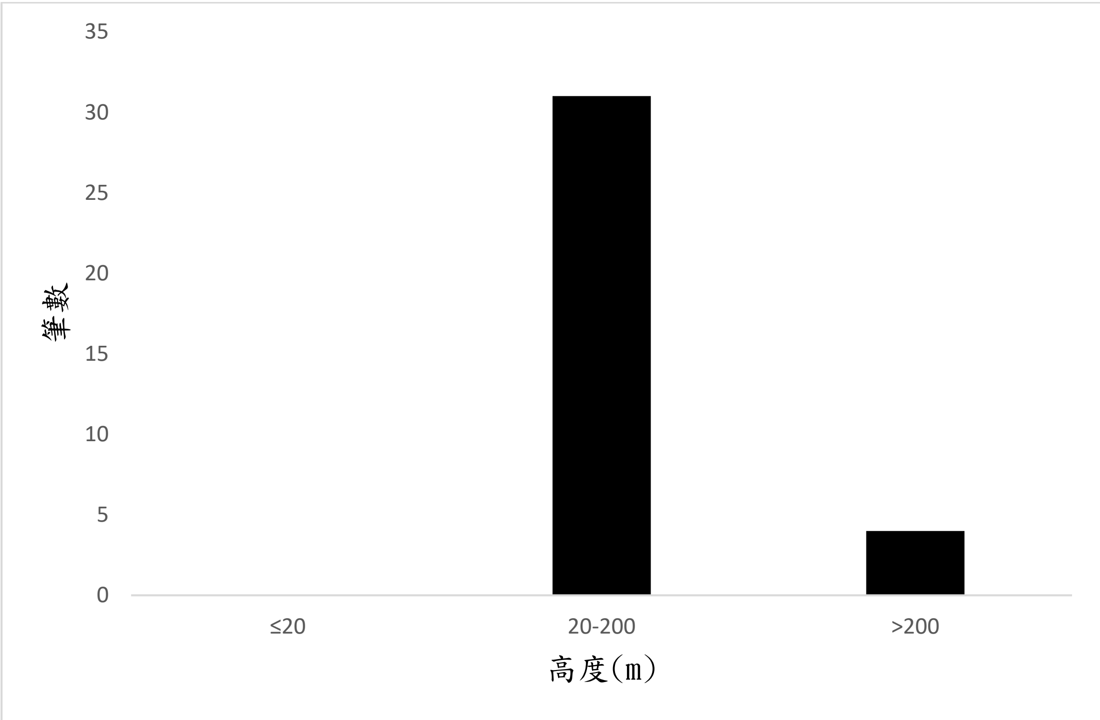


Figure 6.8.1-1 Nocturnal Bird Flying Altitude in 2018 Winter (Cont.)

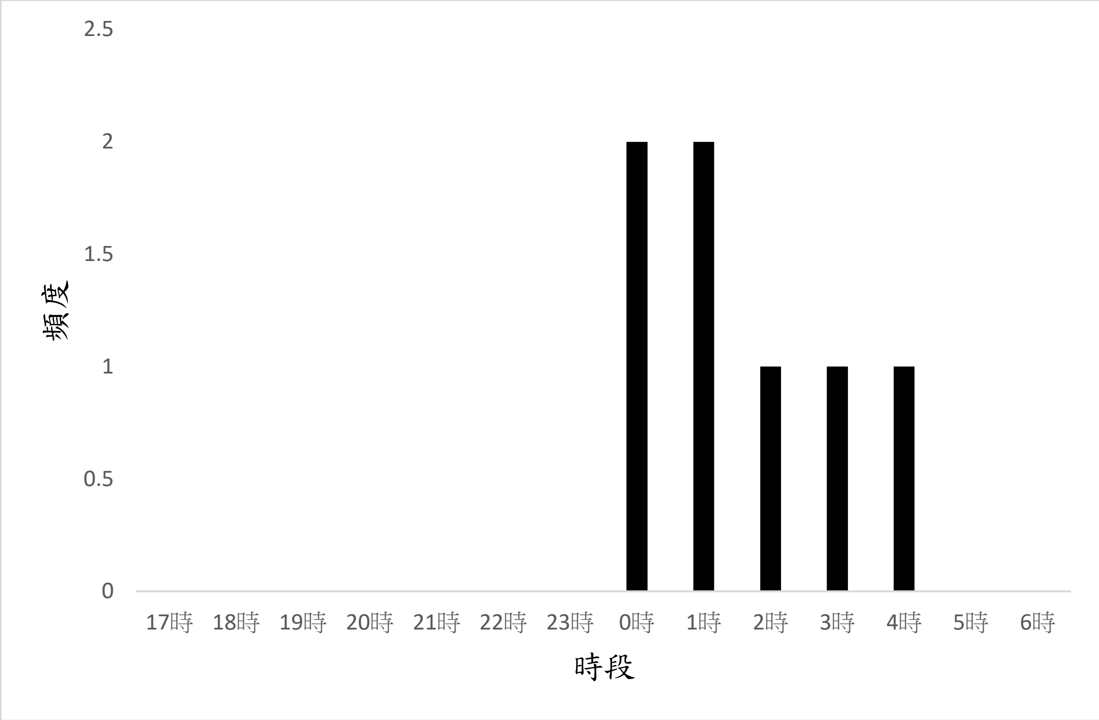


Figure 6.8.1-2 Nocturnal Bird Activity in 2018 Winter

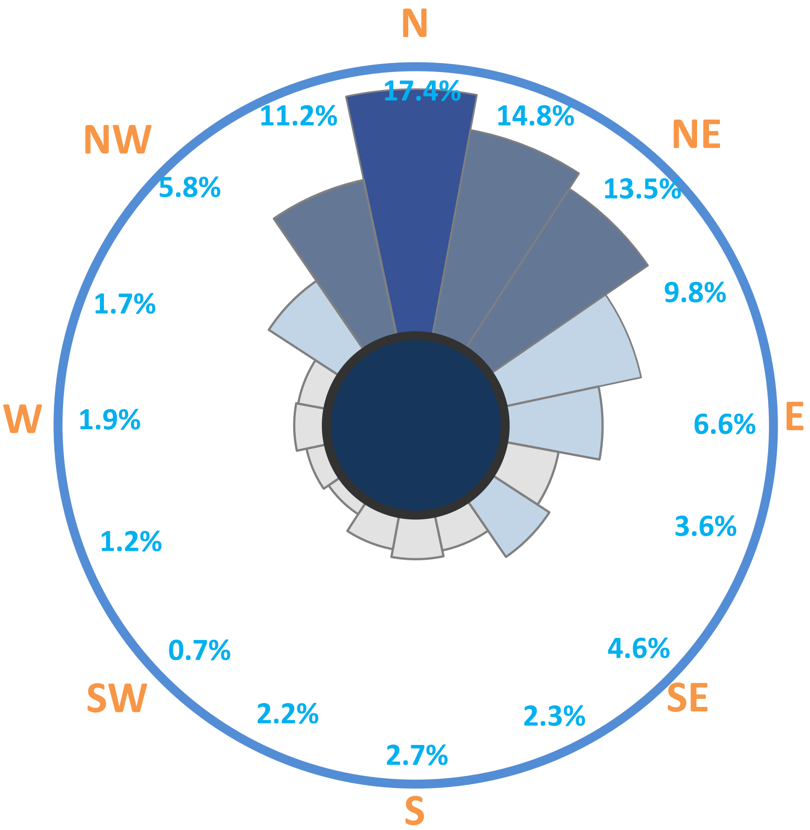


Figure 6.8.1-3 Flying Direction in the 5 Horizontal Radar Survey in Spring 2018

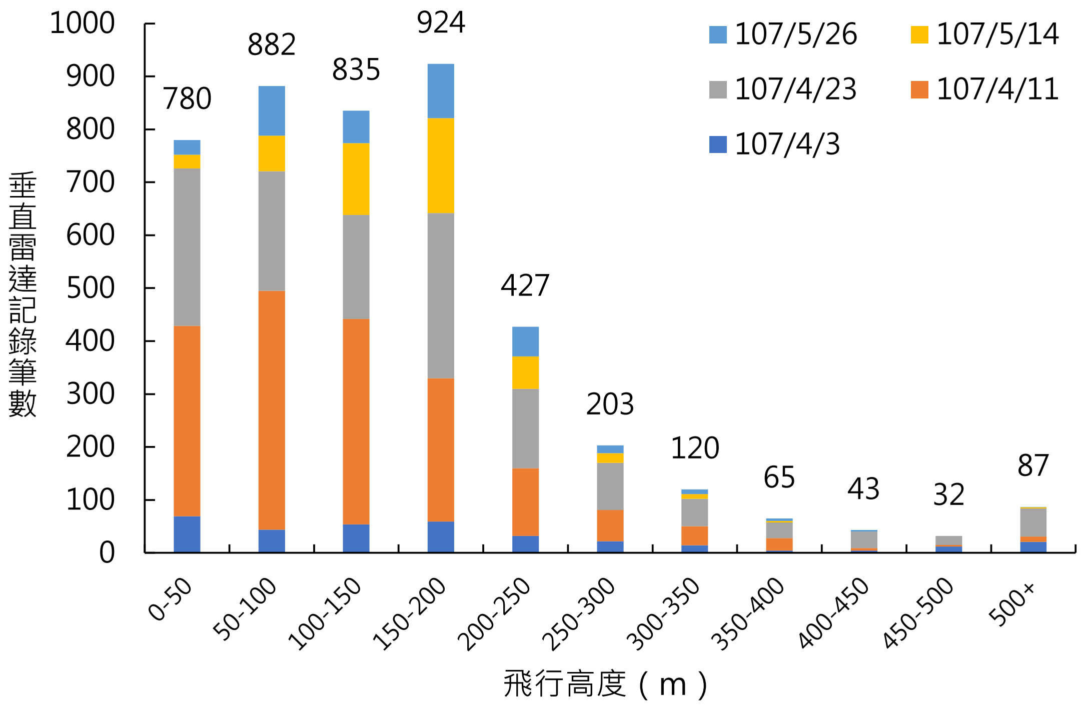


Figure 6.8.1-4 Flying Altitude in the 5 Vertical Radar Survey in Spring 2018

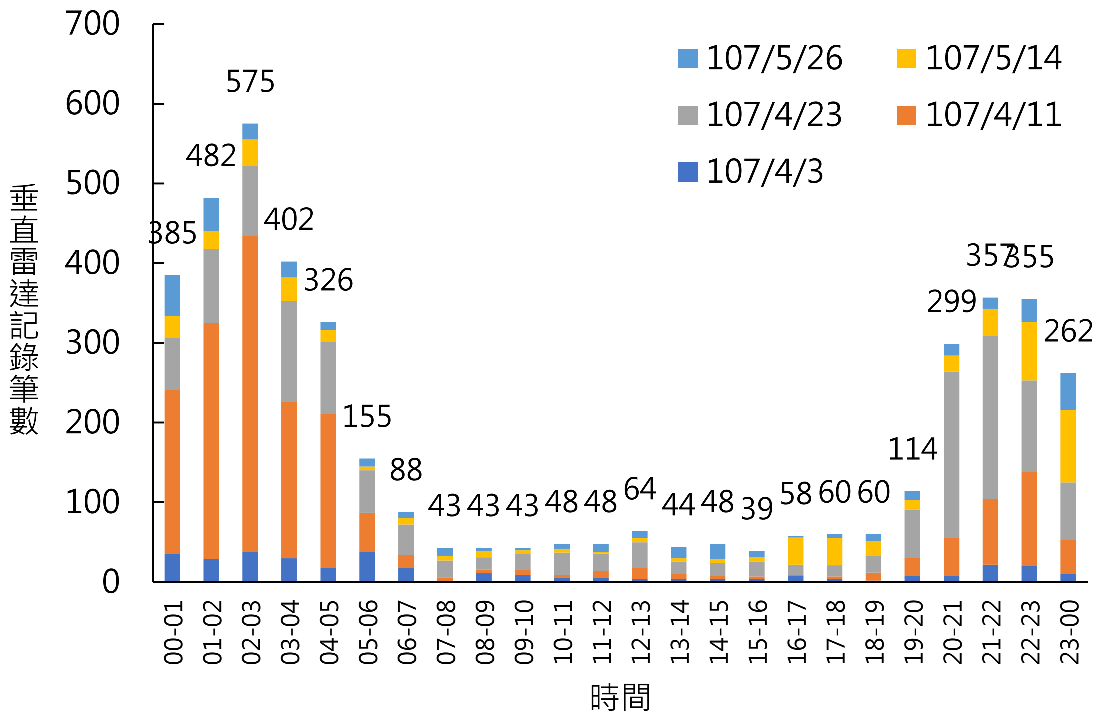


Figure 6.8.1-5 Time Distribution in the 5 Vertical Radar Survey in Spring 2018

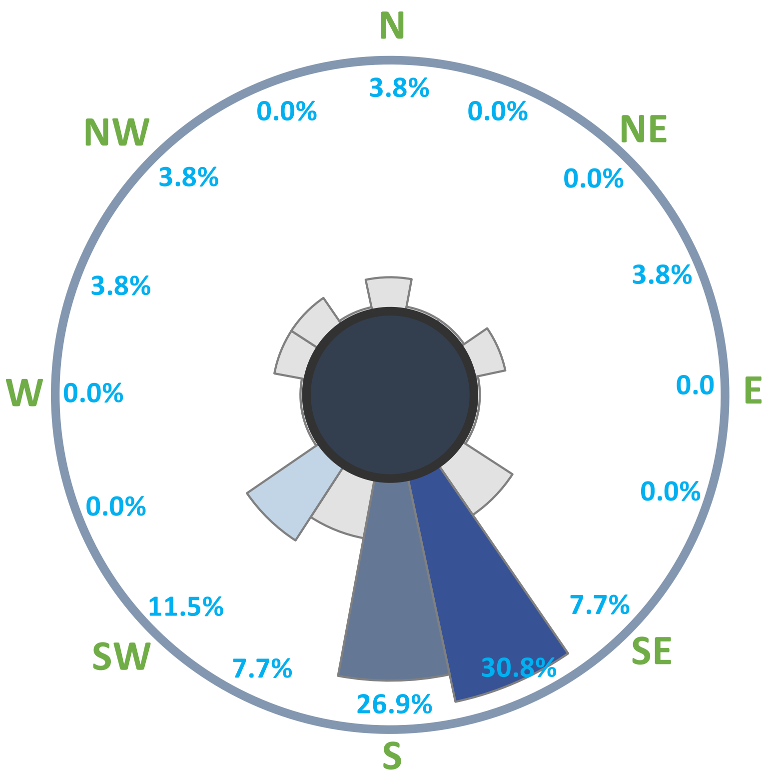


Figure 6.8.1-6 Horizontal Radar Survey Results in Winter 2021

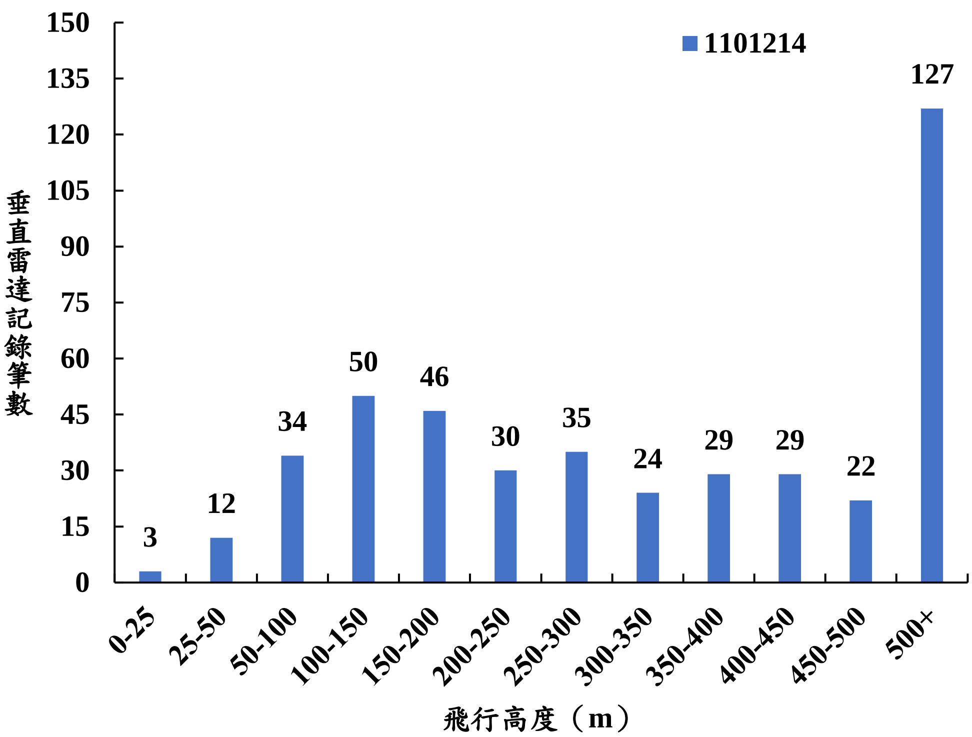


Figure 6.8.1-7 Vertical Radar Survey Results in the Winter of 2021

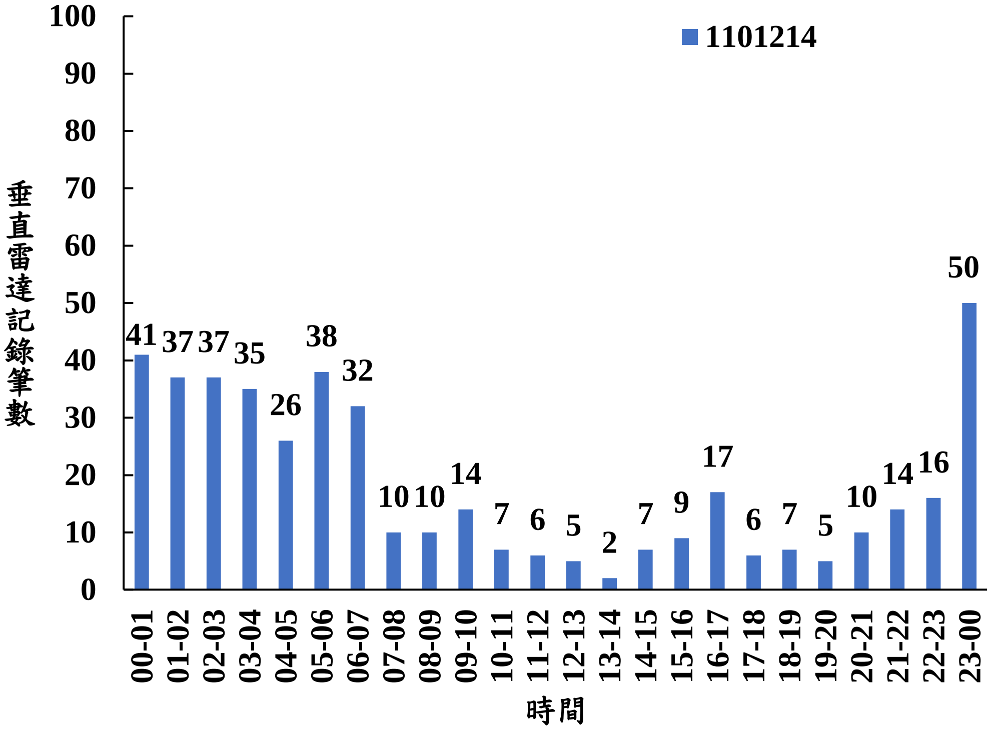


Figure 6.8.1-8 Vertical Radar Survey Results in the Winter of 2021

II. Pre-construction Monitoring

1. Survey Results in 2019 Spring

A total of five radar surveys were conducted in the spring of 2019. Analysis of the results of the five spring vertical radar surveys showed that the main flight direction in spring was toward north-northwest, accounting for 15.1% of all recorded tracks, followed by 13.3% toward northwest (Figure 6.8.1-9). Regarding the flight height data of birds, the most frequently used flight height during the spring bird crossing was the airspace between 100-150 meters, accounting for 16.3% of the total number of records. The data recorded at altitudes above 200 m accounted for 48.5% (Figure 6.8.1-10). In terms of time analysis, it can be found that there were more bird flight activities at night, and the total number of flight birds recorded between 18:00 and 06:00 at night accounted for 75.2% of all vertical radar records (Figure 6.8.1-11).

2. Survey Results in 2019 Summer

A total of five radar surveys were conducted in the summer of 2019. Analysis of the results of the five summer vertical radar surveys showed that the main flight direction in summer was toward south-southwest, accounting for 20.2% of all recorded tracks, followed by 12.9% toward southwest (Figure 6.8.1-12). Regarding the flight height data of birds, the most frequently used flight height during the spring bird crossing was the airspace between 100-150 meters, accounting for 21.7% of the total number of records. The data recorded at altitudes above 200 m accounted for 40.5% (Figure 6.8.1-13). In terms of time analysis, it can be found that there were more bird flight activities at night, and the total number of flight birds recorded between 18:00 and 06:00 at night accounted for 61.6% of all vertical radar records (Figure 6.8.1-14).

3. Survey Results in 2019 Fall

A total of five radar surveys were conducted in the fall of 2019. Analysis of the results of the five fall vertical radar surveys showed that the main flight direction in fall was toward south-southeast, accounting for 31.3% of all recorded tracks, followed by 21.7% toward south (Figure 6.8.1-15). Regarding the flight height data of birds, the most frequently used flight height during the spring bird crossing was the airspace between 100-150 meters, accounting for 17.0% of the total number of records. The data recorded at altitudes above 200 m accounted for 40.7% (Figure 6.8.1-16). In terms of time analysis, it can be found that there were more bird flight activities at night, and the total number of flight birds recorded between 18:00 and 06:00 at night accounted for 75.1% of all vertical radar records (Figure 6.8.1-17).

4. Survey Results in 2019 Winter

One radar survey were conducted in the winter of 2019. Analysis of the results of the winter vertical radar survey showed that the main flight direction in winter was toward south and south-southeast, accounting for 14.6% of all recorded tracks, followed by 12.4% toward southwest (Figure 6.8.1-18). Regarding the flight height data of birds, the most frequently used flight height during the spring bird crossing was the airspace between 0-50 meters, accounting for 20.3% of the total number of records. The data recorded at altitudes above 200 m accounted for 44.1% (Figure 6.8.1-19). In terms of time analysis, it can be found that there were more bird flight activities at night, and the total number of flight birds recorded between 18:00 and 06:00 at night accounted for 59.9% of all vertical radar records (Figure 6.8.1-20).

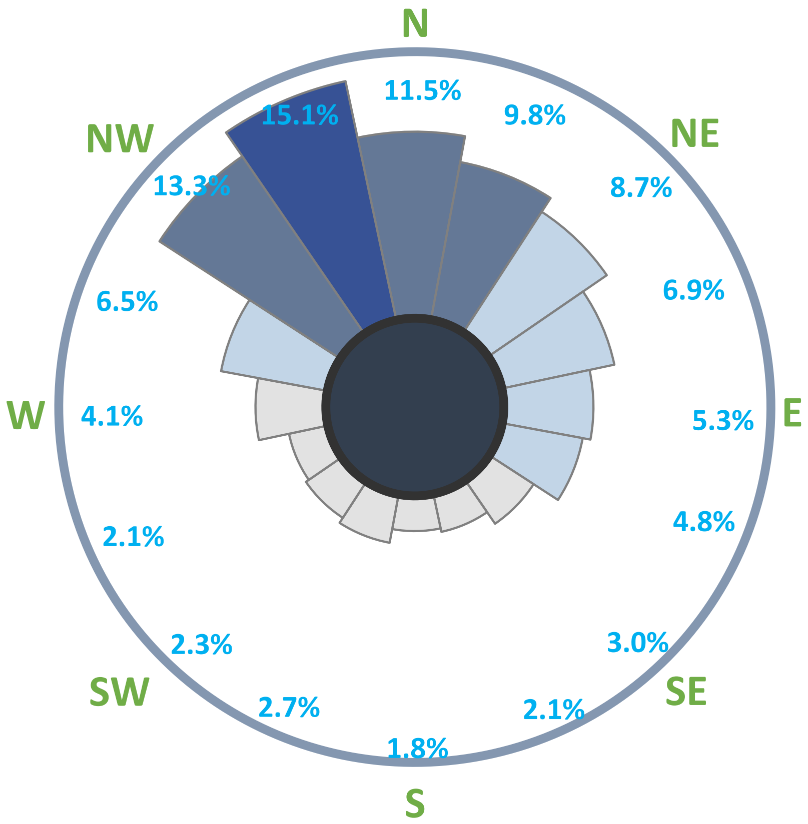


Figure 6.8.1-9 Bird Flying Direction in the Five Horizontal Radar in Spring 2019

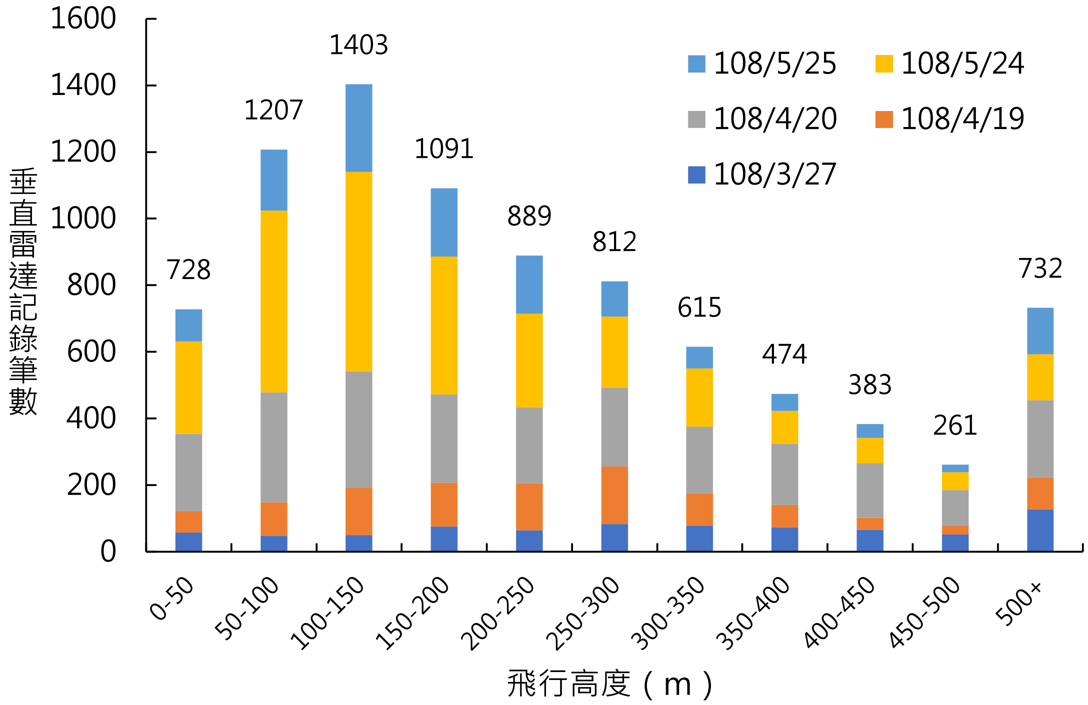


Figure 6.8.1-10 Flying Altitude in the Five Vertical Radar in Spring 2019

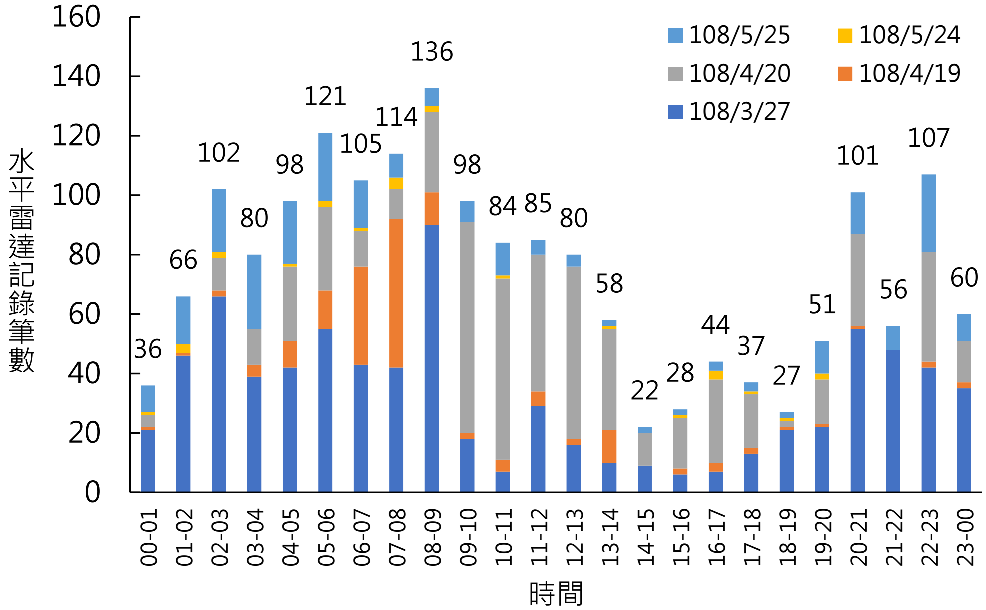


Figure 6.8.1-11 Time Distribution in the Five Vertical Radar in Spring 2019

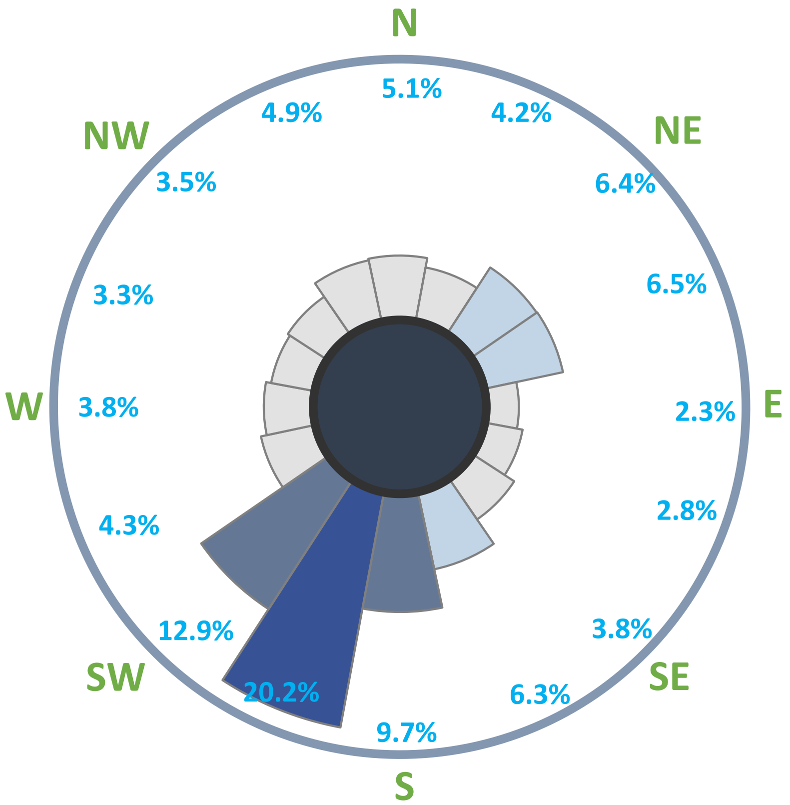


Figure 6.8.1-12 Bird Flying Direction in the Five Horizontal Radar in Summer 2019

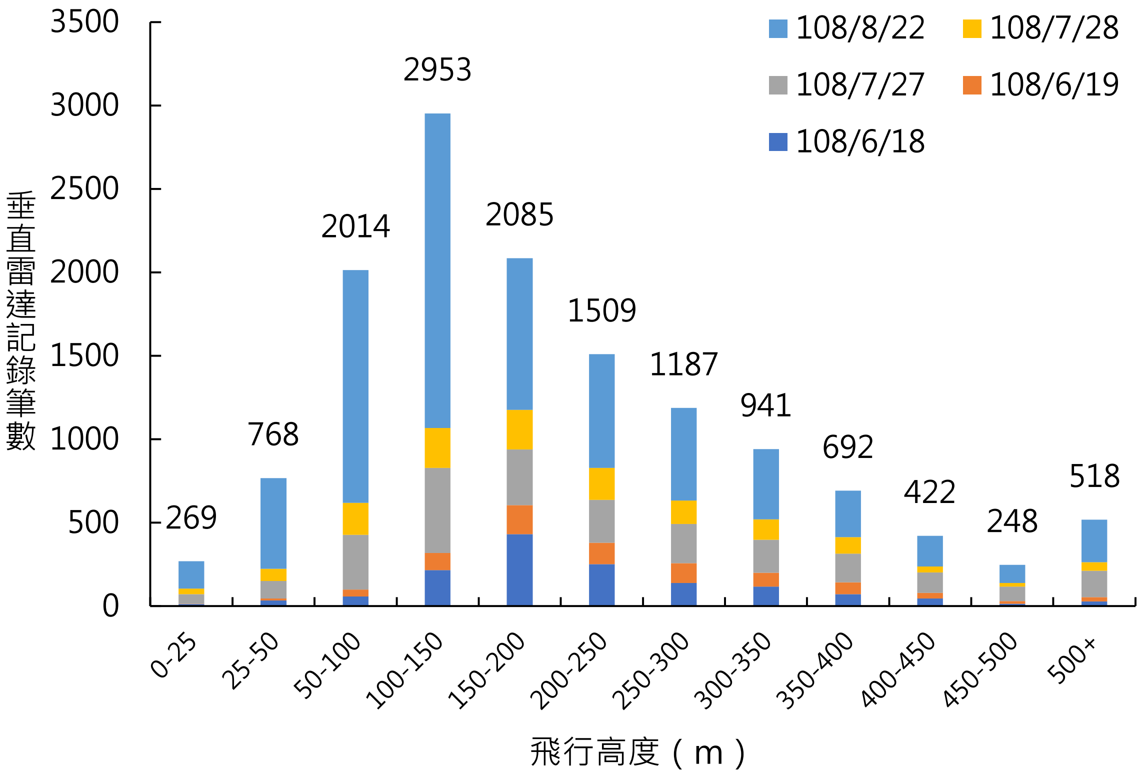


Figure 6.8.1-13 Flying Altitude in the Five Vertical Radar in Summer 2019

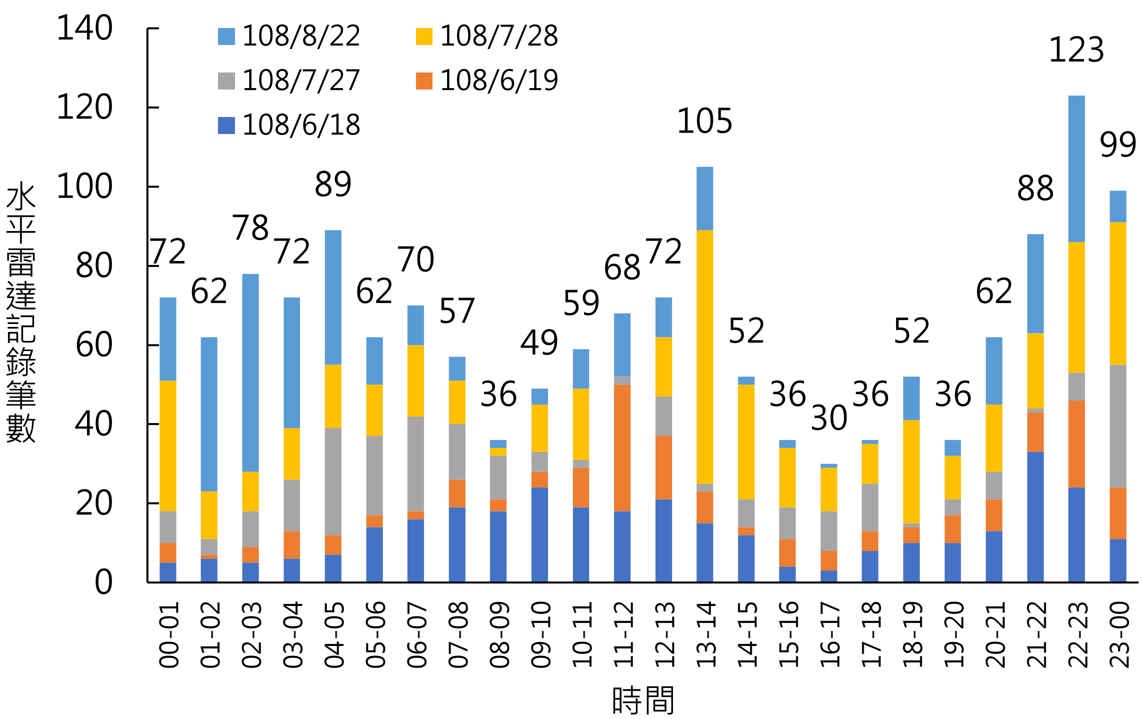


Figure 6.8.1-14 Time Distribution in the Five Vertical Radar in Summer 2019

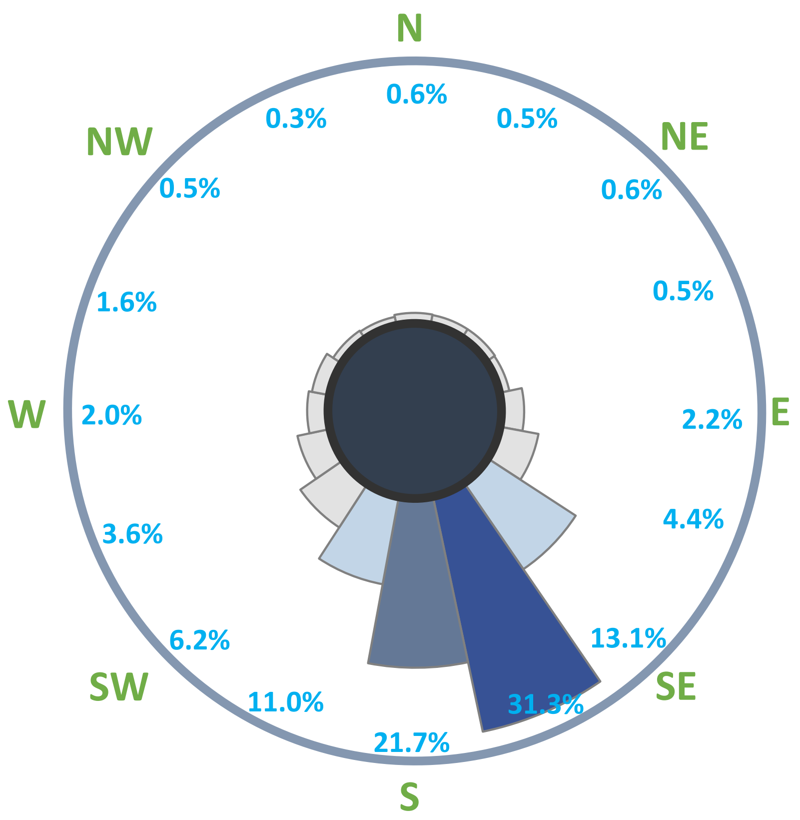


Figure 6.8.1-15 Bird Flying Direction in the Five Horizontal Radar in Fall 2019

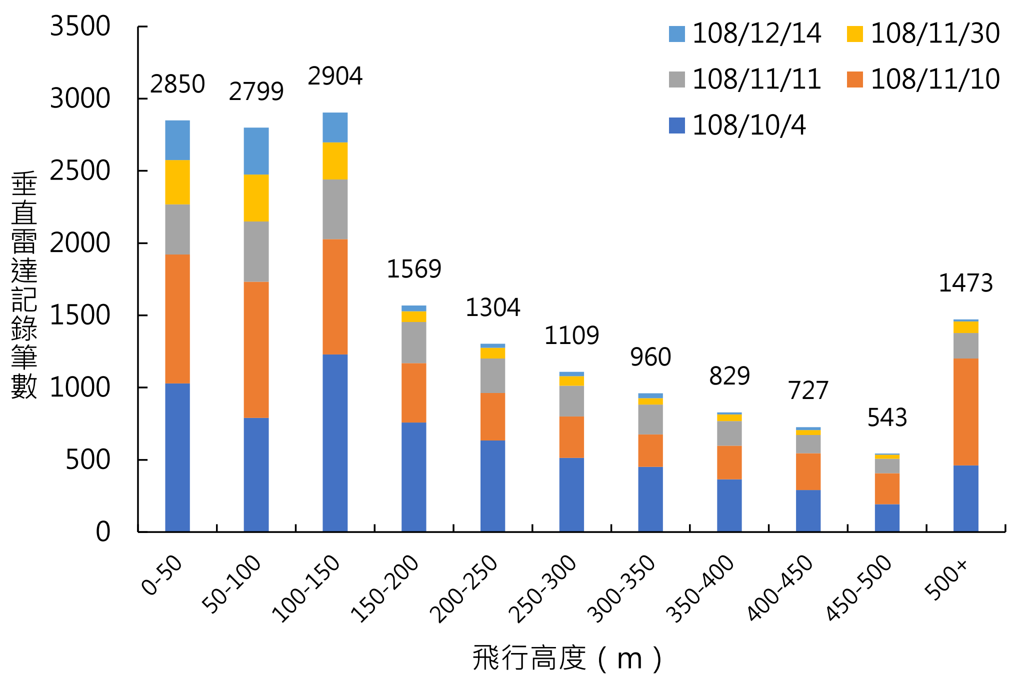


Figure 6.8.1-16 Flying Altitude in the Five Vertical Radar in Fall 2019

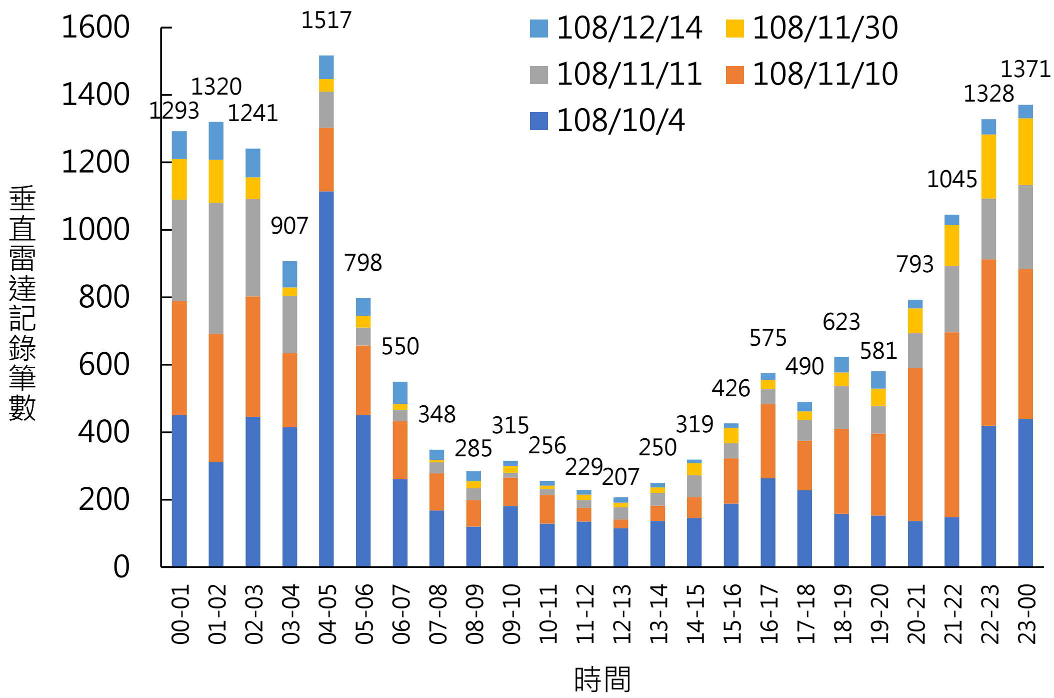


Figure 6.8.1-17 Time Distribution in the Five Vertical Radar in Fall 2019

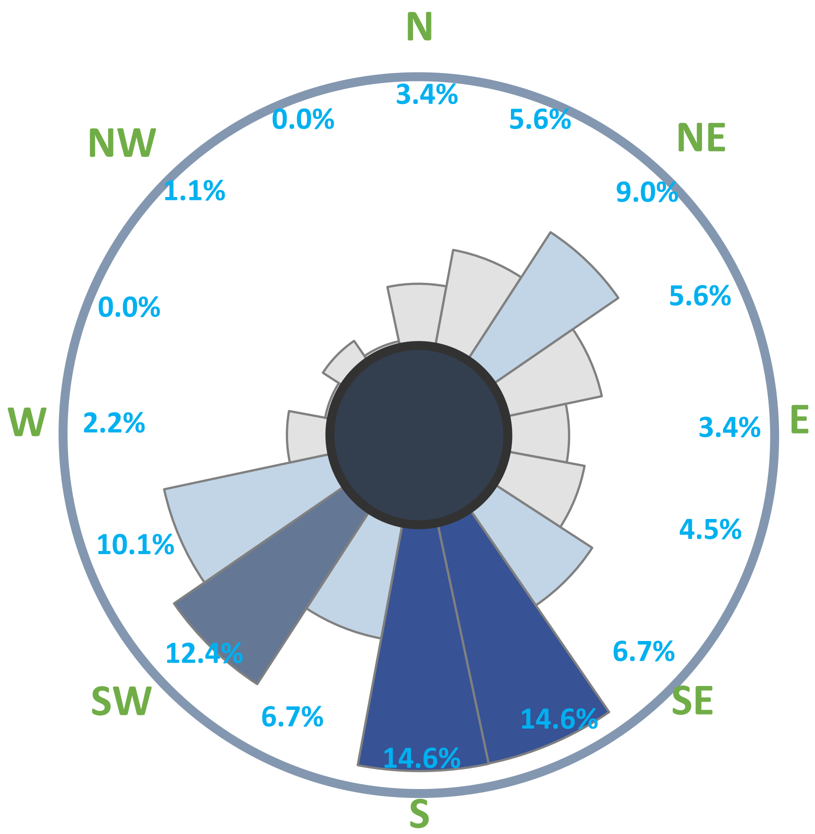


Figure 6.8.1-18 Bird Flying Direction in the Five Horizontal Radar in Winter 2019

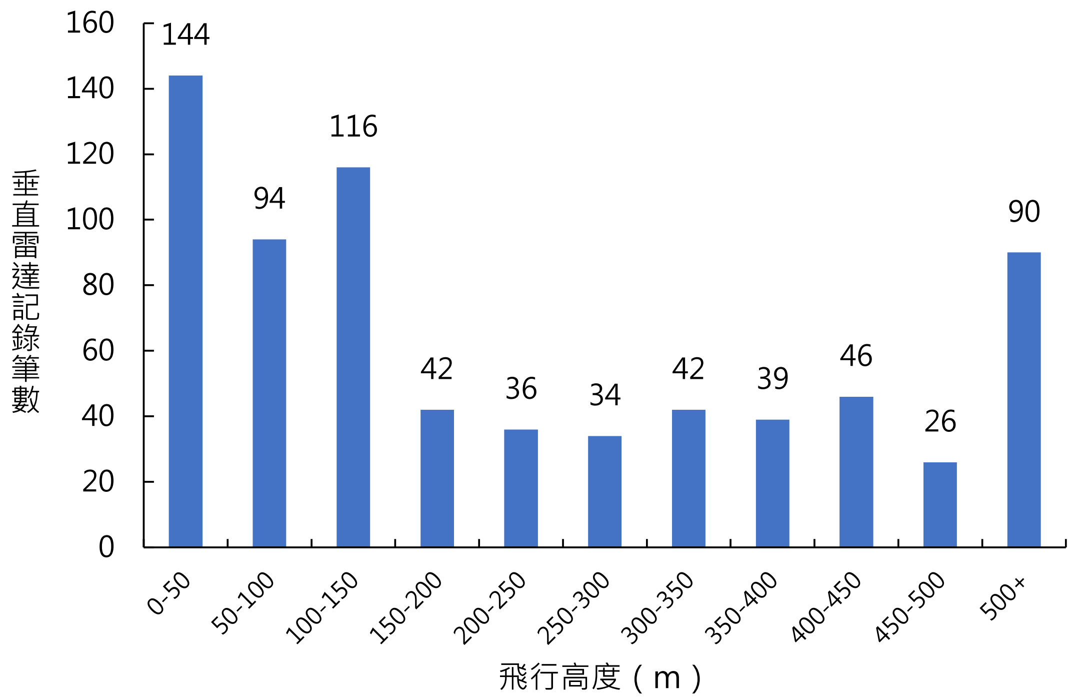


Figure 6.8.1-19 Flying Altitude in the Five Vertical Radar in Winter 2019

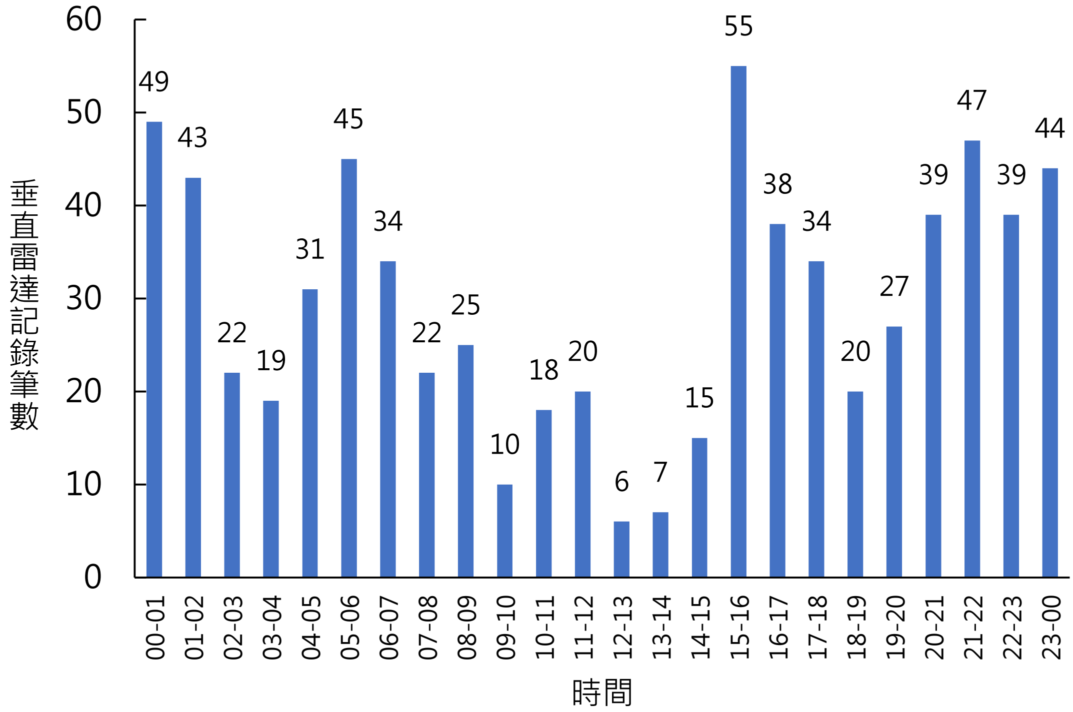


Figure 6.8.1-20 Time Distribution in the Five Vertical Radar in Winter 2019

1. Survey Results in 2020 Spring

A total of five radar surveys were conducted in the spring of 2020. Analysis of the results of the five spring vertical radar surveys showed that the main flight direction in spring was toward northeast, accounting for 20.9% of all recorded tracks, followed by 15.0% toward north-northeast and 14.9% toward north (Figure 6.8.1-21). Regarding the flight height data of birds, the most frequently used flight height during the spring bird crossing was the airspace between 0-50 meters, accounting for 24.9% of the total number of records. (Figure 6.8.1-22). In terms of time analysis, it can be found that there were more bird flight activities at night, and the total number of flight birds recorded between 18:00 and 06:00 at night accounted for 72.8% of all vertical radar records (Figure 6.8.1-23).

2. Survey Results in 2020 Summer

A total of five radar surveys were conducted in the summer of 2020. Analysis of the results of the five summer vertical radar surveys showed that the main flight direction in summer was toward south and south-southwest, accounting for 11.7% of all recorded tracks, followed by 9.7% toward north-northeast (Figure 6.8.1-24). Regarding the flight height data of birds, the most frequently used flight height during the summer bird crossing was the airspace between 100-150 meters, accounting for 15.6% of the total number of records. The data recorded at altitudes above 200 m accounted for 40.5% (Figure 6.8.1-25). In terms of time analysis, it can be found that there were more bird flight activities at night, and the total number of flight birds recorded between 18:00 and 06:00 at night accounted for 57.3% of all vertical radar records (Figure 6.8.1-26).

3. Survey Results in 2020 Fall

A total of five radar surveys were conducted in the fall of 2020. Analysis of the results of the five fall vertical radar surveys showed that the main flight direction in fall was toward south, accounting for 29.3% of all recorded tracks, followed by 19.8% toward south-southeast (Figure 6.8.1-27). Regarding the flight height data of birds, the most frequently used flight height during the fall bird crossing was the airspace between 100-150 meters, accounting for 16.1% of the total number of records. (Figure6.8.1-28). In terms of time analysis, it can be found that there were more bird flight activities at night, and the total number of flight birds recorded between 18:00 and 06:00 at night accounted for 73.6% of all vertical radar records (Figure 6.8.1-29).

4. Survey Results in 2020 Winter

As the offshore weather was bad during the season, offshore survey cannot be carried out.

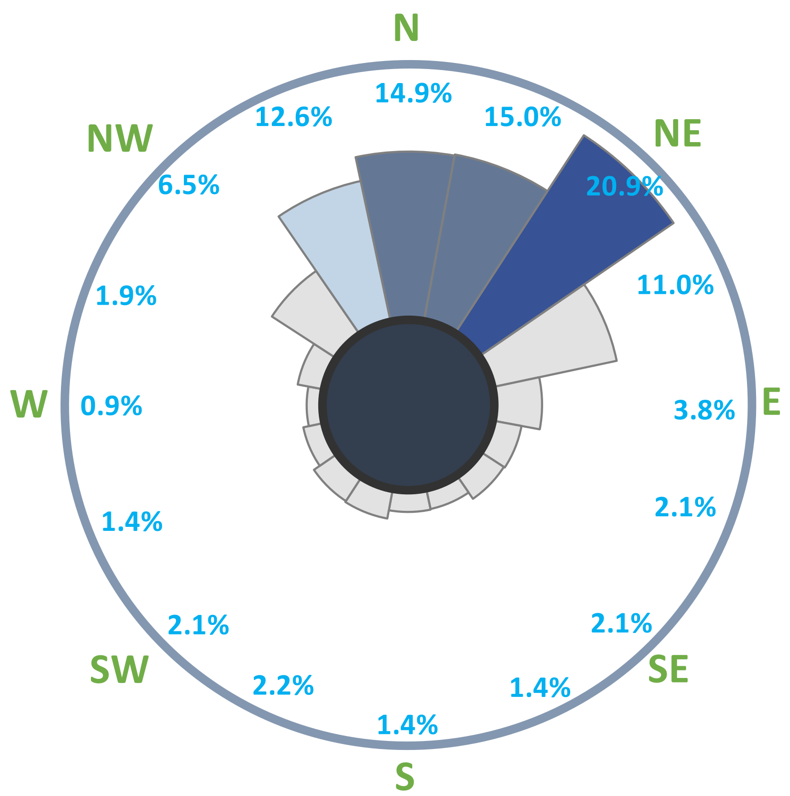


Figure 6.8.1-21 Bird Flying Direction in the Five Horizontal Radar in Spring 2020

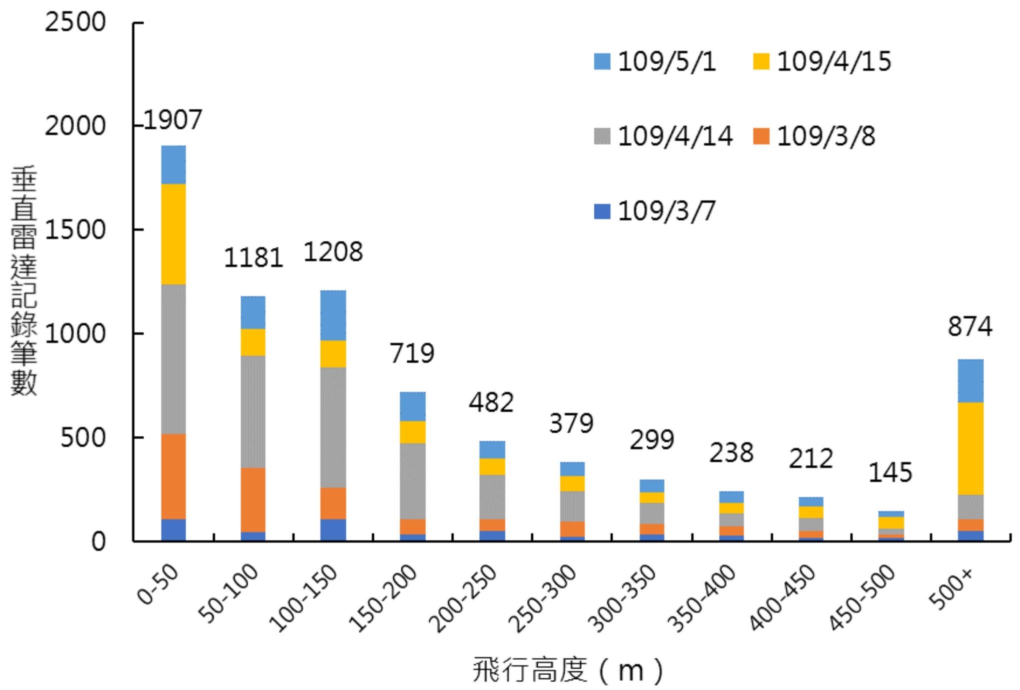


Figure 6.8.1-22 Flying Altitude in the Five Vertical Radar in Spring 2020

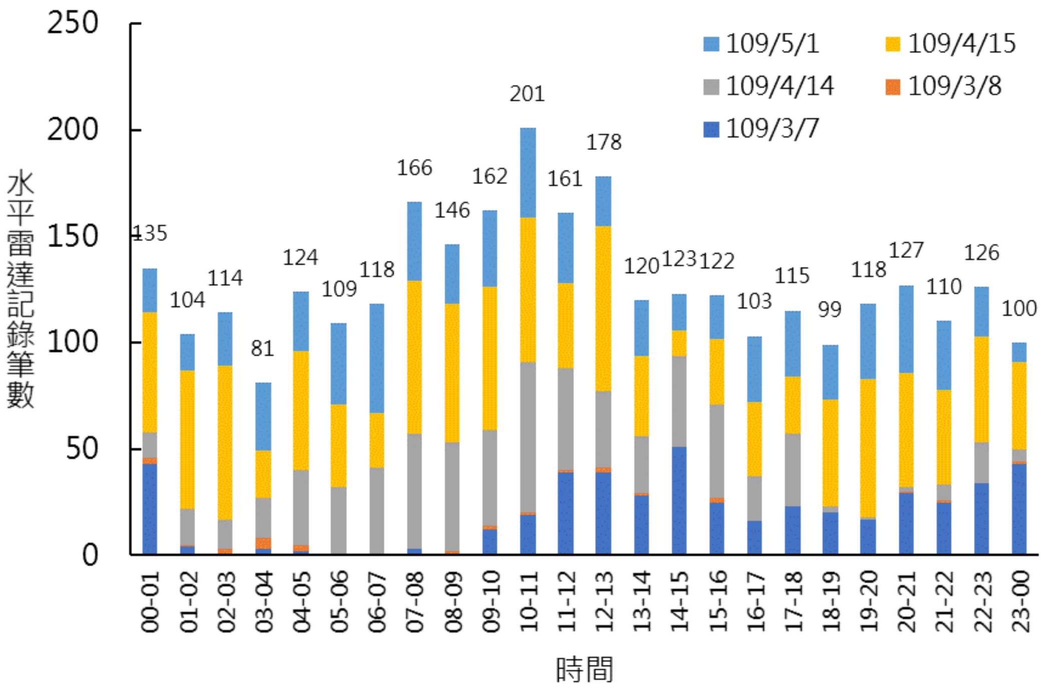


Figure 6.8.1-23 Time Distribution in the Five Vertical Radar in Spring 2020

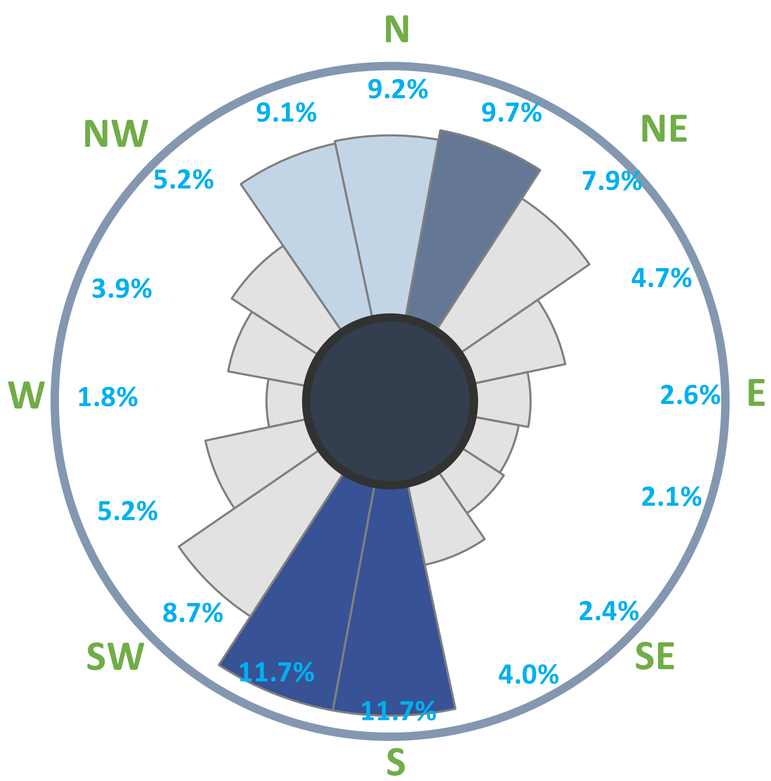


Figure 6.8.1-24 Bird Flying Direction in the Five Horizontal Radar in Summer 2020

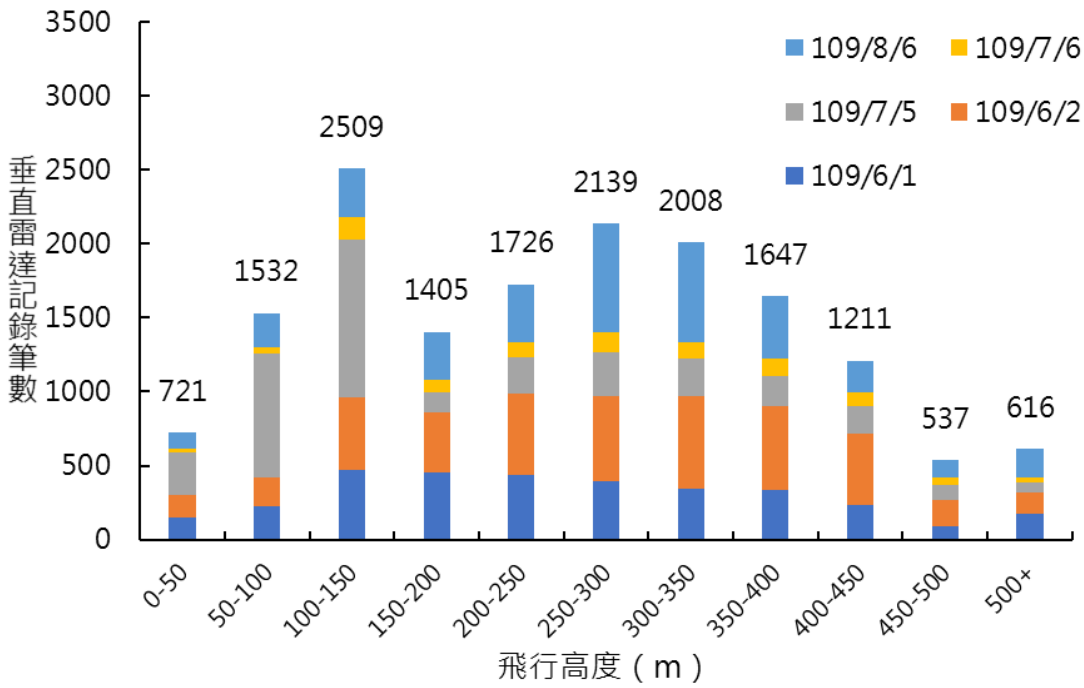


Figure 6.8.1-25 Flying Altitude in the Five Vertical Radar in Summer 2020

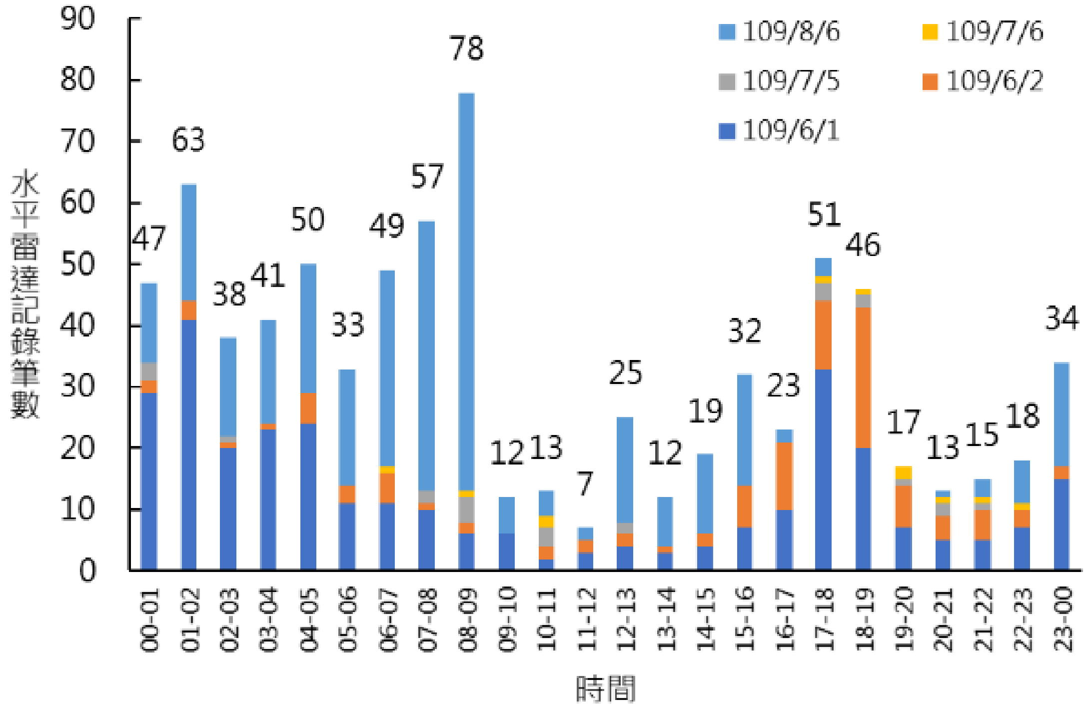


Figure 6.8.1-26 Time Distribution in the Five Vertical Radar in Summer 2020

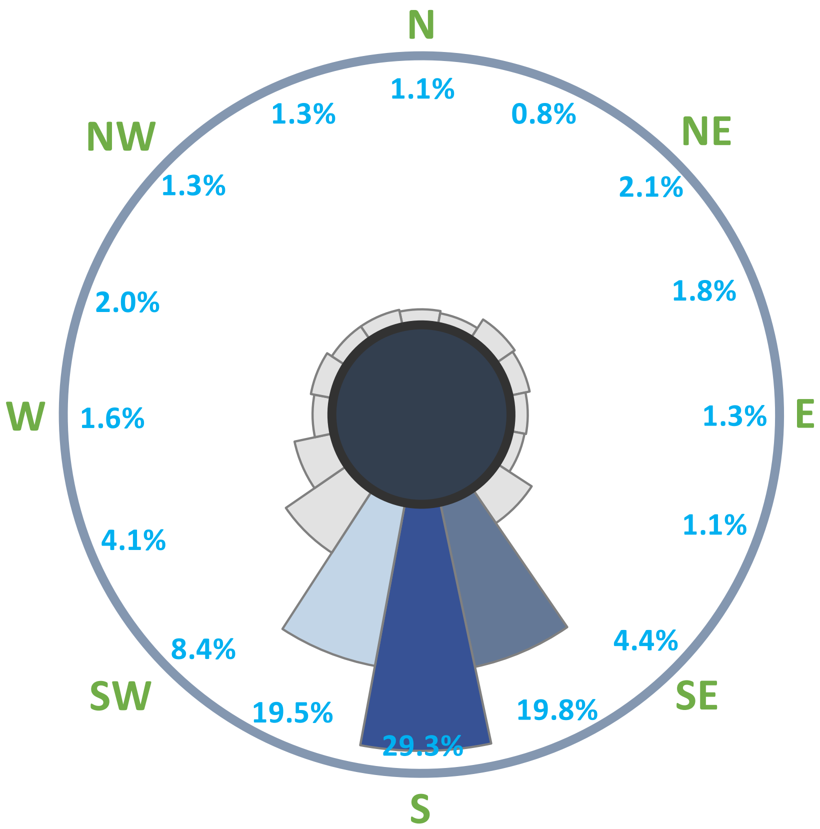


Figure 6.8.1-27 Bird Flying Direction in the Five Horizontal Radar in Fall 2020

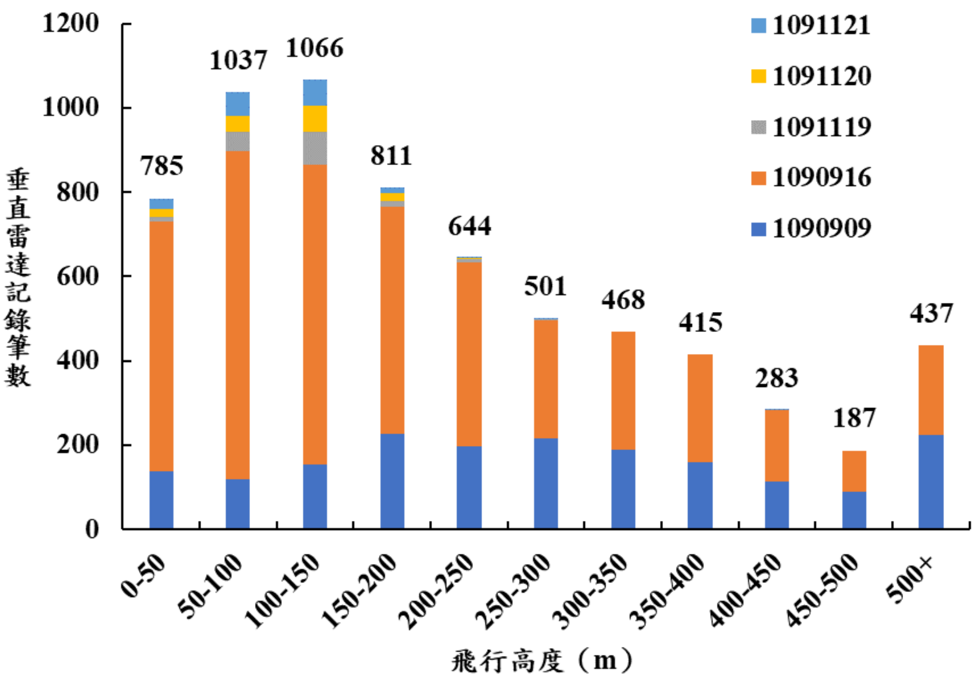


Figure 6.8.1-28 Flying Altitude in the Five Vertical Radar in Fall 2020

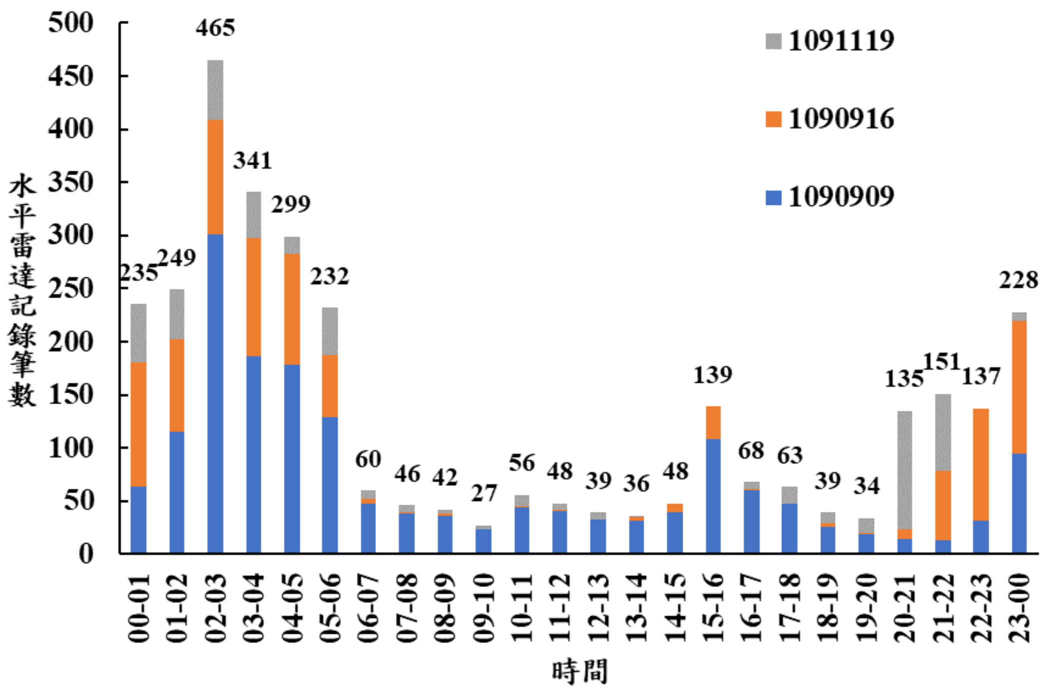


Figure 6.8.1-29 Time Distribution in the Five Vertical Radar in Fall 2020

III. Bird Visual Surveys

1. Survey Results

(1) Original EIS

8 offshore surveys were carried out from April 2016 to March 2017 (Table 6.8.1-1). A total of 133 records and 265 individuals were recorded, covering 6 orders and 9 families. Recorded species include Bulwer's Petrel, Streaked Shearwater, Brown booby, Cattle egret, Bridled tern, Tern, Greater crested tern, Red-necked phalarope, Rock dove, Barn swallow and Arctic warbler. Procellariiformes and Charadriiformes consist of the most individuals, with 87 individuals (32.8%) and 84 individuals (31.7%), followed by Passeriformes (19.6%) and Columbiformes (12.8%). Procellariiformes (sea birds) forage at the area regularly. They were recorded in all seasons except for winter. Scolopacidae & Charadriidae, Passeriformes and Columbiformes are migratory birds that only show up during the migratory seasons. Terns' activities reach the peak during spring and summer. 93 individuals were observed in July, followed by 77 individuals in March. Other species accounting for more than 5% of the total individuals observed include: Rock dove (12.8%), Red-necked phalarope (12.8%) and Bridled tern (10.6%). As for the conservation species, there were 2 rare species of birds, namely Bridled tern, Greater crested tern. A total of 28 Bridled tern were recorded in both spring and summer; 6 Greater crested tern were recorded, all in spring.

The flight heights of the 265 marine birds recorded were all below 30 m. The flight heights of the Procellariiformes, Pelecaniformes, Scolopacidae & Charadriidae species were below 10 m, and those of Passeriformes were also below 15 m. The flight heights of the terns were higher, mostly between 10-30m.

(2) Environmental Impact Survey Report (Bird Survey Report)

From January to May 2018, a total of 4 offshore bird visual crossing surveys were conducted, and a total of 26 birds were recorded. Since it is often difficult to identify species in marine bird surveys, in addition to recording 4 orders, 5 families and 6 species, 2 groups of unidentifiable species were also recorded. Species recorded included Barn swallow, unknown Passeriformes, Bridled tern, Unknown tern, Red-necked phalarope, Unknown Charadriiformes, Cattle egret, Brown booby, Streaked Shearwater and Bulwer's Petrel.

Among the spring survey, Barn swallow is recorded with the most individuals (3 records, 11 individuals, 42.3%), followed by Bulwer's Petrel (5 individuals, 19.2%). The frequency is the highest in the surveys. For flying altitude, all birds were recorded below 10m.

(3) Supplemental survey

Bird visual survey was conducted on December 15, 2021. 1 order, 1 family, 2 species and 2 individuals were recorded. Streaked Shearwater and Bulwer's Petrel were recorded for 1 individual respectively. Flying altitude is between 0-5m. No protected bird species was spotted.

(4) Pre-construction Monitoring

A. Survey Result in 2019

10 offshore bird visual surveys were carried out in 2019 (March-December), as shown in Table 6.8.1-2. 4 orders, 8 families, 13 species and 127 individuals were recorded, Great Egret were recorded with the most individuals (26 ind.), followed by Barn swallow (20 ind.). Spring has the most records (91 ind.), followed by summer, fall and winter. Due to bad sea weather, only 1 survey was conducted in winter, resulting in less recorded individuals. Migratory birds that spend the winter in Taiwan Spring is the peak season for bird migrations. As the climate warms, migratory birds that spend the winter in Taiwan or Southeast Asia are ready to migrate northward and return to their breeding grounds. Overall, the number of records correlates with seasonal changes and is consistent with the migration trend of birds.

B. Survey Result in 2020

10 offshore bird visual surveys were carried out in 2020 (March-December), as shown in Table 6.8.1-3. 6 orders, 8 families, 9 species and 44 individuals were recorded, Rock dove were recorded with the most individuals (24 ind.), followed by Barn swallow (6 ind.). Fall has the

most records (27 ind.), followed by summer, spring and winter. Due to bad sea weather, only 1 survey was conducted in winter, and no individual is recorded. A higher number of Rock dove were recorded in November, making fall (September to November) the season that has the most recorded individuals.

Table 6.8.1-1 Offshore Bird Survey Result in the EIS Stage

物種	學名	3月	4月	5月	7月	9月	10月	11月	12月	總計	百分比
鸌形目											
穴鳥	*Bulweria bulwerii*			4		1				5	2.0%
大水薙鳥	*Calonectris leucomelas*	46		6	1		3	1		57	22.6%
長尾水薙鳥	*Ardenna pacifica*		1							1	0.4%
未知鸌科	Procellariidae spp.			2						2	0.8%
未知海燕科	Hydrobatidae spp.			1	2	4				7	2.8%
未知鸌形目	Procellariiformes spp.				5	5				10	4.0%
合計		46	1	13	8	10	3	1		82	32.5%
鰹鳥目											
白腹鰹鳥	*Sula leucogaster*				1					1	0.4%
合計					1					1	0.4%
鵜形目											
黃頭鷺	*Bubulcus ibis*		1							1	0.4%
未知鷺科	Ardeidae spp.					35				35	13.9%
合計			1			35				36	14.3%
鴴形目											
白眉燕鷗	*Onychoprion anaethetus*		10	10	6					26	10.3%
粉紅燕鷗	*Sterna dougallii*			1						1	0.4%
燕鷗	*Sterna hirundo*		1							1	0.4%
鳳頭燕鷗	*Thalasseus bergii*		5							5	2.0%
黦鷸	*Numenius madagascariensis*		3							3	1.2%
紅領瓣足鷸	*Phalaropus lobatus*		32							32	12.7%
未知鷸鴴類	Unknown shorebirds		1							1	0.4%
合計			52	11	6					69	27.4%
鴿形目											
野鴿	*Columba livia*	1			1					2	0.8%
合計		1			1					2	0.8%
雀形目											
家燕	*Hirundo rustica*	44	12		3	1				60	23.8%
極北柳鶯	*Phylloscopus borealis*		2							2	0.8%
合計		44	14		3	1				62	24.6%
總計		91	68	24	19	46	3	1		252	100.0%

Table 6.8.1-2 Offshore Bird Survey Results (2019)

物種	學名	3月	4月	5月	6月	7月	8月	9月	10月	11月	12月	總計	百分比
雀形目													
紅胸鶲	*Ficedula parva*									1		1	1%
家燕	*Hirundo rustica*			1		3	15	1				20	16%
褐色柳鶯	*Phylloscopus fuscatus*			2								2	2%
鴴形目													0%
未知鷗科	-		4	12								16	13%
未知鷸科	-		4	3				1				8	6%
未知鷸鴴	-	2										2	2%
白眉燕鷗	*Onychoprion anaethetus*			10				2				12	9%
白翅黑燕鷗	*Chlidonias leucopterus*		5	5								10	8%
Kentish plover	*Charadrius alexandrinus*						2					2	2%
黑腹燕鷗	*Chlidonias hybrida*		7									7	6%
黑嘴鷗	*Saundersilarus saundersi*								1			1	1%
鵜形目													0%
大白鷺	*Ardea alba*			26								26	20%
小白鷺	*Egretta garzetta*						1				1	2	2%
黃頭鷺	*Bubulcus ibis*	6		3								9	7%
鸌形目													0%
大水薙鳥	*Calonectris leucomelas*			1	1		1					3	2%
穴鳥	*Bulweria bulwerii*				2		4					6	5%
總計		**8**	**20**	**63**	**3**	**3**	**23**	**4**	**1**	**1**	**1**	**127**	**100%**

Table 6.8.1-3 Offshore Bird Survey Results (2020)

物種	學名	3月	4月	5月	6月	7月	8月	9月	10月	11月	總計	百分比
雀形目												
家燕	*Hirundo rustica*	1				1	2		2		5	14%
鴴形目												
紅領瓣足鷸	*Phalaropus lobatus*		1									2%
未知鷸鴴	-	2									2	5%
玄燕鷗	*Anous stolidus*						1				1	2%
長尾賊鷗	*Stercorarius longicaudus*					2					2	5%
鵜形目												
黃頭鷺	*Bubulcus ibis*			1								2%
鴿形目												
野鴿	*Columba livia*									24	24	55%
鰹鳥目												
紅腳鰹鳥	*Sula sula*	1						1			1	5%
鸌形目												
大水薙鳥	*Calonectris leucomelas*					1					1	2%
穴鳥	*Bulweria bulwerii*				2	1	1				4	9%
總計		**4**	**1**	**1**	**2**	**5**	**4**	**1**	**2**	**24**	**44**	**100%**

6.8.2 Differential Analysis on Bird Collision

In this amendment, the capacity for single turbine is 8-16MW. Comparing to the 8-11MW turbines, the total number of turbines has been reduced. However, the swept zone of a single turbine will be increased due to the larger blade/sweeping diameter. In addition, in the original EIS, the wind farm layout was mainly in a east-west direction; a change in the capacity would require a new wind farm layout, which may affect the change in the space of bird corridor. 8MW, 11MW and 16MW turbines will be applied for the simulation in this amendment.

I. Assessment of Bird Collision

Carrying out assessment of bird collision requires (1) the bird species and density in each quarter/month in the wind farm area obtained via onsite survey. (2) Parameters for the simulation module, including bird's body shape, wind farm layout and turbine design, (3) combination of the abovementioned data to estimate collision risk through module. Band Model (Band 2012, Masden 2015), the most widely used model in Europe, is applied for the simulation. The parameters for each wind farm layout is shown as Table 6.8.2-1.

This project is near to CHW02, and the background of the two projects are similar. Also, the bird collision simulation results using the bird survey data from the EIA stage are similar. CHW02 has carried out pre-construction bird monitoring from 2019 to 2020, which is a long-term, continuous monitoring. In this amendment, CHW02 completed the bird collision simulation based on the monitoring result. Therefore, this Project will adapt the simulation result of CHW02 to explain the difference of the results obtained from the EIA stage and the current stage. The wind farm layouts used in the simulation are shown as Table 6.8.2-1 ~ 6.8.2-2.

There is no avoidance rate regarding the bird species engaged in this simulation. Therefore, following BTO's suggestion (Cook et al. 2012), the default avoidance rate is set as 98%. 8 surveys are arranged in a year; surveys are carried out monthly in the spring and fall (6 months) and once per 3 months in the summer and winter. Therefore, as the collision times are simulated, the value obtained in the summer and winter will be multiplied by 3 to get the monthly result. After adding with the monthly collision times in the spring and fall, the annual collision can be obtained.

Table 6.8.2-1 Parameters for Simulation (3 Turbine Layouts)

Turbine Layout	Single Turbine Capacity (MW)	Swept Zone (m)	Max Blade Width (m)	Height of the Lowest Tip(m)
Layout I	8	82	6	25
Layout II	11	105	5	25
Layout III	16	82 / 125	8	25

Table 6.8.2-2 Turbine Layout for Simulation in CHW02

Turbine Layout	Single Turbine Capacity (MW)	Swept Zone (m)	Max Blade Width (m)	Height of the Lowest Tip(m)
Layout I	8	82	6	25
Layout II	11	105	5	25
Layout III	8 / 16	82 / 125	6 / 8	25

II. Result of the Bird Collision Simulation

i Simulation Result of the Survey Data in the EIS Stage

8 offshore bird surveys have been carried out in 4 seasons from April 2016 to March 2017. Survey data are shown as Table 6.8.1-1, the simulation result is shown as Table 6.8.2-3

ii Simulation Results of the Survey Data in the Pre-construction Monitoring

The simulation was done using the data from the offshore bird surveys from 2019 to 2020. Considering the large number of birds found in the survey in 2019 and the pattern in long-term survey results, collision simulation were made under two scenarios, which use the survey data in 2019 and all survey data from 2019 to 2020. The relevant data are shown in Table 6.8.1-2 to 6.8.1-3, and the simulation results are shown in Table 6.8.2-4 to 6.8.2-5

Table 6.8-3 Collision Times for each Species under Different Turbine Layout (Collision Rate 98%)

Chinese Name	English Name	Scientific Name	Layout I (8 MW)	Layout II (11 MW)	Layout III (16 MW)
穴鳥	Bulwer's Petrel	*Bulweria bulwerii*	<0.1	<0.1	<0.1
大水薙鳥	Streaked Shearwater	*Calonectris leucomelas*	<0.1	<0.1	<0.1
長尾水薙鳥	Wedge-tailed Shearwater	*Puffinus pacificus*	<0.1	<0.1	<0.1
未知鸌科	Unknown Procellariidae	*Procellariidae spp.*	<0.1	<0.1	<0.1
未知鸌形目	Unknown Procellariiformes	*Procellariiformes spp.*	<0.1	<0.1	<0.1
白腹鰹鳥	Brown Booby	*Sula leucogaster*	<0.1	<0.1	<0.1
黃頭鷺	Cattle Egret	*Bubulcus ibis*	1.0	0.7	0.9
未知鷺科	Unknown Ardeidae	*Ardeidae spp.*	32.8	24.3	27.9
黦鷸	Far Eastern Curlew	*Numenius madagascariensis*	5.4	3.8	4.4
紅領瓣足鷸	Red-necked Phalarope	*Phalaropus lobatus*	<0.1	<0.1	<0.1
未知鷸鴴類	Unknown shorebirds	*Charadriiformes spp. (shorebirds)*	1.3	0.9	1.1
白眉燕鷗	Bridled Tern	*Onychoprion anaethetus*	8.8	5.8	7.0

Table 6.8-3 Collision Times for each Species under Different Turbine Layout (Collision Rate 98%) (Cont.)

Chinese Name	English Name	Scientific Name	Layout I (8 MW)	Layout II (11 MW)	Layout III (16 MW)
粉紅燕鷗	Roseate Tern	*Sterna dougallii*	0.2	0.2	0.2
燕鷗	Common Tern	*Sterna hirundo*	0.8	0.6	0.7
鳳頭燕鷗	Great Crested Tern	*Thalasseus bergii*	4.8	3.3	3.9
野鴿	Rock Pigeon	*Columba livia*	0.7	0.1	0.2
家燕	Barn Swallow	*Hirundo rustica*	1.7	1.1	1.4
極北柳鶯	Arctic Warbler	*Phylloscopus borealis*	0.2	0.2	0.2
Total	–	–	57.8	41.0	47.7

Table 6.8.2-4 Number of Bird Collision under Different Turbine Layout (Avoidance rate 98%)(Adopting the survey data in 2019)

Family	Chinese Name	Scientific Name	Layout 3-1 (8 MW)	Layout 3-2 (16 MW)	Layout 3 (8+16 MW)
鸌 科	穴鳥	*Bulweria bulwerii*	<0.1	<0.1	<0.1
鸌 科	大水薙鳥	*Calonectris leucomelas*	<0.1	<0.1	<0.1
鷺 科	大白鷺	*Ardea alba*	34.9	31	65.9
鷺 科	小白鷺	*Egretta garzetta*	4	3.6	7.6
鷺 科	黃頭鷺	*Bubulcus ibis*	8.8	7.8	16.7
鴴 科	東方環頸鴴	*Charadrius alexandrinus*	0.5	0.4	0.9
鷸 科	未知鷸科	Scolopacidae spp.	2.5	2.1	4.6
–	未知鷸鴴類	Charadriiformes spp. (shorebirds)	0.6	0.5	1.1
鷗 科	黑嘴鷗	*Saundersilarus saundersi*	0.5	0.4	0.9
鷗 科	白眉燕鷗	*Onychoprion anaethetus*	1	0.8	1.9
鷗 科	白翅黑燕鷗	*Chlidonias leucopterus*	3.5	2.8	6.3
鷗 科	黑腹燕鷗	*Chlidonias hybrida*	2.5	2.1	4.6
鷗 科	未知海鷗類	Larida spp.	8.7	6.9	15.6
燕 科	家燕	*Hirundo rustica*	0.1	<0.1	0.1
鶯 科	褐色柳鶯	*Phylloscopus fuscatus*	<0.1	<0.1	<0.1
鶲 科	紅胸鶲	*Ficedula parva*	<0.1	<0.1	<0.1
Total	-	-	67.8	58.5	126.3

Note :1. Layout 3-1 refers to the layout in the 1st stage
2. Layout 3-2 refers to the layout in the 2nd stage
3. Layout 3 refers to the layout in the 1st and the 2nd stage

Table 6.8.2-5 Number of Bird Collision under Different Turbine Layout (Avoidance rate 98%)(Adopting the survey data in 2019-2020)

Family	Chinese Name	Scientific Name	Layout 3-1 (8 MW)	Layout 3-2 (16 MW)	Layout 3 (8+16 MW)
鸌　科	穴鳥	*Bulweria bulwerii*	<0.1	<0.1	<0.1
鸌　科	大水薙鳥	*Calonectris leucomelas*	<0.1	<0.1	<0.1
鰹鳥科	紅腳鰹鳥	*Sula sula*	<0.1	<0.1	<0.1
鷺　科	大白鷺	*Ardea alba*	17.5	15.5	33.0
鷺　科	小白鷺	*Egretta garzetta*	3.5	3.1	6.6
鷺　科	黃頭鷺	*Bubulcus ibis*	4.4	3.9	8.3
鴴　科	東方環頸鴴	*Charadrius alexandrinus*	0.3	0.2	0.5
鷸　科	未知鷸科	Scolopacidae spp.	1.3	1.0	2.3
–	未知鷸鴴類	Charadriiformes spp. (shorebirds)	0.3	0.3	0.6
賊鷗科	長尾賊鷗	*Stercorarius longicaudus*	0.9	0.7	1.5
鷗　科	黑嘴鷗	*Saundersilarus saundersi*	0.2	0.2	0.4
鷗　科	玄燕鷗	*Anous stolidus*	0.2	0.2	0.4
鷗　科	白眉燕鷗	*Onychoprion anaethetus*	0.6	0.5	1.0
鷗　科	白翅黑燕鷗	*Chlidonias leucopterus*	1.7	1.4	3.1
鷗　科	黑腹燕鷗	*Chlidonias hybrida*	1.3	1.0	2.3
鷗　科	未知海鷗類	Larida spp.	4.3	3.5	7.8
鳩鴿科	野鴿	*Columba livia*	0.2	0.2	0.4
燕　科	家燕	*Hirundo rustica*	<0.1	<0.1	0.1
鶯　科	褐色柳鶯	*Phylloscopus fuscatus*	<0.1	<0.1	<0.1
鶲　科	紅胸鶲	*Ficedula parva*	<0.1	<0.1	<0.1
合　計	–	–	36.7	31.7	68.4

Note :1. Layout 3-1 refers to the layout in the 1st stage
2. Layout 3-2 refers to the layout in the 2nd stage
3. Layout 3 refers to the layout in the 1st and the 2nd stage

III. Result of the Bird Collision Simulation

i Review on the Simulation Result

(a) Analysis of the Impact under Different Turbine Layout

Comparing the simulation result under different wind farm layout, it is discovered that the bird collision impact is smaller when bigger turbines are applied. Turbine with bigger capacity will have a larger swept zone, a single turbine also pose a bigger threat to birds. However, under the same total capacity, less turbines are required in a wind farm if bigger turbines are applied. Therefore, the overall impact on birds is generally smaller. This indicates that applying larger turbines and decreasing the number of turbines may be a more friendly design to birds.

(b) Bird Ecology

Migratory water birds (Scolopacidae, Charadriidae and Ardeidae) and sea birds (Tern) have the most collision in the area, as flying altitude of these birds overlaps more with the swept zone of turbine, resulting in a bigger collision rate. Although there are a considerable number of Streaked Shearwater and Barn Swallow in the project area, the collision rate is lower as they usually fly slightly above the sea surface.

(c) Seasonal influence

In terms of seasonal distribution, in spring, a considerable number of migratory birds pass through the wind farm area. In summer, the conservative species Bridled tern are found in the area. Therefore, the installation of the wind farm will derive a certain degree of collision impact. The most collisions takes place on April, mainly due to the migration of yellow- headed herons, terns and crested terns. The second highest collision rate occurs in July, and the main victims are sandpipers and white-browed terns.

(d) Discussion on the Simulation Result

In Europe, it is generally considered that terns rarely fly during nighttime, and the coefficient for nighttime flight is set as 0 (no flying activity in nighttime, equivalent to Level 1 in King et al. (2009)). In the EIA stage, we referred to the European literature and the local difference. To be conservative, the coefficient for tern's nighttime flight is set as 0.5 (nighttime flying activity is half of that in daytime, equivalent to Level 3). However, as per Profession Sun's latest satellite tracking result, it is discovered that Greater crested tern in Penghu has equivalent activity in daytime and nighttime. It is suggested to set the coefficient as 1 (Level 5). However, the phenomenon is not shown

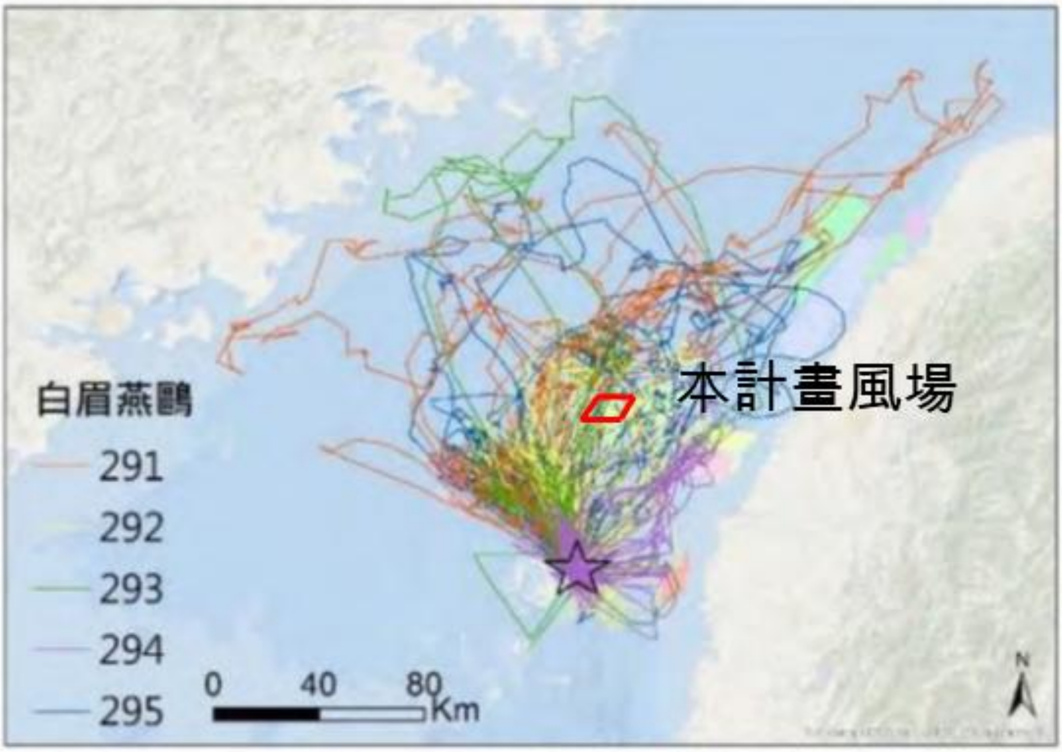
ii regarding Bridled tern.

However, the avoidance rate 0.98 suggested by BTO may be extremely conservative to terns. Since terns have excellent control over flying, they can perform very quick avoidance. According to the monitoring results in several wind farms in Europe (SmartWind 2015), the avoidance rate of Little tern (Sternula albifrons), normal tern (Sterna hirundo) and Sandwich Tern (Thalasseus sandvicensis) are above 0.99. If apply this avoidance rate for terns, the annual collision individuals will be reduced to half in comparison with this analysis.

In addition, referring to the “Research on Marine Ecology Monitoring of Demonstration Wind Farms” published by BOE, 3 bird species were banded and tracked, which were Greater crested tern, Bridled tern and Roseate tern. their feeding paths during the breeding period are shown in Figure 6.8.2-1 to Figure 6.8.2-3. Among them, only Bridled tern past the wind farm area, the result is similar to the results of previous surveys of this project.

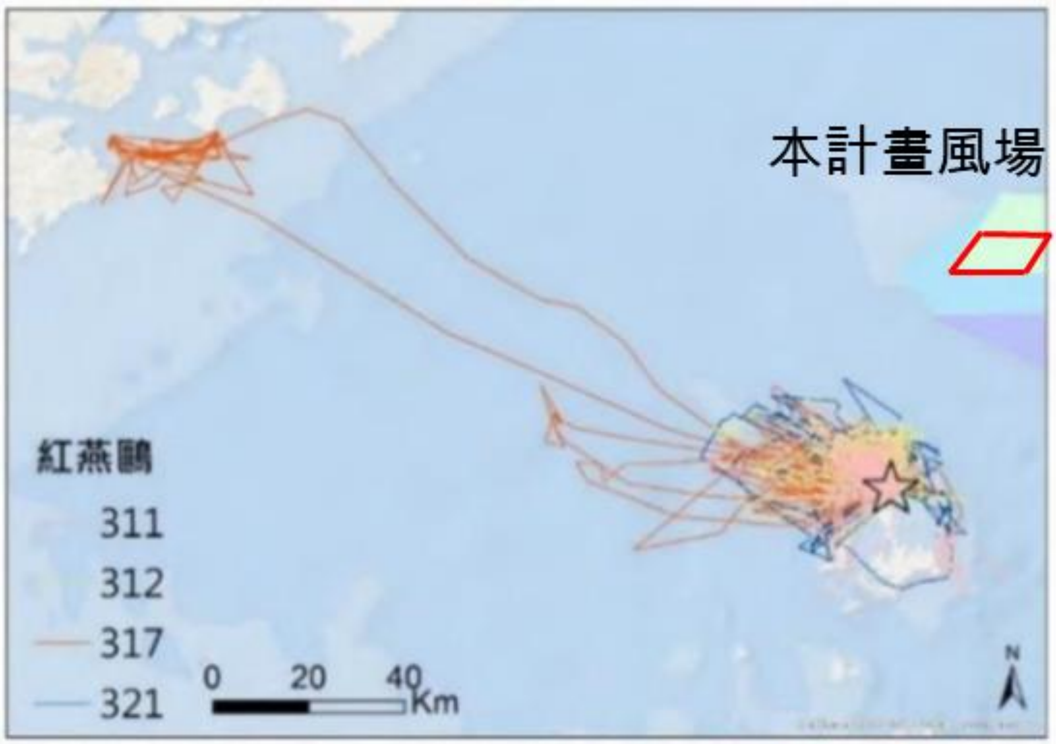
The maximum single capacity of the wind turbine was increased in this Amendment. Referring to the results of the bird strike assessment regarding this amendment, there was no significant change in the number of Bridled tern strikes after the amendment (Layout III), as shown in Table 6.8.2-2.

In addition, according to the foraging habits of terns, they usually fly within 20 meters above the sea level when foraging. As committed in the EIA stage, the minimum height of the wind turbine blades is 25 meters above sea level, so it should not affect the flight path of the terns.



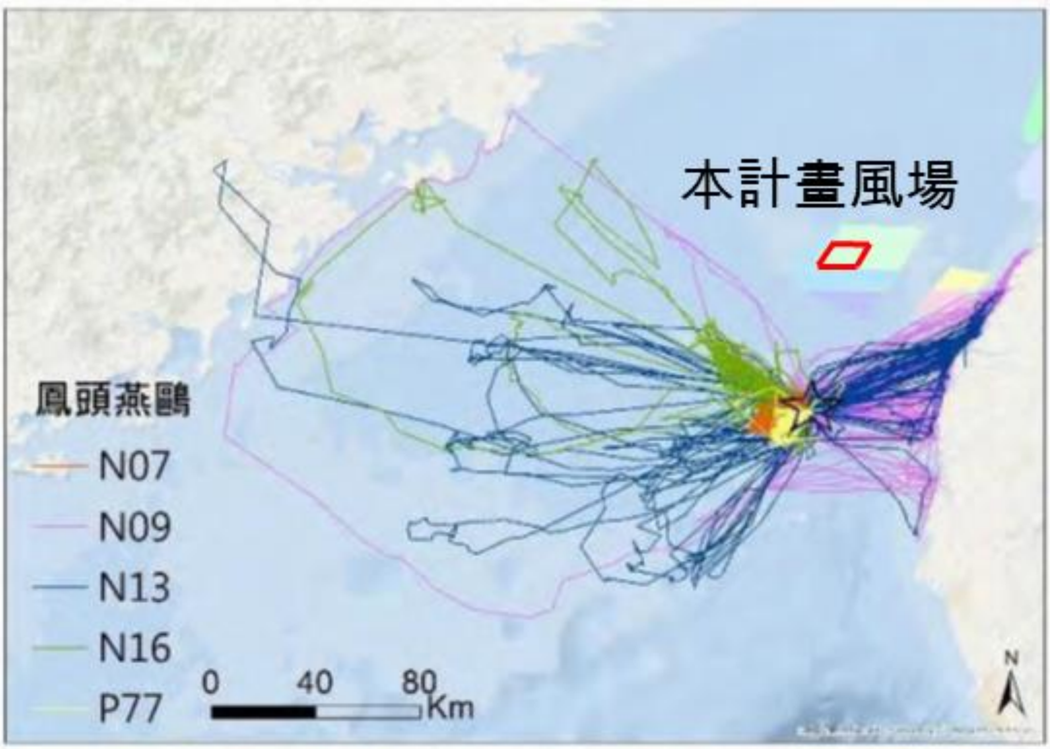
Source: Study of Marine Ecology-Research on the Operation Phase of Demonstrative Wind Farms (Summary) August 2021.

Figure 6.8.2-1 Flying Path of Bridled Tern



Source: Study of Marine Ecology-Research on the Operation Phase of Demonstrative Wind Farms (Summary) August 2021.

Figure 6.8.2-2 Flying Path of Roseate Tern



Source: Study of Marine Ecology-Research on the Operation Phase of Demonstrative Wind Farms (Summary) August 2021.

Figure 6.8.2-3 Flying Path of Greater Crested Tern

IV. Discussion on the Simulation Results of the Surveys in Pre-construction Phase and the EIS Stage

i. Composition of Bird Strikes

Comparing the monitoring data (2019-2020) with the simulated impact results of the EIA phase (2016-2017), both showed that the Ardeidae was the group with the highest potential strikes, followed by the terns (Figure 6.8-1). The estimated number of annual strikes of Procellariiformes, Charadriiformes, terns and Land birds in both periods was quite similar, but the number of simulated strikes of Ardeidae in the monitoring period was much higher than that in the EIS period, which was due to the sighting of a larger group of Great Egrets in May of 2019. Ardeidae are migratory birds. They will migrate all together on certain days in a season, and the migration will be composed of huge amounts of individuals. Therefore, the estimated bird density may be very different if the monthly bird survey overlaps with the migratory date, and the density obtained from the survey is prone to large variation because of the occasional timing of migration in flocks. The collision simulation can only estimate the flux for the whole month based on the results of this survey, so the bird strike is high. The representativeness of the result should be verified through long-term monitoring.

Since size of a population varies between species, the impact of the same number of strikes on different bird species is also different. Usually, the 1% threshold is used as the safety loss amount for birds, and this is used as a reference for whether the strike may cause impact on the bird populations. According to the "Handbook of Important Wild Bird Habitats in Taiwan, 2nd Edition" jointly compiled by the Wild Bird Society and the Forestry Bureau, Great Egrets are distributed throughout East Asia, and the estimate of 1% of the East Asian biogeographic group is 1,000 birds. The number of collisions is still far below the threshold of 1% of the Great Egret population, so it should not have any significant impact on the Great Egret.

ii. Seasons

In terms of seasonal changes, there is a peak in the number of collisions in April and October in the EIS stage, which corresponds to the migratory periods in spring and fall respectively, and the species with more collisions in the spring are Snipe and Terns, while in the autumn are Ardeidae. during the monitoring phase, the peak of collisions in spring occurred in May, and the collisions were mainly of Ardeidae. There was no significant peak of migratory birds in autumn.

iii. Protected Species

Three conservation species were recorded in the EIS stage, which are : Bridled tern, Roseate tern and Greater crested tern, while two species of Saunders's gull and Bridled tern were recorded in the monitoring stage. The density of these species was affected by the randomness of the season, as the Greater crested tern and the Bridled tern were migratory, while the Roseate tern was an occasional occurrence.

iv. Development of Bird Strike Countermeasures

Since the bird strike assessment is only a prediction, the actual impact on birds still needs to be assessed from long-term observation data after the wind farm is set up to obtain more accurate results. The first stage of the wind farm has entered the construction stage, and a high-performance bird monitoring radar has been planned to be installed in accordance with the EIA commitment. The chosen radar is 3D Max Robin Radars, which is a 3D array radar with the function of tracking multiple individuals in high resolution, 3-Dimentional image, and can effectively increase the collecting of the data of bird's flying altitude. This radar can filter the signal noise in the offshore environment (as shown in Figure 6.8.2-4), which can track the movement of birds more precisely to analyze the flight direction and height of birds. Therefore, in the future, we will collect information for a long time, including data at night and at high places, to actually understand the avoidance status of birds after the wind farm is set up. The preliminary plan of this project is to place the bird radar monitoring facilities on the offshore substation, and the related planning and design will be submitted to the Supervisory Committee for review and approval in accordance with the EIA commitment. The preliminary location of the OSS is shown as Figure 6.8.2-5.

Offshore bird radar surveys are currently conducted using a vessel-boarded radar. The vessel-mounted radar uses a horizontal radar with a vertical radar to conduct the survey. Since the horizontal radar cannot provide the flight height of birds, the birds' flying altitude can only be determined in areas where the horizontal radar and vertical radar overlap. This survey has more limitations, and can only provide limited information regarding nocturnal bird activities and birds activities at height. The radar survey can only show that a significant number of birds are active in a specific time/space.

It is expected that long-term data regarding bird flux and bird avoidance behaviors after the radars are activated in the future. These data will be useful in the environmental impact survey report to be proposed in the future.

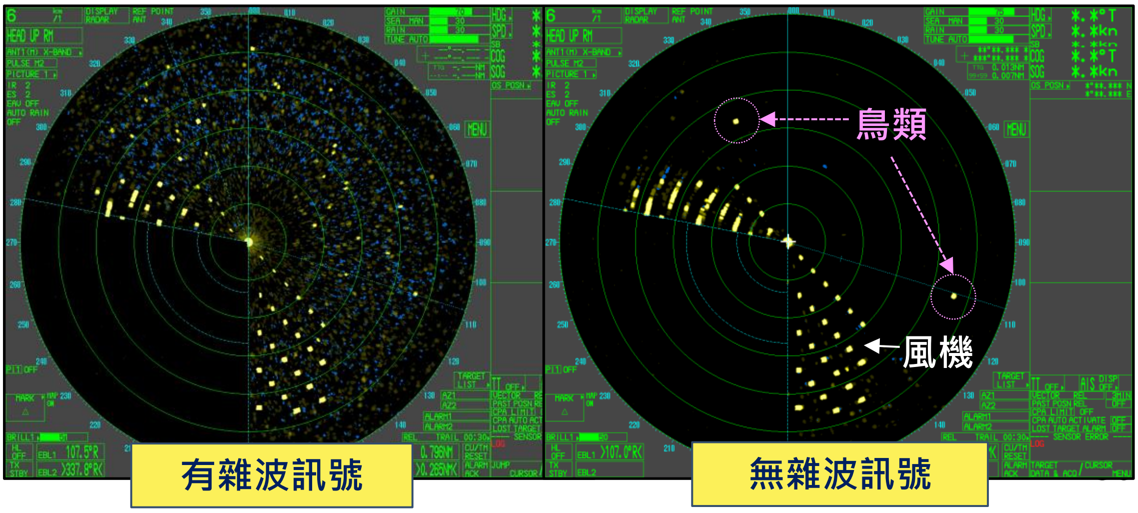
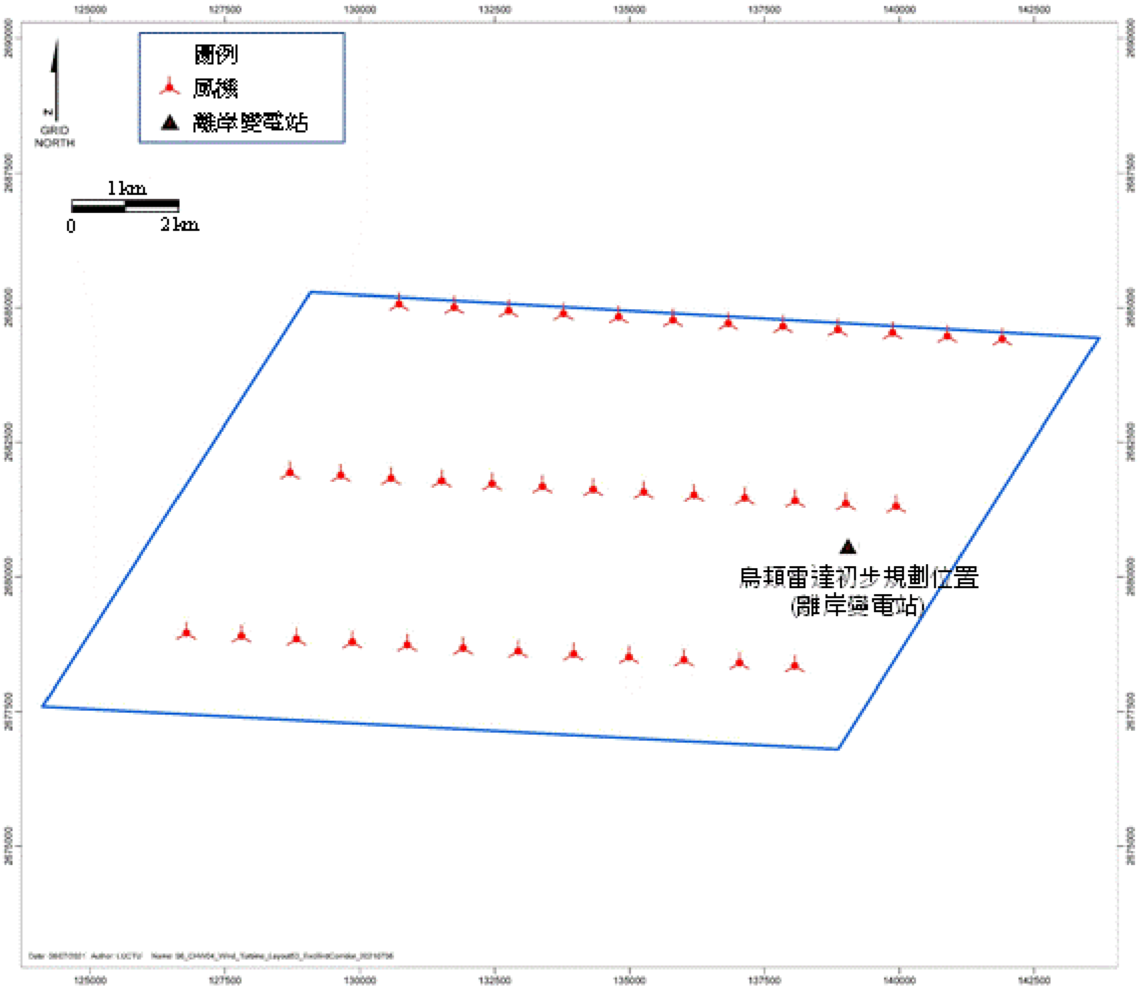


Figure 6.8.2-4 Filtering of Noise in High-performance Bird Monitoring Radar



Note: 1. The actual wind farm layout is subject to the final design approved by the competent authority

Figure 6.8.2-5 Locations of the Bird Radar Monitoring System in the Wind Farm

V. Assessment on other impacts on birds

i The impact of turbine spacing on birds

In the original EIS, it has been committed that eight bird corridors will be reserved in the four Greater Changhua wind farms. Each corridor will be at least 2km in width. The corridors will be extended in stage 2, so the existing bird corridors and the 6D buffer zone are still in this Project.

In addition, it has been committed that a 6D buffer zone will be reserved between wind farms. The buffer zones between wind farms are already a part of the corridor, meaning that the buffer zones are at least 2km in width. After this amendment, the maximum rotor diameter is 250m, and the 6 times of the rotor diameter (6D) is only 1.5km. Therefore, the original design of the corridors will not be affected by the amendment.

For this amendment, the original wind farm layout will be applied, as shown in Figure 6.8.3-1-6.8.3-2. The width of the N-S spacing between turbines are all above 2 km for birds to fly through. For the W-E turbine spacing, we have followed the committee members' suggestions to increase the W-E spacing to 850m for the 16MW turbines proposed in the amendment. With this layout, the net distance between the blades of two turbines can reach 600m.

In the environmental impact survey report (bird survey report) of the Greater Changhua Northwest Offshore Wind Power Project, corridors are reserved with nearby wind farms as the overall bird flight corridors for the wind farms in the Changhua area, as shown in Figure 6.8.3-3. This Amendment does not involve the change of wind farm area, so the corridors between wind farms are still the same, and the design of the overall corridors will not be affected.

The planning of the overall corridors has not been changed after the amendment, and the spacing between turbines have been adjusted as bigger turbines are proposed. The bird collision assessment using different single turbine capacities shows no significant difference in the bird strikes after this amendment. Therefore, it is expected that the spacing between turbines after the amendment will not increase the impact on birds compared to that before the amendment.

ii Installation of aviation warning light

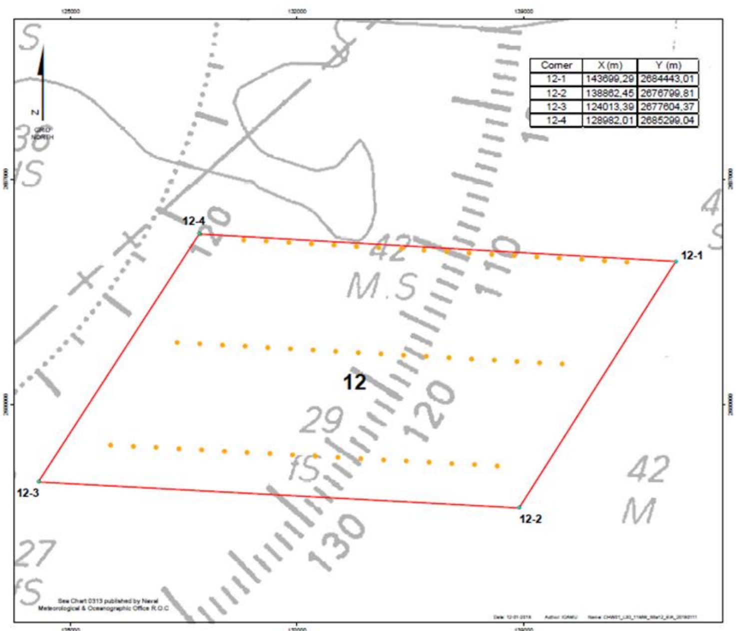
International studies show that using flashing lights instead of steady-burning lights can reduce the fatality of bird strikes during nighttime. However, the color of the lights has little connection to bird fatality. (United States and Canada, 2012., Manville AM, 2009., Longcore T et al., 2008.) related researches are as follows:

(a) As per the research on the avian mortality at communication towers in the United States and Canada, bird strikes can be effectively reduced after replacing the steady-burning lights with red or white flashing lights. (An Estimate of Avian Mortality at Communication Towers in the United States and Canada, 2012)。

(b) As per the research by Fish and Wildlife Service, the bird strike mortality can be reduced by 50-71% after replacing the steady-burning with flashing lights. However, the color of the lights has little connection to bird fatality. (Towers, turbines, power lines, and buildings – steps being taken by the U.S. Fish and Wildlife Service to avoid or minimize take of migratory birds at these structures., Manville AM, 2009).

(c) The study shows that the red flashing lights attract less migratory birds at night. However, the color of the lights does not affect its attraction to birds. (Height, Guy Wires, and Steady-Burning Lights Increase Hazard of Communication Towers to Nocturnal Migrants: A Review and Meta-Analysis., Longcore T et al., 2008).

However, since the installation of aviation warning lights is mainly for the protection of aviation safety, aviation warning lights must still be installed in accordance with the "Standards for the Installation of Aviation Obstruction Signs and Obstruction Lights" issued by the Civil Aeronautics Administration (CAA) in order to achieve the purpose of maintaining



aviation safety.

Figure 6.8.3-1 11MW Turbine Layout in the Original EIS (58 sets)

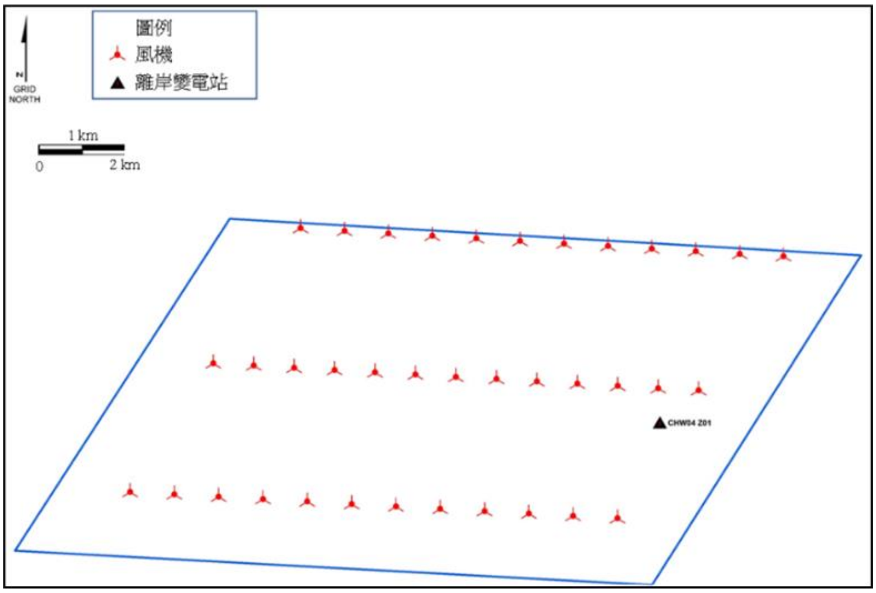


Figure 6.8.3-2 11MW Turbine Layout in the Original EIS (58 sets)

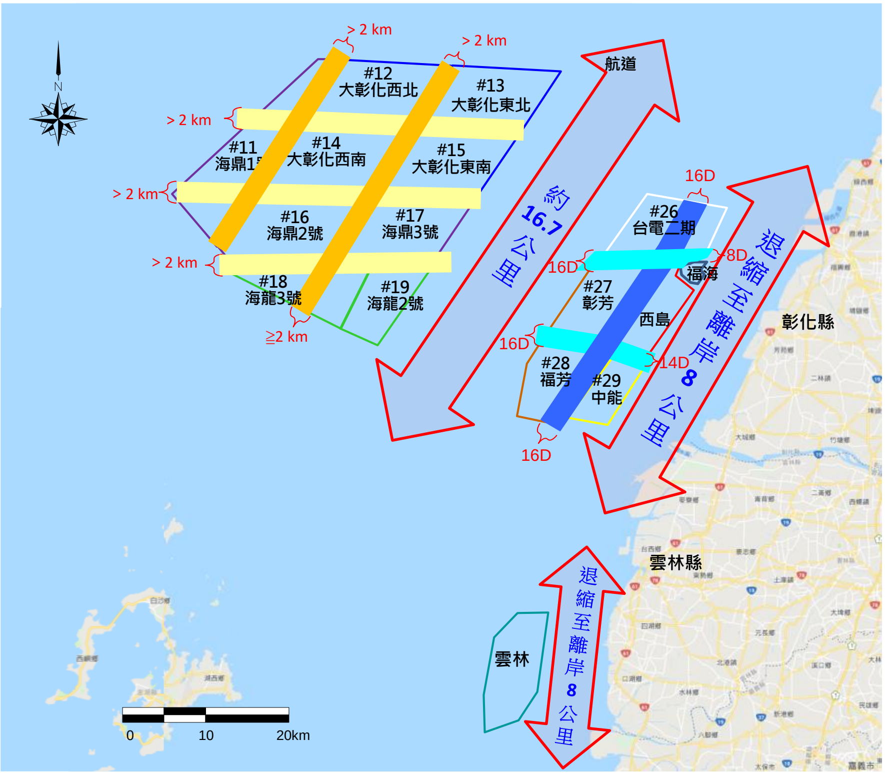


Figure 6.8.3-3 Large Bird Corridors in Changhua and Yunlin Area

6.9 Terrestrial Ecology

As per the construction phase environmental monitoring report from 2019 Q3 to the 2021 Q3, the location of the terrestrial ecological survey is located in the Lunwei Dist. of Changbin Industrial Park, Changhua County. The survey area has included the area of the onshore booster/step-down station and 1000m of the station shared with the Northwest wind farm after the amendment. The monitoring location, survey route, locations for rat cage and plant sampling area are shown in Figure 6.9-1.

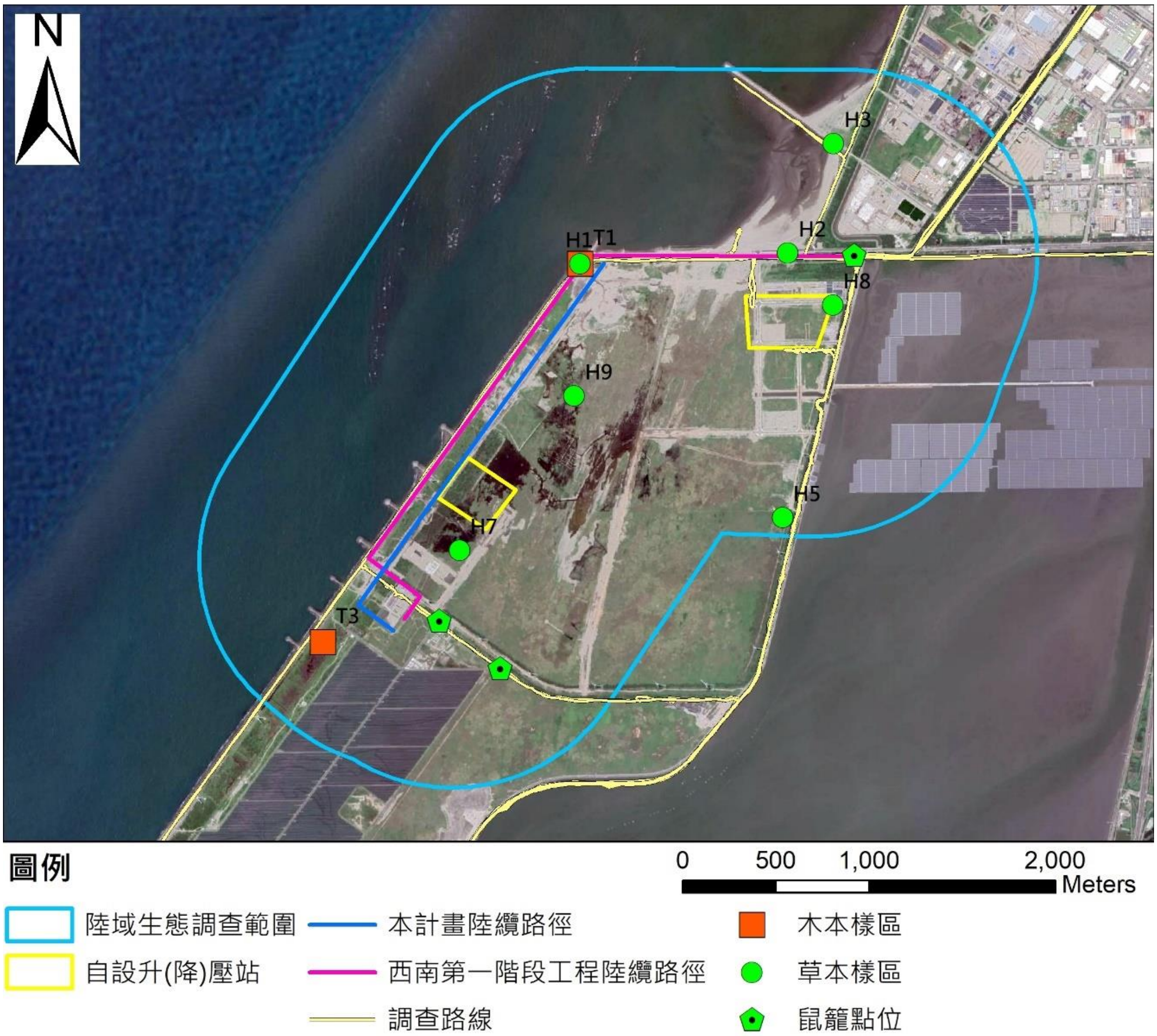


Figure 6.9-1 Monitoring Location, Survey Route, Locations for Rat Cage and Pant Sampling Area

I. Terrestrial Plants

i Attribution

The statistics of plant attribution from 2019 Q3 to 2021 Q3 is shown as Table 6.9.1. No significant difference is found. Survey results are described as follows:

Table 6.9-1 Statistical Table of Plant Characteristics

Attribution		2019 Q3	2019 Q4	2020 Q1	2020 Q2	2020Q3	2020 Q4	2021 Q1	2021 Q2	2021 Q3
Category	Families	52	52	52	52	52	52	52	52	52
	Genera	116	116	118	120	121	120	120	120	120
	Species	131	131	135	137	138	140	142	142	143
Gymnosperm	Families	3	3	3	3	3	3	3	3	3
	Genera	3	3	3	3	3	3	3	3	3
	Species	3	3	3	3	3	3	3	3	3
Dicotyledon	Families	43	43	43	43	43	43	43	43	43
	Genera	85	85	87	89	89	89	89	88	88
	Species	98	98	101	103	103	105	107	106	107
Monocotyledon	Families	6	6	6	6	6	6	6	6	6
	Genera	28	28	28	28	29	28	28	29	29
	Species	30	30	31	31	32	32	32	33	33
Growth Type	Arbor	31	31	31	31	32	32	33	33	33
	Shrub	12	12	12	12	12	12	12	12	12
	Wood Climber	1	1	1	1	1	1	1	1	1
	Herbaceous Climber	11	11	11	11	12	13	13	13	14
	Herb	76	76	80	82	81	82	83	83	83
Attribute	Indigenous	64	64	67	69	69	71	71	72	72
	Endemic	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	1
	Naturalized	52	52	53	53	53	54	55	54	56
	Invasive	*16*	*16*	*16*	*16*	*16*	*16*	*16*	*16*	*18*
	Cultivated	15	15	15	15	16	15	16	16	15

Note: Endemic species are included in indigenous species; Invasive species are included in Naturalized species. The two categories are presented with *Italic* and are aligned to the right.

ii Distribution of Rare and Valuable Species

From 2019 Q3 to 2021 Q3, no rare and valuable stated in the Cultural Heritage Preservation Act or the Technical Guideline for Animal Ecology Assessment is recorded. The survey basing on the Red List of Vascular Plant promulgated by Editorial Committee, (2017) shows that 2 Critically Endangered (CE) species (Lanyu Podocarp and Japanese Spindle-tree), 2 Endangered (EN) species (Common Garcinia and Portia Tree), 2 Vulnerable (VU) species (Indian Barringtonia and Fan Palm), and 3 Near Threatened (NT) species (Kandelia obovate, velvet apple and Formosan peacock-plum) were recorded. Except for Kandelia obovate and Formosan peacock-plum, which are natural plantation, all species above were artificially grown. These plants are planted as street trees. They are neatly arranged and were properly taken care of; they were also far from their place of origin. (Table 6.9-2 and Figure 6.9-2).

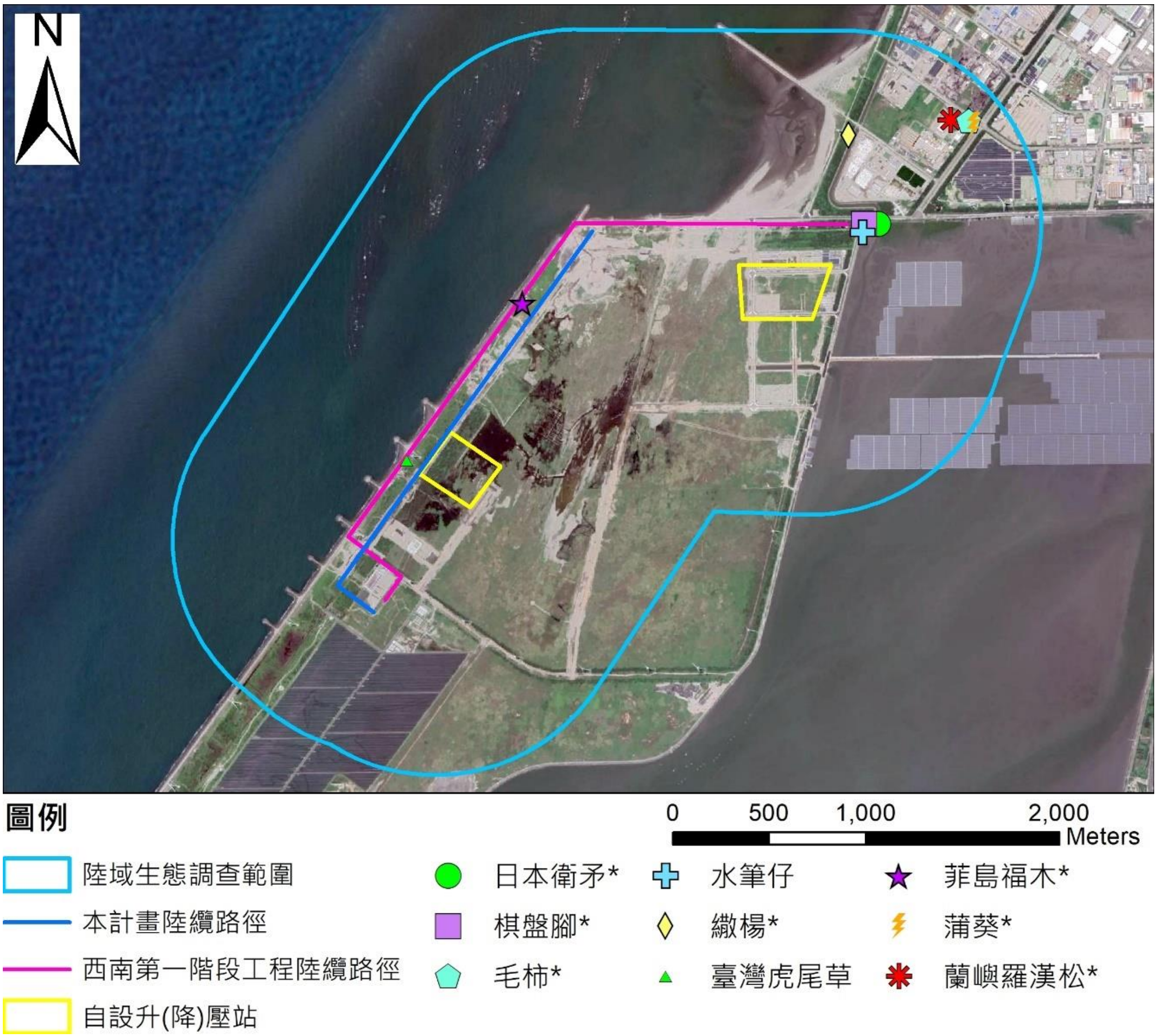
iii Distribution Status of Protected Woods

From 2019 Q3 to 2021 Q3, no recorded woods within survey area were protected woods mentioned in Article 2 of "Protected Wood Criteria Except For Forest" issued by Council of Agriculture, Executive Yuan (Council of Agriculture, Executive Yuan, 2016) and Article. 5 of "Changhua County Self-Government Ordinance for Tree Protection" (Changhua County Government, 2007) were discovered in the survey area.

Table 6.9-2 Resource Table of Rare Plants

Species	Rare and Valuable	The Red List	Floristic Region	Coordinate	
				X	Y
Lanyu Podocarp*	-	CR	Indigenous	191363	2669558
Common Garcinia*	-	EN	Indigenous	189152	2668610
Japanese Spindle-tree*	-	CR	Indigenous	190989	2669019
Portia Tree*	-	EN	Indigenous	190840	2669479
Indian Barringtonia*	-	VU	Indigenous	190918	2669023
Kandelia obovata	-	NT	Indigenous	190909	2668976
Velvet apple*	-	NT	Indigenous	191457	2669554
Formosan peacock-plum	-	NT	Indigenous	188554	2667799
Fan Palm*	-	VU	Indigenous	191486	2669532

Note 1: "Species" with * indicates it is artificially planted.
Note 2: "Rare and Valuable" indicates rare and valuable plants issued by Environmental Protection Administration, Executive Yuan (2002). Rare and valuable plants mentioned in Cultural Heritage Act are specified.
Note 3: "The Red List" indicates conservation status of plant species promulgated by Editorial Committee, the Red List of Vascular Plant (2017), including Critically Endangered (CR), Endangered (EN), Vulnerable (VU) and National Threatened (NT). Near Threatened (NT) indicates the species is close to level of vulnerable, so it is presented in the list.
Note 4: "Floristic Region" indicates nature of floristic region which can be divided into indigenous species and endemic species in Taiwan.



Note: "＊" indicates cultivated individuals

Figure 6.9-2Distribution of Rare Plants in this Survey

iv Types and Characteristics of Vegetation

(a) <u>Forest Plantation</u>

Forest plantation in the survey area are mainly coastal wind-break forest, which are artificial cultivation. Dominant species for cultivated plants are Beef wood and Linden hibiscus. A tendency of secondary forest is observed in forest that are not continuously nurtured or blown down by wind.

(b) <u>Grass-Covered Land</u>

Distributed in exposed region and roadside within survey area. The dominant species can be divided into 4 types:

- A. Spinifex Littoreus

  It is usually seen at exposed region in large-scale coverage and is widely distributed at beach with great sun light. Dominant species is Spinifex littoreus, which is frequently accompanied by Seashore vine morning glory, Simpleleaf shrub chaste tree and Chinese crab grass.

- B. Artemisia Capillaris

  It is usually seen at exposed region in large-scale coverage and is widely distributed at beach with strong sun light. Dominant species is Artemisia capillaris, which is frequently accompanied by Spanish needles, Guinea grass and Seashore vine morning glory.

- C. Natal Grass

  It is usually seen at exposed region and is widely distributed at grass land with great sun light. Dominant species is Natal Grass, which is frequently accompanied by Spanish needles, Guinea grass and South African hoarypea.

- D. Spanish Needles

  It is usually seen at exposed region in large-scale coverage and is widely distributed at grass land with great sun light. Dominant species is Spanish Needles, which is frequently accompanied by Seashore vine morning glory, Kans grass, Stinky cat grass and Indian sesbania.

v Sample Area Survey

(a) Analysis of Dominance Composition

This survey area was mainly constituted by forest plantation and grass-covered land. 2 forest sample Areas and 8 grass-covered land sample Areas, as assigned in EIA stage, are deployed in total. T1 is located in the wind-break forest at the northeast side of the survey area; T3 is located in the wind-break forest at the southwest side of the survey area; H1 is located at the northwest side of the survey area; H2 and H8 are located at the east side of the survey area; H3 is located at the north side of the survey area; H5 is located at the southeast side of the survey area; H7 is located at the southwest side of the survey area; H9 is located at the west side of the survey area. H5 was moved to a nearby area with similar plantation as the original area was damaged in order to widen roads in January 2020. In addition, H2 (April 2020) was damaged due to construction landfill this quarter. (Figure 6.9-1). Environmental factors (Table 6.9-3), plantation composition and dominance analysis are described as followed:

Table 6.9-3 Environmental Data of Plant Sample Areas

Sample Area Number	Types of Vegetation	Coordinates		Area (m^2)	Altitude (m)
		X	Y		
T1	Forest	189385	2668980	100	3
T3	Forest	188006	2666953	100	5
H1	Grass-Covered Land	189385	2668980	25	5
H2	Grass-Covered Land	190498	2669040	25	3
H3	Grass-Covered Land	190742	2669625	25	1
H5	Grass-Covered Land	190471	2667622	25	1
H7	Grass-Covered Land	188739	2667446	25	5
H8	Grass-Covered Land	190739	2668760	25	4
H9	Grass-Covered Land	189353	2668273	25	7

Note: Coordinates system is TWD97 (Transverse Mercator Projection in 2^o Zones).

- Xylophyta of Forest Sampling Area

  Analysis of dominant species from 2019 Q3 to 2021 Q3 is as Table 6.9-4. Among which, Beef wood was the most dominant species.

Table 6.9-4 Dominant Species of Xylophyta in Forest Sampling Area

Item	2019 Q3	2019 Q4	2020 Q1	2020 Q2	2020Q3	2020 Q4	2021 Q1	2021 Q2	2021 Q3
T1	Beef wood	Beef wood	Beef wood	Beef wood	Beef wood	Beef wood	Beef wood	Beef wood	Beef wood
T3	Beef wood	Beef wood	Beef wood	Beef wood	Beef wood	Beef wood	Beef wood	Beef wood	Beef wood
Number of Species	4	4	4	4	4	4	4	4	4
Coverage of dominant species	Beef wood (115%)	Beef wood (115%)	Beef wood (115%)	Beef wood (109%)	Beef wood (104%)	Beef wood (105%)	Beef wood (86%)	Beef wood (86%)	Beef wood (86%)

- Ground-Cover Plants at Forest Sampling Area

  Analysis of dominant species from 2019 Q3 to 2021 Q3 is as Table 6.9-5. 9-14 species were recorded. The dominant species is Spanish Needles from 2019Q3 to 2020Q3 and Guinea grass from 2020Q4 to 2021Q3.

Table 6.9-5 Dominant Species of Ground-Cover Plants at Forest Sampling Area

Item	2019 Q3	2019 Q4	2020 Q1	2020 Q2	2020Q3	2020 Q4	2021 Q1	2021 Q2	2021 Q3
T1	Spanish Needles	Spanish Needles	Spanish Needles	Spanish Needles	Guinea grass	Guinea grass	Guinea grass	Guinea grass	Guinea grass
T3	Spanish Needles	Spanish Needles	Spanish Needles	Spanish Needles	Spanish Needles	Spanish Needles	Spanish Needles	Spanish Needles	Spanish Needles
Number of Species	9	9	10	9	14	14	14	13	13
Coverage of dominant species	Spanish Needles(53%)	Spanish Needles(52%)	Spanish Needles(54%)	Spanish Needles(55%)	Spanish Needles(39%)	Guinea grass(38%)	Guinea grass(36%)	Guinea grass(35%)	Guinea grass(37%)

- Plants at Grass-Covered Land Sampling Area

  Analysis of dominant species from 2019 Q3 to 2021 Q3 is as Table 6.9-6. 14-22 species were recorded. The dominant species is Spinifex littoreus in 2019Q3, 2019Q4, and 109Q4 to 110Q2 and Spanish Needles from 2020Q1 to 2020Q3 and in 110Q3.

Tab6.9-6 Dominant Species of Plants at Grass Sampling Area

Item	2019 Q3	2019 Q4	2020 Q1	2020 Q2	2020Q3	2020 Q4	2021 Q1	2021 Q2	2021 Q3
H1	Spinifex littoreus	Spinifex littoreus	Spinifex littoreus	Spinifex littoreus	Spinifex littoreus	Spinifex littoreus	Spinifex littoreus	Spinifex littoreus	Spinifex littoreus
H2	Spinifex littoreus	Spinifex littoreus	Indian Sesbania	—[註]	—[註]	—[註]	Wo-spiked Signal-grass and Spinifex littoreus	Spinifex littoreus	Spinifex littoreus
H3	Spinifex littoreus	Spinifex littoreus	Spinifex littoreus	Spinifex littoreus	Spinifex littoreus	Spinifex littoreus	Spinifex littoreus	Spinifex littoreus	Spinifex littoreus
H5	Artemisia capillaris	Artemisia capillaris	Artemisia capillaris	Artemisia capillaris	Artemisia capillaris	Artemisia capillaris	Artemisia capillaris	Artemisia capillaris	Artemisia capillaris
H7	Spanish Needles	Spanish Needles	Spanish Needles	Spanish Needles	Spanish Needles	Spanish Needles	Spanish Needles	Spanish Needles	Spanish Needles
H8	Natal Grass	Natal Grass	Natal Grass	Spanish Needles	Spanish Needles	Spanish Needles	Guinea grass	Guinea grass	Guinea grass
H9	Spanish Needles	Spanish Needles	Spanish Needles	Spanish Needles	Spanish Needles	Spanish Needles	Spanish Needles	Spanish Needles	Spanish Needles
Number of species	19	22	17	12	17	14	15	15	15
Coverage of dominant species	Spinifex littoreus (37%)	Spinifex littoreus (37%)	Spanish Needles (35%)	Spanish Needles (38%)	Spanish Needles (35%)	Spinifex littoreus (33%)	Spinifex littoreus (36%)	Spinifex littoreus (36%)	Spinifex littoreus (32%)

Note: H2 was found buried during construction in April 2020, so there was no survey data. The H2 sampling area was re-established in 2021 Q1.

vi Index of Diversity Analysis

(a) Xylophyta of Forest Sampling Area

The diversity from 2019 Q3 to 2021 Q3 is shown as Table 6.9-7. No significant is found in the *H´* and *E*5 index among each quarter.

Table 6.9-7 Diversity Index of Xylophyta at Forest Sample Area

Item	2019 Q3	2019 Q4	2020 Q1	2020 Q2	2020 Q3	2020 Q4	2021 Q1	2021 Q2	2021 Q3
H´	0.62-0.85	0.62-0.86	0.62-0.86	0.61-0.89	0.61-0.90	0.64-0.78	0.62-0.78	0.65-0.83	0.65-0.83
*E*5	0.69-0.87	0.70-0.87	0.70-0.87	0.69-0.86	0.70-0.85	0.70-0.90	0.70-0.88	0.74-0.92	0.74-0.92

(b) Ground-Cover Plant at Forest Sampling Area

The diversity from 2019 Q3 to 2021 Q3 is shown as Table 6.9-8. No significant is found in the *H´* and *E*5 index among each quarter.

Table 6.9-8 Diversity Index of Ground Cover at Forest Sample Area

Item	2019 Q3	2019 Q4	2020 Q1	2020 Q2	2020 Q3	2020 Q4	2021 Q1	2021 Q2	2021 Q3
H´	0.65-1.57	0.70-1.59	0.73-1.51	0.64-1.59	0.97-1.67	1.13-1.61	1.16-1.67	1.25-1.72	1.27-1.72
*E*5	0.49-0.84	0.53-0.82	0.42-0.83	0.44-0.84	0.46-0.60	0.62-0.63	0.60-0.64	0.63-0.68	0.66-0.68

(c) Plant at Grass-Covered Land Sampling Area

The diversity from 2019 Q3 to 2021 Q3 is shown as Table 6.9-9. No significant is found in the *H´* and *E*5 index among each quarter.

Table 6.9-9 Diversity Index Table of Grass-Covered Land Sample Area

Item	2019 Q3	2019 Q4	2020 Q1	2020 Q2	2020 Q3	2020 Q4	2021 Q1	2021 Q2	2021 Q3
H´	0.33-1.20	0.33-1.46	0.16-1.26	0.15-1.24	0.23-1.17	0.20-1.19	0.27-1.32	0.27-1.32	0.34-1.16
*E*5	0.45-0.65	0.46-0.69	0.37-0.87	0.43-0.80	0.39-0.82	0.42-0.77	0.41-0.84	0.44-0.84	0.51-0.78

II. Terrestrial Animal

i Mammals

(a) Species Composition

The statistics from 2019 Q3 to 2021 Q3 is shown as Table 6.9.10. There is no significant difference in the species among each quarter.

(b) Endemism

In 2021Q1, 1 endemic subspecies, Horikawa’s brown bat was recorded, accounting for 20.0% of total recorded species. No subspecies was recorded in the rest of the quarters.

(c) Protected Level

No protected species were recorded from 2019Q3 to 2021Q3.

(d) Dominant Species

Dominant species from 2019Q3 to 2021Q3 is shown as Table 6.9.10. The dominant species are all Japanese house bat in all quarters except for 2020 Q1 (Musk shrew) and 2021 (all species is recorded with 1 individual).

(e) Index analysis

The index analysis from 2019 Q3 to 2021 Q3 is shown as Table 6.9-10. Overall, the survey area is in the coastal area, which provide less habitat suitable for mammals.

Table 6.9-10 Statistics in the Mammal Survey

Item		2019 Q3	2019 Q4	2020 Q1	2020 Q2	2020 Q3	2020 Q4	2021 Q1	2021 Q2	2021 Q3
Category	Order	3	3	3	3	3	3	3	3	3
	Family	3	3	3	3	3	3	3	3	3
	Species	4	5	7	4	7	6	5	3	4
Individuals recorded		9	19	20	16	14	11	14	11	3
Dominant species (individual)		Japanese house bat (6)	Japanese house bat (8)	Musk shrew (9)	Japanese house bat (10)	Japanese house bat (10)	Japanese house bat (7)	Japanese house bat (9)	Japanese house bat (8)	—
H’		1.00	1.41	1.43	1.04	0.99	1.16	1.03	0.76	1.10
J’		0.72	0.88	0.89	0.75	0.62	0.72	0.74	0.69	1.00

Note: The bat species recorded by the ultrasonic bat detector were not included in the calculation of the number and diversity index because the actual number of species could not be calculated.

ii Bird

(a) Species Composition

The statistics from 2019 Q3 to 2021 Q3 is shown as Table 6.9.11. Species recorded are mainly residents and water birds foraging at paddy lands. The main difference in species and amounts is the water birds.

(b) Endemism

7 endemic subspecies recorded from 2019 Q3 to 2021 Q3 are Savanna nightjar, Black drongo, Plain Prinia, Golden-headed cisticola, Light-vented bulbul, Barred buttonquail and House swift. Percentage of the endemic species in each quarter is between 13.0-19.4%.

(c) Protected Level

Location of the protected birds from 2019 Q3 to 2021 Q3 is shown as Figure 6.9.3. 5 rare and protected species were recorded, including Little tern, Greater crested tern, Common kestrel, Black-winged kite and Eastern marsh harrier. 3 other species deserving protection are Brown shrike, Chestnut munia and Oriental pratincole.

(d) Migratory Habit

Birds recorded from 2019 Q3 to 2021 Q3 are mostly residents or winter migrants.

(e) Dominant species

The statistics of dominant species from 2019 Q3 to 2021 Q3 is shown as Table 6.9-11. The dominant species is Kentish plover except for 2019 Q4 (Little egret), 2020 Q2 (Cattle egret), 2020 Q4 (Japanese white-eye) and 2021 Q3 (Greater sand plover).

(f) Index analysis

The analysis of index from 2019 Q3 to 2021 Q3 is shown as Table 6.9-11. The survey area is mainly coastal area and exposed land. The index shows that the species is rich, the uniformity index is relatively low, and the number of species is unevenly distributed. Except for 2019 Q3 and 2021 Q3, where the index is affected by the dominant species Kentish plover, the distribution of species in the rest of the quarters are even and are not affected by dominant species.

Table 6.9-11 Statistics for Bird Surveys

Item		2019 Q3	2019 Q4	2020 Q1	2020 Q2	2020 Q3	2020 Q4	2021 Q1	2021 Q2	2021 Q3
Category	Order	6	7	7	11	9	9	7	6	10
	Family	19	17	18	25	24	22	20	22	25
	Species	31	27	30	46	43	42	34	36	38
Individual recorded		1,123	355	342	648	591	479	355	373	835
Major dominant species (ind.)		Kentish plover (519)	Little egret (75)	Kentish plover (70)	Cattle egret (75)	Kentish plover (80)	Japanese white-eye (57)	Kentish plover (48)	Kentish plover (83)	Greater sand plover (512)
Secondary dominant species (ind.)		Lesser sand plover (120)	Japanese white-eye (46)	Light-vented bulbul (43)	Kentish plover (63)	Japanese white-eye (52)	Kentish plover (53)	Japanese white-eye (38)	Sparrow (32)	Kentish plover (65)
H'		2.19	2.74	2.82	3.29	3.25	3.25	3.07	3.01	1.86
J'		0.64	0.83	0.83	0.86	0.86	0.87	0.87	0.84	0.51

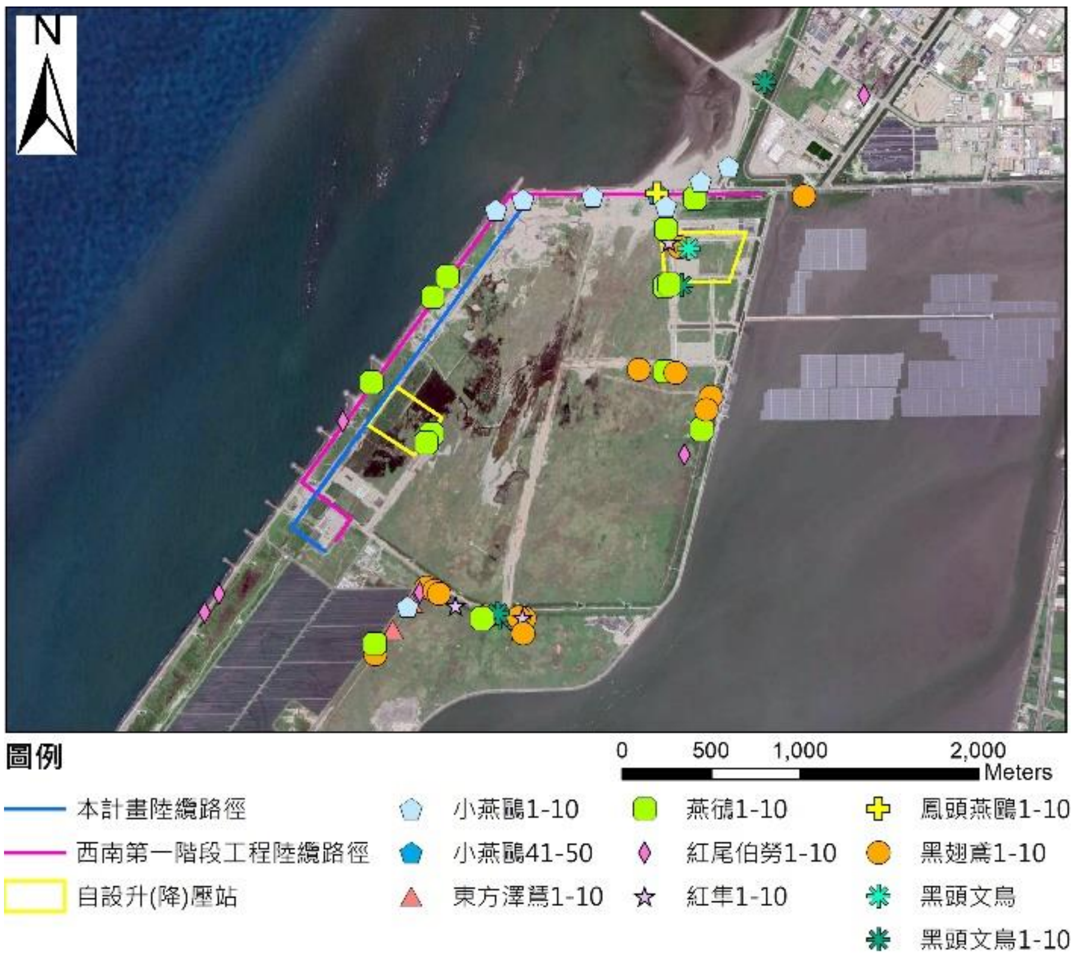


Figure 6.9-3 Location for Protected Species

iii Reptile

(a) Species Composition

The statistics for reptile from 2019 Q3 to 2021 Q3 is shown as Table 6.9.12. The dominant species for each quarter is Common house gecko. Other species were recorded with very few individuals.

(b) Endemism

Stejneger’ s grass lizard is recorded in 2019 Q3, 2020 Q1 and 2020 Q2; and Chinese skink (subspecies) is recorded in 2020 Q4. No endemic species is recorded in the rest of the quarters.

(c) Protected Species

No protected species is recorded from 2019 Q3 to 2021 Q3.

(d) Dominant Species

The statistics of dominant species from 2019 Q3 to 2021 Q3 is shown as Table 6.9-12. The dominant species in all quarters is Common house gecko except for 2021 Q3 where only 1 species is recorded.

(e) Index Analysis

Analysis of index from 2019 Q3 to 2021 Q3 is shown as Table 6.9-12. Overall, the survey area is located in coastal area, where less grass lands or secondary forests available for reptiles, so the diversity index is low.

Table 6.9-12 Statistics for Reptile Surveys

Item		2019 Q3	2019 Q4	2020 Q1	2020 Q2	2020 Q3	2020 Q4	2021 Q1	2021 Q2	2021 Q3
Category	Order	1	1	1	1	1	1	1	1	1
	Family	3	3	4	2	2	2	2	2	1
	Species	3	4	5	3	2	4	2	2	1
Individual recorded		18	14	20	15	18	18	8	7	1
Dominant species (ind.)		Common house gecko (16)	Common house gecko (11)	Common house gecko (14)	Common house gecko (12)	Common house gecko (17)	Common house gecko (13)	Common house gecko (7)	Common house gecko (5)	—
H’		0.43	0.75	0.98	0.63	0.21	0.88	0.38	0.60	0.00
J’		0.39	0.54	0.61	0.57	0.31	0.64	0.54	0.86	N/A

iv Amphibian

(a) Species Composition

The statistics from 2019 Q3 to 2021 Q3 is shown as Table 6.9-13. No amphibian is recorded in 2021 Q3. No significant difference is found for the species recorded in the rest of the quarters.

(b) Endemism

No endemism is recorded from 2019 Q3 to 2021 Q3.

(c) Protected Level

No protected species is recorded from 2019 Q3 to 2021 Q3.

(d) Dominant Species

The statistics of dominant species from 2019 Q3 to 2021 Q3 is shown as Table 6.9-13. Species recorded in 2019 Q4 and 2020 Q3 is between 1-5. No species is recorded in 2021 Q3. For the rest of the quarters, only Paddy frog is recorded. No dominant species is observed.

(e) Index Analysis

Analysis of index from 2019 Q3 to 2021 Q3 is shown as Table 6.9-13. Overall, the survey area is located in coastal area, where habitats available for reptiles are less, so the species and individuals are less.

Table 6.9-13 Statistics for Amphibian Surveys

Item		2019 Q3	2019 Q4	2020 Q1	2020 Q2	2020 Q3	2020 Q4	2021 Q1	2021 Q2	2021 Q3
Category	Order	1	1	1	1	1	1	1	1	0
	Family	1	1	1	1	1	1	1	1	0
	Species	1	2	2	1	1	1	1	1	0
Individual recorded		5	7	6	8	6	6	2	2	0
Dominant species (ind.)		—	—	—	—	—	—	—	—	—
H'		0.00	0.60	0.45	0.00	0.00	0.00	0.00	0.00	—
J'		N/A	0.86	0.65	N/A	N/A	N/A	N/A	N/A	—

v Butterfly

(a) Species Composition

The statistics from 2019 Q3 to 2021 Q3 is shown as Table 6.9-14. No significant difference is found in the species among all quarters.

(b) Endemism

No endemism is recorded from 2019 Q3 to 2021 Q3.

(c) Protected species

No protected species is recorded from 2019 Q3 to 2021 Q3.

(d) Dominant Species

The statistics of dominant species from 2019 Q3 to 2021 Q3 is shown as Table 6.9-14. Except for 2019 Q4, Taiwan yellow butterfly were the dominant species in all quarters, except for 2019 Q4 (only 1-5 species were recorded), 2021 Q4 (dominant species: Taiwan yellow butterfly and White butterfly) and 2021 Q2 (dominant species: White butterfly).

(e) Index Analysis

Analysis of index from 2019 Q3 to 2021 Q3 is shown as Table 6.9-14. For *H'*, the *H'* in 2019 Q3, 2021 Q1 and 2021 Q2 are lower, and the species composition is not rich. For the rest of the quarters, the species composition is rich, and the *H'* is high. For *J'*, the species number is even throughout the quarters, and the *J'* is high.

Table 6.9-14 Statistics for Butterfly Surveys

Item		2019 Q3	2019 Q4	2020 Q1	2020 Q2	2020 Q3	2020 Q4	2021 Q1	2021 Q2	2021 Q3
Category	Order	1	1	1	1	1	1	1	1	1
	Family	4	4	4	4	4	4	4	4	4
	Species	9	11	11	9	10	11	7	7	9
Individual recorded		31	34	38	38	29	33	28	24	36
Dominant species (ind.)		Taiwan yellow butterfly (12)	—	Taiwan yellow butterfly (13)	Taiwan yellow butterfly (11)	Taiwan yellow butterfly (10)	Taiwan yellow butterfly 及White butterfly (各7)	Taiwan yellow butterfly (11)	White butterfly (10)	Taiwan yellow butterfly (11)
H'		1.76	2.31	2.08	1.91	1.92	2.09	1.73	1.63	1.98
J'		0.80	0.96	0.87	0.87	0.83	0.87	0.89	0.84	0.90

vi The Comparison between the Baseline Data and the Data in the EIS Stage

For the environmental monitoring during the construction phase, a total of 52 families, 118 genera, and 147 species were recorded. For rare endemic species, 2 Near Threatened (NT) plants were recorded, which are Kandelia obovata and Formosan peacock-plum. In the EIS stage (July 2017), 47 families, 115 genera, and 142 species were recorded. Formosan peacock-plum was recorded. Overall, no huge difference is found if compared with the EIS stage. The overall environment is similar to that in the EIS stage. Some plants were brought into or removed from the survey area due to human activities, such as planting, mowing, vehicle trails, or animal carrying. Also, some of the species only distribute in a limited area and were only recorded in the later surveys. These are the main reason for the difference in species.

During the construction phase, a total of 18 orders, 43 families and 89 species of animals were recorded in the terrestrial surveys. Birds were recorded with the most species, and Kentish plover is the dominant species. Butterfly were recorded with the most individuals, and Taiwan yellow butterfly is the dominant species. Overall, only 1 survey was conducted in summer in the EIS stage, and 9 surveys were conducted during the construction phase. The main difference between the 2 stages is the winter migratory bird, and the difference was due to the different number of surveys in the two stages.

vii Impact on the Terrestrial ecology

In the original plan, a 23,800 m^2 onshore substation is planned. After this amendment, 29,300m^2 onshore substation is planned for use by both the project CHW02. 1 substation with 18,000m^3 is now under construction for CHW02 phase 1, and another substation with 29,300m^3 is planned for CHW04 and CHW02 phase 2. The Project still maintained its planning of having two substations before and after the amendment, and the development locations have not been adjusted, so the difference regarding the substations is not significant, and therefore the difference in impact is assessed to be minimal.

The project has already selected three designated sites in the Lunwei area of the Changbin Industrial Park in the EIS stage. It planned to build an onshore substation at one of these three designated sites, as shown in Figure 6.9-4. After this amendment, although the substation will be jointly set up with the second phase of CHW02, the location of the substation is still in one of the three predetermined sites proposed in the EIS, as shown in Figure 6.9-5. Therefore, the proposed location of the onshore substation are within the original planned area, and no additional environmental impact will be derived due to the adjustment of the installation location.

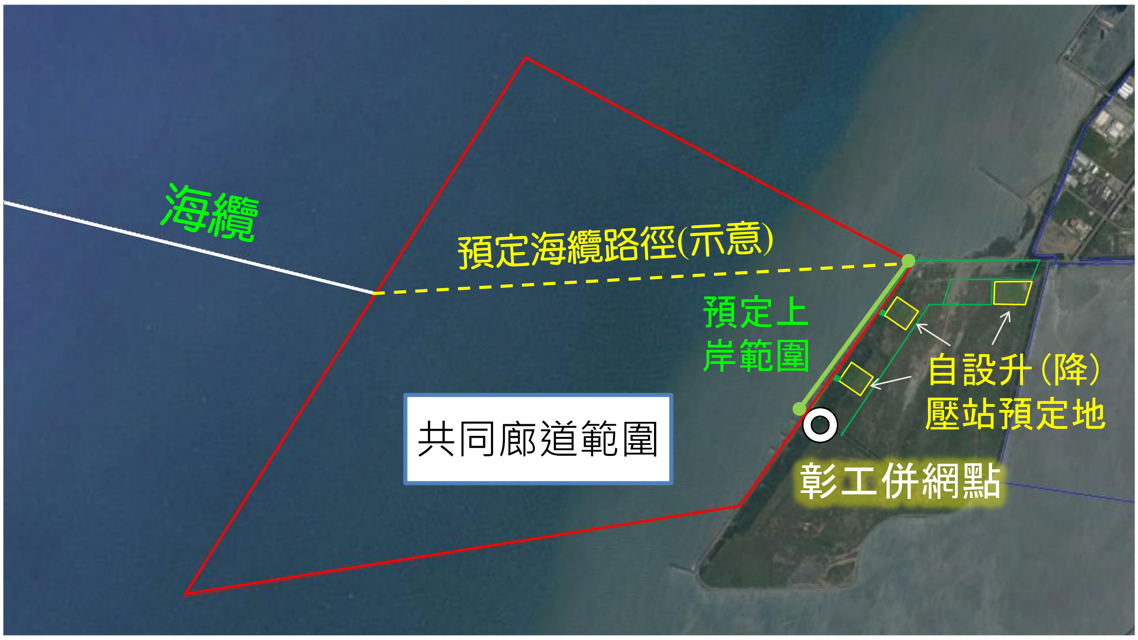


Figure 6.9-4 Location of Landfall and Onshore Facilities in the Original EIS

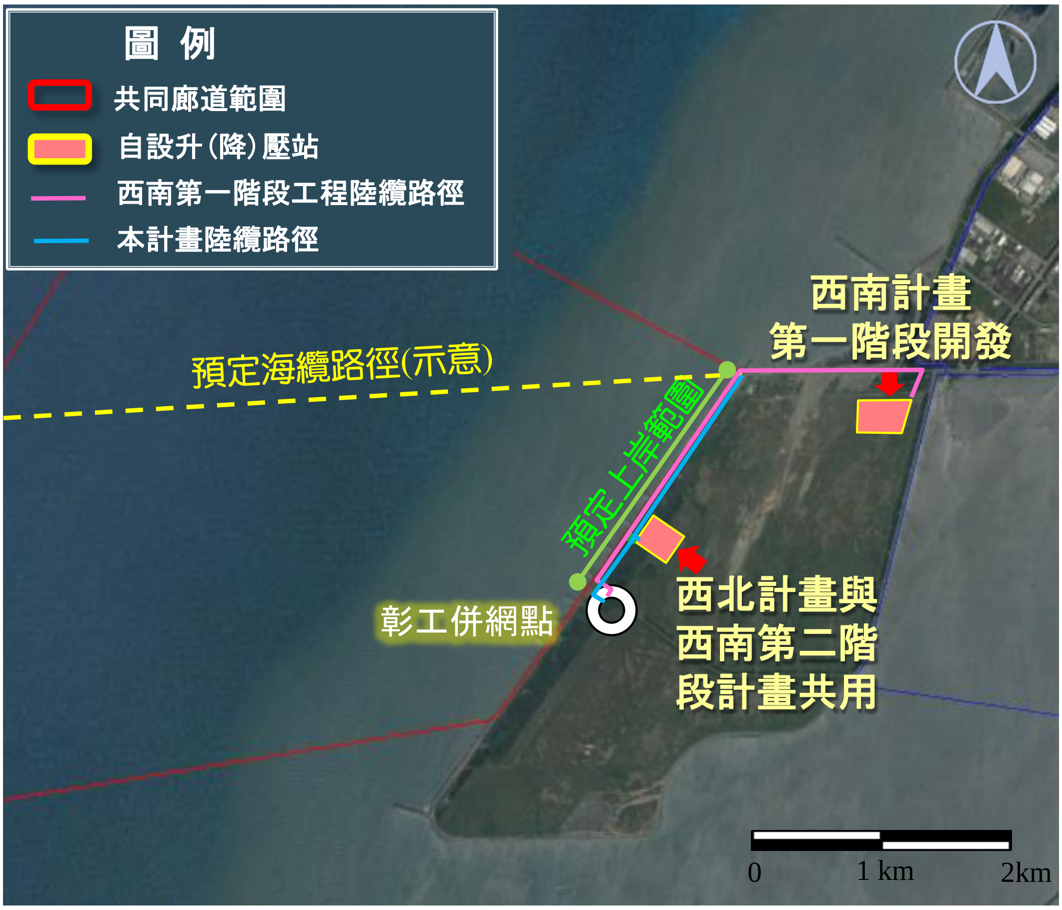


Figure 6.9-5 Location of Onshore Facilities in this Amendment

6.10 Safety Assessment of the Turbines and Foundations

In response to the international trend of applying larger turbines, the maximum single turbine capacity is increased in this Amendment. Therefore, the wind resistance and seismic resonance of the wind turbine are re-evaluated. As for the foundations, the suction bucket type jacket is proposed in this Amendment. Therefore, the bearing capacity of the foundation structure and the subsidence stability are re-evaluated. The results are as follows:

I. Safety Assessment of the Turbine Structure

1. Wind Resistance

Since there are many typhoons in Taiwan, the Project will use Class T wind turbines that meet the latest standards announced by the Bureau of Standards and Testing. The latest standards currently available is CNS 15176-1 issued on January 4, 2017. Turbines in this class can withstand an average wind speed of 57m/s in 10 minutes, which is equivalent to a strong typhoon with wind force 17.

Based on the Best Track data from 1977～2016 (40 years), there were no typhoon that exceed the turbine's limitation within 200 km from the center of the wind farm. There were 5 typhoons with an average wind speed of 50m/s in 10 minutes and 70m/s of strong gusts within 300 km from the center of the wind farm. The frequency is equivalent to 0.125 times/year.

The current design of the wind turbine is designed to withstand a 10-minute average wind speed of 57m/s and a 3-second gust wind speed in the range of 70-74m/s. The load safety factor is based on IEC 61400-1 and 61400-3, both of which have been confirmed by an in-depth survey submitted to the IEC 61400-1 committee and have considered the occurrence of more dangerous typhoons. Since the safety coefficients are taken into account in the design, the safety coefficients can ensure that the fan and support structure can withstand loads in the range of 63-67m/s for a 10-minute average wind speed of 54-57m/s.

2. Seismic Resonance

Since the type of wind turbine to be used has not been confirmed yet, the natural vibration frequency of the wind turbine as a whole and the blades will be considered and reviewed during the detailed design stage, so relevant information is not yet available. In the future, during the detailed design stage, seismic analysis will be conducted on the whole structure according to the national standard CNS 15176-1 on typhoon and seismic requirements, and seismic response spectra will be established and reviewed in order to comply with the relevant regulations. In the future, we will cooperate with professional technicians in China and commission a third-party verification unit to conduct project verification, and the Bureau of Standards and

Inspection will conduct examination.

In addition, although the natural vibration frequency of the wind turbines expected to be used in the future is not available, the Company has been conducting offshore wind farm development projects for many years, and the issues of avoiding the resonance of the wind turbines and blades has always been highly addressed in the design stage. After the load analysis and structural analysis, it was confirmed that the natural frequency of the structure is 0.27, which is in accordance with the site conditions.

3. Bearing capacity of the Suction Bucket Foundation and the subsidence stability

(1) Soil Liquefaction and Correlative Actions with the Soil under Earthquakes

In addition to the seismic hazard analysis (PSHA) in accordance with CNS 15176-1, Appendix H, this Project also conducted site response analysis and soil liquefaction potential assessment based on soil test results. Based on the results of the existing analysis, it was found that the earthquakes at the Great Changhua Wind Farm were mainly from regional seismic sources. The designed seismic response spectrum shows that the earthquakes with a period of above 3 seconds should be studied. In the designing stage, in order to clarify the effects of the designed earthquake on the offshore wind turbine, the impact of the earthquake in a long-term on the dynamic response analysis of the offshore wind turbine will be analyzed based on the design load combinations (DLC 11.1 to DLC 11.3) and will be included in the design of the offshore wind turbine support structure.

The behavior of the suction bucket jacket foundation after installation is similar to that of the gravity foundation. the seabed soil within 40m of the surface layer of the Greater Changhua Wind Farms is mostly medium-compacted sandy soil, and the depth of the rock plate surface is about 80m. To be conservative, the foundation has been tested on a large sharking platform at the National Earthquake Engineering Research Center to simulate the seismic behavior of the foundation and to evaluate the potential for soil liquefaction around the foundation. This is to ensure the stability and safety of the foundation in earthquakes.

(2) Analysis on the Bearing capacity and the subsidence stability

According to the general load data provided by the wind turbine manufacturers and the conceptual design results of Orsted, if suction bucket jacket is applied, the lateral force is about 2MN on the hub height and about 15MN at a water depth of 40m during the operation phase, and the vertical load is about 37MN. Later this project will be in accordance with the results of sea meteorological survey, the results of soil drilling on the seabed, the design load combination conditions, dynamic response analysis, to ensure the safety of the design results of the negative pressure

Shen box structure of the shelf. At present, this project has not yet entered the design stage before construction permit, and later will be submitted to the construction permit, in accordance with the requirements of the Bureau of Energy, Ministry of Economic Affairs to attach the dynamic reaction analysis results of the design report of the negative pressure Shen box structure of the pipe rack and the stability check of the support structure.

The friction impedance at the blade edge is about 15MN, which is enough to bear the vertical load of the wind turbine and the supporting structure (about 12MN). The project will ensure the safety of the suction bucket foundation basing on the results of sea meteorological survey, soil drilling on the seabed, the designed load combinations, and dynamic response analysis. At present, the Project has not yet entered the detailed design stage. When the Project is going to apply for the construction permit, the results of the dynamic reaction analysis and the stability inspection of the supporting structure required by the BoE will be attached.

Chapter 7 Review and Amendment on Environmental Protection Measure or on Comprehensive Environmental Management Plan

The amendment includes the developer's name and address, design envelope for maximum single turbine capacity, foundation type for turbine foundations, design of the offshore substation, voltage for offshore transmission cables, transition joint bay, and the onshore transmission system. The remaining development plans will be kept from the original EIS. According to the results of assessments and reviews of this DA, the following items will be added or revised, including contents in environmental protection measures and environmental monitoring plans. The environmental protection measures and environmental monitoring plans before and after amendments are compared, as shown in Table 7-1. Descriptions are as follows:

I. Construction Phase Offshore Environmental Protection Measure - Cetacean

In this amendment, "SBJ Foundation Type" is added to "choose a foundation type that produces less noise"; "reference point for underwater noise and acoustic monitoring" is adjusted; "commit to an underwater noise limit for a certain portion of the jackets during the installation phase" is added to "noise reduction measures during the construction"; "underwater noise threshold" is adjusted to underwater noise limitation; and a "underwater noise warning threshold of piling" is proposed.

i Choose a foundation type that produces less noise

The text is amended to "**Pin-Pile Jacket or SBJ foundation** will be selected for this Project, as they are expected to produce less noise".

ii Underwater acoustic and real-time monitoring

The mitigation measures for cetaceans in the original environmental impact statement stated: "In consideration of increasing the extent of cetacean detection, the Project commits to select a total of four reasonable locations approximately 750m from piling location to setup an underwater acoustic monitoring equipment…". However, this above statement did not clarify the reference point of the 750m distance. The purpose of this amendment is to provide a clearer definition of the reference point for this 750m distance: "In consideration of increasing the extent of cetacean detection, the Project commits to select a total of four reasonable locations approximately 750m from the **center of the jacket** as the reference point to setup underwater acoustic monitoring equipment…" and "underwater noise monitoring campaign will be carried out once at 750m from **the center of jacket** during pile driving campaign."

iii Noise reduction measures during the construction

In order to reduce impact on cetaceans induced by underwater noise during foundation installation, the Project has amended commitments from the original underwater noise limit.

(a) "**95% of the underwater noise measurement data (SEL_{05})** shall not exceed 160dB and **SPLpeak shall not exceed 190dB** at 750m to the **center of jacket** where the underwater noise monitoring is carried out."

(b) "The best noise control method commercially available at the time application of commencement of developed will be employed to ensure the piling noise 750m from piling is under 160dB SEL. The details of the noise mitigation measure will be determined before installation, including the latest noise mitigation technologies such as bubble curtain or balloon curtains. **Additionally, the sound exposure level (SEL) of 25% of all foundations to be installed at 750m distance to the center of jacket shall be lower than 159dB**".

iv Underwater noise warning threshold during piling

"157 dB SEL of single piling event, measured as 30 second average, is set as early warning level during the pile installation". As the noise monitoring shows that the early warning level is exceeded, proper responses (e.g. lower the hammer energy(kJ), decrease the frequency of piling) alongside enhanced mitigation measures such as increase the air supply of bubble curtain, if necessary, will be taken to make sure the noise level is lower than the limit described in EIA commitment. From the beginning of soft-start to piling, real-time monitoring will be conducted through the duration of piling, in order to understand the actual variation in underwater noise. With the underwater noise limitation being 160dB and warning value set at 157dB, the following describes the procedure when exceedance of the warning level is reached:

(a) Noise mitigation methods and underwater noise monitoring

- The best commercially available noise mitigation measures will be utilized during the entire course of pile driving campaign to alleviate the impact to marine ecology.
- Real-time underwater noise monitoring will be carried out by deploying 4 underwater noise monitoring devices at 4 locations at 750m to the center of jacket. The pile driving campaign will commence, by using soft-start, only after the deployment of noise monitoring devices and noise mitigation measures are in place.

(b) Real-time monitoring of underwater noise and warning mechanisms

The Project currently plans to use UNM devices, which have wireless transmission capabilities, to transmit UNM results to the installation vessel in real-time during piling. **Additionally, "157 dB SEL of single**

piling event, measured as 30 second average, is set as early warning level during the pile installation.”. As the noise monitoring shows that the early warning level is exceeded, proper responses will be taken.

(c) Underwater noise response plans

The variation on underwater noise and hammer energy during the entire course of pile installation campaign can be transmitted and seen by monitoring personnel and installation team in real-time (as shown in Figure 7-1). Relevant response measures will be taken when monitoring data exceeds the early warning threshold, e.g. lower the hammer energy, decrease the frequency of piling, alongside enhanced mitigation measures such as increase the air supply of bubble curtain, if necessary, to control underwater noise. The overall procedure goes as Noise monitoring → Real time communication and coordination → Take response measures→Control underwater noise. This is to prevent the sudden increase in noise level or exceedance of noise limit. (The overall procedure is shown in Figure 7-2).

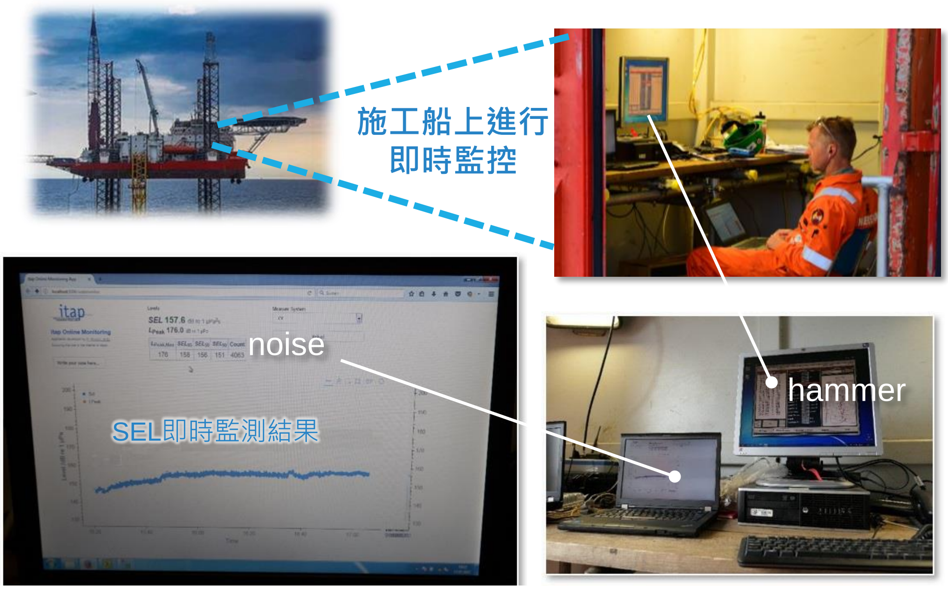


Figure 7-1 Underwater Noise Personnel Conducting Real-Time Monitoring

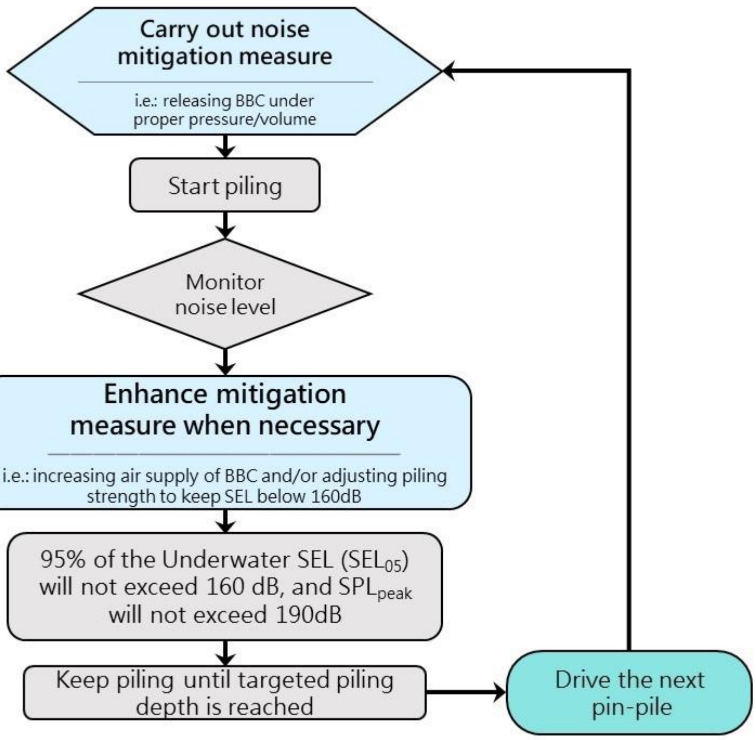


Figure 7-2 Underwater Noise Real-time Monitoring and Response Process

II. Construction Phase Offshore Environmental Protection Measure - Marine Water Quality and Air Quality

i To reduce the impact of scour protection to the marine water quality, the fall-pipe vessel will be deployed for the construction phase. New statements are as follows: "**<u>Installation of scour protection will be carried out by fall-pipe vessel to alleviate the influence on marine water quality during construction.</u>**"

ii In addition to marine water quality monitoring during the construction phase: "For turbines using SBJ in CHW22, 1 turbine will be selected from each row (east-west direction) where its underwater environment around the foundation will be observed by using ROV, which is capable of transmitting images to the installation vessels on real time bases, during the installation of SBJ. This is meant to understand if there is disturbance to the seabed during SBJ installation and thus affect water quality in the surrounding area."

iii In this amendment, "All marine spread on this Project will use fuel with the least sulfur content **(<0.5%)** available in Taiwan at that time" is proposed.

III. Construction Phase Onshore Environmental Protection Measure

The environmental protection measure for "air quality" during the construction phase, specifically, the length of roadway to be cleaned have been increased from the original EIS commitment, and a commitment to require the onshore construction equipment and vehicles to comply with the Self-Management Label Program decreed by the EPA is added. Amended wording are described as follows:

i During the construction phase, a total of **<u>1km</u>** roadway to the front and rear of the construction site will be swept and cleaned to mitigate dust fall from the passage of construction and transportation vehicles (except for days of precipitation).

ii During construction, onshore construction equipment and vehicles will comply with Class 4 environmental standards (or above), and possess Grade A Self Management Label. The aforementioned requirements will be integrated into the contracts for the construction subcontractors.

IV. Operation Phase Offshore Environmental Protection Measure – Marine Ecology

Amendment text: During underwater filming, the presence of marine reptiles will also be monitored.

V. Operation Phase Environmental Impact Mitigation Measure- Waste

The mitigation measures for waste generated from the operational phase have been added, as shown below:

"This Project has committed not to bury turbine blades during the decommissioning. In the future, the Project will participate blade recycling-related initiatives to monitor all possible recycling methods and adopt them where possible to improve the sustainability of wind turbines. These initiatives include finding common solutions through cooperating with other companies and organizations, or participating in research and innovation projects focused on recycling blade materials. If a suitable solution is not found during the decommissioning, the Project has also committed to legitimately store blades temporarily rather than landfill. This commitment is incorporated as part of the mitigation measures that will be provided, at least 1 year before official decommissioning, to the competent authority for approval."

VI. Environmental Monitoring Plan

i According to the air quality monitor station in the originally approved "Environmental Monitoring Plan for the Construction Phase", this amendment will add a pre-construction air quality survey at the same monitoring stations in the aforementioned plan. Survey items will include wind direction, wind speed, particulate matter (TSP, PM_{10}, $PM_{2.5}$), SO_2, nitrogen oxides (NO, NO_2), and **O_3.** The environmental monitoring plans during the construction phase before and after the amendment are as shown in Table 7-2 to Table 7-3.

ii Ozone and Underwater Filming at OSS have been added to the construction phase environmental monitoring plan. The construction environmental monitoring plan before and after the amendment are as shown in Table 7-4 to Table 7-5.

iii "Response measures regarding loss of UNM device and data during retrieval" is added as footnotes under the UNM item in pre-construction, construction and operation phases, as shown in Table 7-4 and 7-5.

iv Contingency measures for poor sea state that continue for extended period during the pre-construction, construction and operation phases are added to the environmental monitoring plan. The pre-construction, construction and operation environmental monitoring plans before and after the amendment are as shown in Table 7.2 to Table 7.7.

v "Marine Reptile Monitoring" is added to the environmental monitoring plan for cetaceans during the pre-construction, construction and operation phases. The pre-construction, construction and operation environmental monitoring plans before and after the amendment are as shown in Table 7-2 to Table 7-7.

Table 7-1 Comparison of Environmental Protection Measures and Monitoring Plans Before and After this Amendment

Item		Original Content	This Amendment
Environmental protection measures	Construction phase-Cetacean	Pin-pile jackets will be selected for as the foundation for the wind turbines used for this Project, as they are expected to produce less noise.	**Pin-pile or Suction Bucket Jacket** will be selected for as the foundation for the wind turbines used for this Project, as they are expected to produce less noise.
		"to have a bigger detection area regarding cetacean activities, four PAM devices will be deployed at appropriate locations 750m from the piling location" and "underwater noise monitoring campaign will be carried out once at 750m from piling during pile driving campaign."	"to have a bigger detection area regarding cetacean activities, 4 PAM device will be deployed in proper locations 750m from **the centre of the jacket as the reference point**" and "underwater noise monitoring campaign will be carried out once at 750m **from the center of jacket** during pile driving campaign."
		The best commercially available noise control method at the time of development will be applied during pile driving to all of the wind turbine locations, to ensure the noise levels at the 750m warning zone is below SEL 160dB. Details of the noise mitigation measures to be used will be determined before the pile driving campaign commences, including consideration of the latest noise reduction technology available at that time, such as bubble curtain or balloon curtains.	The best commercially available noise control method at the time of development will be applied during pile driving to all of the wind turbine locations, to ensure the noise levels at the 750m warning zone is below SEL 160dB. Details of the noise mitigation measures to be used will be determined before the pile driving campaign commences, including consideration of the latest noise reduction technology available at that time, such as bubble curtain or balloon curtains. **Additionally, the sound exposure level (SEL) of 25% of all foundations to be installed at 750m distance to the center of jacket shall be lower than 159dB.**

Table 7-1 Comparison of Environmental Protection Measures and Monitoring Plans Before and After this Amendment (Continued)

<table>
<tr><th colspan="2">Item</th><th>Original Content</th><th>This Amendment</th></tr>
<tr><td rowspan="4">Environmental protection measures</td><td rowspan="2">Construction phase-Cetacean</td><td>–</td><td>"157 dB SEL of single piling event, measured as 30 second average, is set as early warning level during the pile installation." As the noise monitoring shows that the early warning level is exceeded, proper responses (e.g. lower the hammer energy(kJ), decrease the frequency of piling) alongside enhanced mitigation measures such as increase the air supply of bubble curtain, if necessary, will be taken to make sure the noise level is lower than the limit described in EIA commitment.</td></tr>
<tr><td>The project commits that the underwater noise exposure value (Sound Exposure Level, SEL) shall not exceed 160 decibels [(dB) re. $1\mu Pa^2s$] as the impact assessment threshold.</td><td>95% of the underwater noise measurement data (SEL_{05}) shall not exceed 160dB and SPLpeak shall not exceed 190dB at 750m to the center of jacket where the underwater noise monitoring is carried out.</td></tr>
<tr><td rowspan="2">Construction phase-Marine water quality</td><td>–</td><td>Installation of scour protection will be carried out by fall-pipe vessel to alleviate the influence on marine water quality during construction.</td></tr>
<tr><td>–</td><td>For turbines using SBJ, one turbine location will be selected from each row (east-west direction) where its underwater environment around the foundation will be observed by using a Remotely Operated Vehicle (ROV), which is capable of transmitting images to the installation vessel in real-time, during the installation of SBJ. This is meant to understand if there is disturbance to the seabed during SBJ installation and thus affect water quality in the surrounding area.</td></tr>
</table>

Table 7-1 Comparison of Environmental Protection Measures and Monitoring Plans Before and After this Amendment (Continued)

Item		Original Content	This Amendment
Environmental protection measures	Construction phase- Air quality	During the construction phase, a total of **100m** roadway to the front and rear of the construction site will be swept and cleaned to mitigate dust fall from the passage of construction and transportation vehicles (except for days of precipitation).	During the construction phase, a total of **1km** roadway to the front and rear of the construction site will be swept and cleaned to mitigate dust fall from the passage of construction and transportation vehicles (except for days of precipitation).
		All marine spread will use fuel with the minimum sulfur content available in Taiwan at the time.	All marine spread will use fuel with the minimum sulfur content **(<0.5%)** available in Taiwan at the time.
		—	**During construction, onshore construction equipment and vehicles will comply with Class 4 environmental standards (or above), and possess Grade A Self Management Label. The aforementioned requirements will be integrated into the contracts for the construction subcontractors.**
	Operation phase- Marine ecology	—	**During underwater filming, the presence of marine reptiles will also be monitored.**
Environmental protection measures	Operation phase- Waste	—	**This Project has committed not to bury turbine blades during the decommissioning. In the future, the Project will participate blade recycling-related initiatives to monitor all possible recycling methods and adopt them where possible to improve the sustainability of wind turbines. These initiatives include finding common solutions through cooperating with other companies and organizations, or participating in research and innovation projects focused on recycling blade materials.** **If a suitable solution is not found during the decommissioning, the Project has also committed to legitimately store blades temporarily rather than landfill.** **This commitment is incorporated as part of the mitigation measures that will be provided, at least 1 year before official decommissioning, to the competent authority for approval.**
Environmental Monitoring Plan	Pre-construction phase	—	**Based on the air quality monitor locations provided in the "Construction Environmental Monitoring Plan", an additional survey will be carried out for particulate matter (TSP 、 PM_{10} 、 $PM_{2.5}$), SO_2, NO_x (NO、NO_2), O_3 before construction.**

Table 7-1 Comparison of Environmental Protection Measures and Monitoring Plans Before and After this Amendment (Continued)

Item		Original Content	This Amendment
Environmental Monitoring Plan	Construction phase	Monitoring items: Wind direction, wind speed, particulate matter (TSP, PM_{10}, $PM_{2.5}$), SO_2, and nitrogen oxides (NO, NO_2).	Monitoring items: Wind direction, wind speed, particulate matter (TSP, PM_{10}, $PM_{2.5}$), SO_2, nitrogen oxides (NO_X, NO, NO_2), and **O_3**.
		Underwater filming to monitor for fish gathering effect (monitor location: at the foundation of a one selected turbine)	Underwater filming to monitor for fish gathering effect (monitor location: at the foundation of a one selected turbine **and one Offshore Substation)**.
	Construction and operation phase	—	Additional explanation around "**responses to lost of underwater noise measurement devices and data during retrieval**" during pre-construction, construction and operation period is added alongside "**response measures for poor sea state that continue for extended period of time**".
		Monitoring item: Cetacean ecology surveys	Monitoring item: Cetacean **(incl. marine reptile monitoring)**

Table 7-2 Environmental Monitoring Plan during the Pre-construction Phase before the Amendment

Category	Items	Sites	Frequency
Marine ecology	Cetacean ecology survey	Project site	20 trips/year. 1 year before the construction
Underwater noise (including PAM)	Underwater noise 20 Hz-20kHz. Spectrogram, 1-Hz band, 1/3 Octave band analysis	2 stns within Wind Farm Area	4 quarter/year, 30 days per survey. (note)
Marine water quality	Water temperature, pH value, BOD, Salinity, Dissolved Oxygen, Ammonia-N, Nutrients, Suspended Solid, Chlorophyll a, Coliform group	12 stns in the area near the wind farm	Once every quarter
Bird ecology	Species, number, habiting and flying activity, flying routes, seasonal flock change etc. (including coastal birds and shore birds)	Vicinity of wind farm and coastal area near the landfall	Once per month from March to November and once between December and February. 10 survey trips annually.
	Bird radar survey (vertical and horizontal)	Project site	Quarterly 2 years before the construction (at least 5 days/times in spring, summer and fall; survey is subject to change in winter due to the weather. Each survey will cover daytime and nighttime)
	Bird satellite tracking	Coastal area of Changhua	Carry out in each season before the construction
Cultural heritage	Interpretation of underwater cultural assets	Drilling at turbine location	Archeologist will help with the interpretation (drilling at turbine location before the construction)
	Interpretation of cultural assets	Drilling at onshore substation location	Archeologist will help with the interpretation (drilling at 3 locations in minimum)

Note 1：The onshore monitoring (interpretation of cultural assets) starts before the beginning of the construction (expected to be Q1 2023), and the monitoring period will follow the associated requirements (expected to be from 2018 to Q1 2023).

Note 2：The offshore monitoring (marine ecology, UNM, marine water quality, bird ecology, underwater cultural interpretation) starts before the beginning of the offshore construction (expected to be 2025 Q1), and the monitoring period will follow the associated requirements (expected to be from 2023 Q1 to 2025 Q1).

Table 7-3 Environmental Monitoring Plan during the Pre-construction Phase After the Amendment

Category	Items	Sites	Frequency
Air Quality	**Wind direction, wind speed,** particulate matter **(TSP, PM_{10}, $PM_{2.5}$), SO_2, nitrogen oxides (NO, NO_2), O_3**	**1. Wuqi Fishing Harbor 2.One station near onshore substation**	**Once before the construction**
Marine ecology	Cetacean ecology survey **(including marine reptiles)**	Project site	20 trips/year. 1 year before the construction
Underwater noise (including PAM)	Underwater noise 20 Hz-20kHz. Spectrogram, 1-Hz band, 1/3 Octave band analysis	2 stn. within Wind Farm Area	4 quarter/year, 30 days per survey. **(note 3)**
Marine water quality	Water temperature, pH value, BOD, Salinity, Dissolved Oxygen, Ammonia-N, Nutrients, Suspended Solid, Chlorophyll a, Coliform group	12 stations in the area near the wind farm	Once every quarter, conduct for one year before construction
Bird ecology	Species, number, habiting and flying activity, flying routes, seasonal flock change etc. (including coastal birds and shore birds)	Vicinity of wind farm and coastal area near the landfall	Once per month from March to November and once between December and February of the following year. 10 survey trips annually.
	Bird radar survey (vertical and horizontal)	Project site	Quarterly for 2 years before the construction (at least 5 days/times in spring, summer and fall; survey is subject to change due to the weather in winter. Each survey will include daytime and nighttime survey)
	Bird satellite tracking	Coastal area of Changhua	Once per season before construction, for a total of four seasons
Cultural heritage	Interpretation of underwater cultural assets	Drilling at turbine location	Professional archeologist will help with the interpretation (drilling at each turbine location before construction)
	Interpretation of cultural assets	Drilling at onshore substation location	Archeologist will help with the interpretation (drilling at 3 locations at a minimum)

Note 1：The onshore monitoring (onshore air quality and cultural assets) starts before the beginning of the terrestrial construction (onshore substation and onshore cable construction, expected to be Q1 2023), and the monitoring period will follow the associated requirements (expected to be from 2018 to Q1 2023).

Note 2：The offshore monitoring (marine ecology, UNM, marine water quality, bird ecology, underwater cultural interpretation) starts before the beginning of the offshore construction (expected to be 2025 Q1), and the monitoring period will follow the associated requirements (expected to be from 2023 Q1 to 2025 Q1).

Note 3:

(1) For this project, ideally the underwater acoustic survey team will deploy underwater measurement devices at the beginning of each quarter. If sea state allows, devices will be retrieved as soon as possible after 30 days of continuous monitoring.

(2) If the underwater measurement devices are found to be lost during retrieval, a proof of survey execution have to be provided for clarification.

(3) If sea state allows, a supplemental underwater noise survey will be conducted as soon as possible, to ensure that the data can be retrieved. Following deployment, once the survey instrument has measured a period of 24 hours, the instrument will be retrieved from each deployed location.

(4) To ensure the safety of monitoring personnel and vessel, if sea state suddenly worsens, the vessel will return back to the harbor on standby.

(5) If the contingency measure is conducted, the activity will be documented and explained.

Note 4: **During the offshore monitoring phase, the Central Weather Bureau sea state system or common international weather forecast systems (incl. Windguru, Windy, ECMWF) will be used as reference, in consideration of safety for vessel and personnel. In principle, surveys will only be conducted during periods of wave height ≦1m for 24 continuous hours. If the time required for conducting the required amount of surveys in the given month or quarter is not available, the remaining surveys for the that month or quarter will be suspended.**

Table 7-4 Environmental Monitoring Plan during the Construction Phase before the Amendment

<table>
<tr><th colspan="2">Category</th><th>Items</th><th>Sites</th><th>Frequency</th></tr>
<tr><td rowspan="5">Onshore</td><td>Air quality</td><td>Wind direction, wind speed, particulate matter (TSP, PM_{10}, $PM_{2.5}$), SO_2, and nitrogen oxides (NO, NO_2).</td><td>1. Wuqi Fishing Harbor
2.One station near onshore substation</td><td>Once every quarter</td></tr>
<tr><td>Noise vibration</td><td>L_{eq} and day-night average vibration level in each time period (day, evening, night)</td><td>1. One station at sensitive area near onshore construction
2. One station at the entrance / exit of onshore construction site</td><td>Once for 24 continuous hours per quarter</td></tr>
<tr><td>Terrestrial ecology</td><td>Ecology of terrestrial animal and plantation (According to EPA's technical regulation on animal/plant survey)</td><td>Onshore transmission cable system (including substation, onshore cable and vicinity)</td><td>Once every quarter</td></tr>
<tr><td>Construction noise</td><td>1. Low frequency (measure L_{eq} at 20Hz-200Hz)
2. Normal frequency (measure L_{eq} and L_{max} at 20Hz-20kHz)</td><td>1. One station near the onshore substation
2. One station in close proximity of the onshore cable construction</td><td>Once every month</td></tr>
<tr><td>Cultural heritage</td><td>Onshore archeological monitoring</td><td>Excavation extents</td><td>Monitored by professional archeologists during excavation</td></tr>
<tr><td rowspan="9">Offshore</td><td>Marine water quality</td><td>Water temperature, pH value, BOD, Salinity, Dissolved Oxygen, Ammonia-N, Nutrients, Suspended Solid, Chlorophyll a, Coliform group</td><td>12 stations in close proximity to the wind farm</td><td>Once every quarter</td></tr>
<tr><td>Bird ecology</td><td>Species, number, habiting and flying activity, flying routes, seasonal flock change etc. (including coastal birds and shore birds)</td><td>Vicinity of wind farm and coastal area near the landfall</td><td>Once per month from March to November and once between December and February (of the following year). 10 survey trips annually.</td></tr>
<tr><td rowspan="5">Marine ecology</td><td>1. Intertidal ecology</td><td>Within 50m on both sides of cable landfall</td><td rowspan="2">Once every quarter</td></tr>
<tr><td>2. Plankton, Fish Egg and Larvae, Benthic Organisms</td><td>12 station spots near the wind turbines</td></tr>
<tr><td>3. Fish</td><td>3 survey lines</td><td>Once every quarter</td></tr>
<tr><td>4. Cetacean</td><td>Project Site</td><td>20 trips each year (at least 1 trip each quarter)</td></tr>
<tr><td>5. Underwater filming to observe fish gathering effect at bottom of turbines</td><td>1 selected wind turbine</td><td>Once before and after piling</td></tr>
<tr><td rowspan="2">Underwater noise</td><td rowspan="2">Underwater noise 20 Hz-20kHz. Spectrogram, 1-Hz band, 1/3 Octave band analysis</td><td>4 locations 750m from turbine piling location</td><td>Once during piling of each turbine</td></tr>
<tr><td>2 stn. within Project Site</td><td>4 quarter/year, 30 days per survey. (note)</td></tr>
</table>

Note:

(1). Monitoring for construction noise will be conducted during construction for the onshore substation and onshore cable.

(2). Onshore monitoring items (air quality, noise and vibration, onshore ecology) will be conducted during the onshore construction phase.

(3). Offshore monitoring items (marine water quality, offshore bird, marine ecology, underwater noise) will be conducted during the offshore construction phase.

Table 7-5 Environmental Monitoring Plan during the Construction Phase after the Amendment

<table>
<tr><th colspan="2">Category</th><th>Items</th><th>Sites</th><th>Frequency</th></tr>
<tr><td rowspan="5">Onshore</td><td>Air quality</td><td>Wind direction, wind speed, particulate matter (TSP, PM_{10}, $PM_{2.5}$), SO_2, nitrogen oxides (NO, NO_2), and **O_3.**</td><td>1. Wuqi Fishing Harbor
2.One station near onshore substation</td><td>Once every quarter</td></tr>
<tr><td>Noise vibration</td><td>L_{eq} and day-night average vibration level in each time period (day, evening, night)</td><td>1. One station at sensitive area near onshore construction
2. One station at the entrance / exit of onshore construction site</td><td>Once for 24 continuous hours per quarter</td></tr>
<tr><td>Terrestrial ecology</td><td>Ecology of terrestrial animal and plantation (According to EPA’s technical regulation on animal/plant survey)</td><td>Onshore transmission cable system (including booster station, onshore cable and vicinity)</td><td>Once every quarter</td></tr>
<tr><td>Construction noise</td><td>1. Low frequency (measure L_{eq} at 20Hz-200Hz)
2. Normal frequency (measure L_{eq} and L_{max} at 20Hz-20kHz)</td><td>1. One station near the onshore substation
2. One station in close proximity of the onshore cable</td><td>Once every month</td></tr>
<tr><td>Cultural heritage</td><td>Onshore archeological monitoring</td><td>Excavation area</td><td>Monitored by professional archeologists during excavation</td></tr>
<tr><td rowspan="10">Offshore</td><td rowspan="2">Marine water quality</td><td>Water temperature, pH value, BOD, Salinity, Dissolved Oxygen, Ammonia-N, Nutrients, Suspended Solid, Chlorophyll a, Coliform group</td><td>12 stns near the wind farm</td><td>Once every quarter</td></tr>
<tr><td>Suspended Solid</td><td>Choose 1 OSS and 3 WTG (1 WTG each row) and conduct monitoring 500m upstream and downstream</td><td>Once during construction of scour protection</td></tr>
<tr><td>Bird ecology</td><td>Species, number, habiting and flying activity, flying routes, seasonal flock change etc. (including coastal birds and shore birds)</td><td>Vicinity of wind farm and coastal area near the landfall</td><td>Once per month from March to November and once between December and February. 10 survey trips annually.</td></tr>
<tr><td rowspan="5">Marine ecology</td><td>1. Intertidal ecology</td><td>Within 50m of both sides of cable landfall</td><td rowspan="2">Once every quarter</td></tr>
<tr><td>2. Plankton, Fish Egg and Larvae, Benthic Organisms</td><td>12 spots near wind turbines</td></tr>
<tr><td>3. Fish</td><td>3 survey lines</td><td>Once every quarter</td></tr>
<tr><td>4. Cetacean **(incl. marine reptile monitoring)**</td><td>Wind Farm Area</td><td>20 trips each year (at least 1 trip each quarter)</td></tr>
<tr><td>5. Underwater filming to observe fish gathering effect at bottom of turbines</td><td>2 selected wind turbine **and 1 OSS**</td><td>Once before and after piling</td></tr>
<tr><td rowspan="2">Underwater noise</td><td rowspan="2">Underwater noise 20 Hz-20kHz. Spectrogram, 1-Hz band, 1/3 Octave band analysis</td><td>4 locations 750m from piling</td><td>Once during piling of each turbine</td></tr>
<tr><td>2 stn. within Wind Farm Area</td><td>4 quarter/year, 30 days per survey. **(note2)**</td></tr>
</table>

Table 7-5 Environmental Monitoring Plan during the Construction Phase after the Amendment (Cont.)

Note 1 : (1). Monitoring for construction noise will be conducted during construction for the onshore substation and onshore cable. (2). Onshore monitoring items (air quality, noise and vibration, onshore ecology) will be conducted during the onshore construction phase. (3). Offshore monitoring items (marine water quality, offshore bird, marine ecology, underwater noise) will be conducted during the offshore construction phase. Note 2 : **(1) For this project, ideally the underwater acoustic survey team will deploy underwater measurement devices at the beginning of each quarter. If sea state allows, devices will be retrieved as soon as possible after 30 days of continuous monitoring.** **(2) If the underwater measurement devices are found to be lost during retrieval, a proof of survey execution have to be provided for clarification.** **(3) If sea state allows, a supplemental underwater noise survey will be conducted as soon as possible, to ensure that the data can be retrieved. Following deployment, once the survey instrument has measured a period of 24 hours, the instrument will be retrieved from each deployed location.** **(4) To ensure the safety of monitoring personnel and vessel, if sea state suddenly worsens, the vessel will return back to the harbor on standby.** **(5) If the contingency measure is conducted, the activity will be documented and explained.** Note 3:**During the offshore monitoring phase, the Central Weather Bureau sea state system or common international weather forecast systems (incl. Windguru, Windy, ECMWF) will be used as reference, in consideration of safety for vessel and personnel. In principle, surveys will only be conducted during periods of wave height ≦1m for 24 continuous hours. If the time required for conducting the required amount of surveys in the given month or quarter is not available, the remaining surveys for the that month or quarter will be suspended**

Table 7-6 Environmental Monitoring Plan during the Operation Phase before the Amendment

Category	Items	Sites	Frequency
Bird ecology	Species, number, habiting and flying activity, flying routes, seasonal flock change etc. (including coastal birds and shore birds)	Vicinity of wind farm and coastal area near the landfall	Once a month between March-November, once between December – February (of following year), 10 times each year (For offshore bird surveys in winter, survey will be vessel-based or supplemented with equipment such as video recording device)
	Joint monitoring system for birds (install thermography, sonic microphone, and high efficiency radar, or "high-tech" monitoring systems of the time)	1 WTG location	Continuous monitoring
	Bird footage (Install filming equipment)	2 locations within Project Site	Continuous monitoring
Marine ecology	1. Plankton 2. Fish Egg and Larvae 3. Benthic Organisms	12 stations near wind turbines	Once every quarter
	4. Fish (incl. species distribution and abundance near WTG)	3 survey lines	Once every quarter
	5. Cetacean	Project Site	20 trips each year
	6. Underwater filming to observe fish gathering effect at bottom of turbines	2 selected wind turbines	Once every quarter during operation phase, for at least 6 years
Underwater noise	Underwater noise 20 Hz-20kHz. Spectrogram, 1-Hz band, 1/3 Octave band analysis	2 stn. within Project Site	4 quarter/year, 30 days per survey (note)
Fishery economy	Compile data relevant to fishery economy within the annual fishery report announced by the FA (Fishery environment, facility, productivity, and population)	Annual fishery report announced by the FA (Changhua County)	Once every year

Note :
Before terminating the monitoring during the operation phase, application need to be carried out in accordance with Article 37 of the Environmental Impact Assessment Act Enforcement Rules.

Table 7-7 Environmental Monitoring Plan during the Operation Phase after the Amendment

Category	Items	Sites	Frequency
Bird ecology	Species, number, habiting and flying activity, flying routes, seasonal flock change etc. (including coastal birds and shore birds)	Vicinity of wind farm and coastal area near the landfall	Once a month between March-November, once between December-February (of the following year), 10 times each year (For offshore bird surveys in winter, survey will be vessel-based or supplemented with equipment such as video recording device)
	Joint monitoring system for birds (install thermography, sonic microphone, and high efficiency radar, or better monitoring systems of the time)	1 WTG location	Continuous monitoring
	Bird footage (Install filming equipment)	2 locations within Project Site	Continuous monitoring
Marine ecology	1. Plankton 2. Fish Egg and Larvae 3. Benthic Organisms	12 stations near wind turbines	Once every quarter
	4. Fish (incl. species distribution and abundance near WTG)	3 survey lines	Once every quarter
	5. Cetacean **<u>(incl. marine reptile monitoring)</u>**	Project Site	20 trips each year
	6. Underwater filming to observe fish gathering effect at bottom of turbines	2 selected wind turbine	Once every quarter during operation phase, for at least 6 years
Underwater noise	Underwater noise 20 Hz-20kHz. Spectrogram, 1-Hz band, 1/3 Octave band analysis	2 stn. within Project Site	4 quarter/year, 30 days per survey **<u>(note2)</u>**
Fishery economy	Compile data relevant to fishery economy within the annual fishery report announced by the FA (Fishery environment, facility, productivity, and population)	Annual fishery report announced by the FA (Changhua County)	Once every year

Note 1 :Before terminating the monitoring during the operation phase, application need to be carried out in accordance with Article 37 of the Environmental Impact Assessment Act Enforcement Rules.

Note 2 :

<u>(1) For this project, ideally the underwater acoustic survey team will deploy underwater measurement devices at the beginning of each quarter. If sea state allows, devices will be retrieved as soon as possible after 30 days of continuous monitoring.</u>

<u>(2) If the underwater measurement devices are found to be lost during retrieval, a proof of survey execution have to be provided for clarification.</u>

<u>(3) If sea state allows, a supplemental underwater noise survey will be conducted as soon as possible, to ensure that the data can be retrieved. Following deployment, once the survey instrument has measured a period of 24 hours, the instrument will be retrieved from each deployed location.</u>

<u>(4) To ensure the safety of monitoring personnel and vessel, if sea state suddenly worsens, the vessel will return back to the harbor on standby.</u>

<u>(5) If the contingency measure is conducted, the activity will be documented and explained.</u>

<u>Note 3: During the offshore monitoring phase, the Central Weather Bureau sea state system or common international weather forecast systems (incl. Windguru, Windy, ECMWF) will be used as reference, in consideration of safety for vessel and personnel. In principle, surveys will only be conducted during periods of wave height ≦1m for 24 continuous hours. If the time required for conducting the required amount of surveys in the given month or quarter is not available, the remaining surveys for the that month or quarter will be suspended.</u>

Chapter 8 Other Issues Assigned by the Competent Authority

According to Article 38 of “Environmental Impact Assessment Guidelines for Development Activities (revised and decreed by the EPA on 8th December 2017),” if hazardous chemicals are likely used or produced during the development activity, the developer shall conduct a human health risk assessment by following technical guidance on human health risk assessment. The assessment will need to be included in the preliminary draft of EIS or EIA. However, only maximum turbine capacity is adjusted, new turbine foundation is added, cable landing approach, onshore transmission system and offshore substation design, and mitigation measures / environmental monitoring plan are adjusted. Therefore, no hazardous chemicals, as stated in Article.3 of “Technical Guidance on Human Health Risk Assessment (revised and decreed on 20th July 2011)” will be used or produced due to the amendment proposed. No extra risk is expected to be brought to residents in the nearby areas. It is not necessary to conduct human health risk assessment.